Joint Sawing Practices And Effects on Durability

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16. Abstract

Joint deterioration has become a renewed concern for concrete pavements in Northern climates. Recently, a large number of relatively young pavements (less than 20 years) have experienced premature joint deterioration requiring disproportionately high amounts of maintenance. While specifications and testing help to identify d-cracking aggregates, optimize mixtures for low shrinkage and permeability, utilize advanced air testing techniques, and help determine potential deicer issues; the current joint deterioration problem spans many states and concrete mixtures and has the potential, if left unchecked, to seriously damage the reputation of concrete pavements as durable, low maintenance options.

This research report presents findings from joint durability studies conducted on test specimens extracted from two research test sections specifically built with southern limestone and northern igneous gravel as the predominant coarse aggregates. Transverse saw cuts were made with conventional and early entry saws using a variety of blade types and post-construction timing intervals. Sections sawn early in the timing window exhibited physical damage to the aggregate and concrete. Sections sawn with old/worn saw blades were more absorptive to water and exhibited more variability. Silane treatment of the joints provided significant reduction in water absorption. The concrete mixtures were freeze-thaw durable to 300 cycles and had acceptable performance to 600 cycles. Surface deicer scaling was not influenced by sawing factors. The application of silane did not reduce chloride penetration for the limestone mixture but did reduce penetration by 50% for the gravel mixture.

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Executive Summary

Wisconsin has recently seen a large number relatively young concrete pavements experiencing premature joint deterioration, requiring high amounts of maintenance. The overall objectives of this study were to investigate joint sawing techniques currently in use in Wisconsin and to assess the impacts of these techniques on the durability of the constructed pavement joints. To achieve these objectives, the following four tasks were performed:

Literature review: A literature review of the types and mechanisms of joint deterioration and the various types of joint sawing practices was conducted. Past studies on freeze-thaw degradation and the impact of deicing/anti-icing materials on concrete were also synthesized.

Field study: Four sites were visited for visual inspection and joint coring to help identify the relationship between joint sawing practices and concrete joint durability.

Test Sections: Two specific concrete pavement test sections were constructed to assess the impacts of joints sawing practices, including the type of saw used (conventional versus early-entry), the timing of sawing operations, the type and quality of the saw blade/equipment, the depth of the saw cut, the matching/mis-matching of saw blade type with predominant coarse aggregate (northern igneous gravels versus southern limestones), and the application of penetrating joint sealers.

Laboratory Testing: Laboratory tests were conducted on samples recovered from the joints of each constructed test section, including water absorption, freeze-thaw durability, and deicer scaling resistance.

A summary of key findings is as follows:

- Sawing early in the timing window using early entry equipment can cause physical damage to the aggregate and concrete. For limestone aggregate the damage occurred directly underneath the sawing shoe, while for granite aggregate a crack formed immediately outside the shoe.
- Differences in absorption caused by sawing timing, technique, and equipment can be observed. The mixture containing igneous gravels had less absorption than the limestone mixture. Sawing early in the timing window produced the lowest absorption only when sawn using a new blade appropriate for the aggregate. An old/worn blade produces higher absorption and more variability in all cases than the corresponding joint sawn at the same time with a new blade. Silane treatment of the joints provided significant reduction in absorption.
- The concrete mixtures used within the test sections were freeze-thaw durable to 300 cycles with no significant freeze-thaw deterioration at 300 cycles. Samples with statistically significant high or low absorption generally had acceptable performance through 600 cycles indicating that the field-produced concrete was of high quality, considered highly freeze-thaw durable, and not able to distinguish effectively the effects from sawing. The one condition to note was physical damage from early sawing did present distinguishable damage but only beyond 500 cycles.
- Surface deicer scaling was not influenced by sawing factors. The limestone mixture performed worse than the granite mixture, with both significantly improved by the application of a topical silane sealer. The application of silane did not reduce chloride

penetration for the limestone mixture but did reduce penetration by 50% for the granite mixture.

Recommendations

The following recommendations are provided on the basis of the analysis of this study:

- Sawing early in the early-entry sawing window should be discouraged. The minimum time to commence sawing should not result in any marring of the surface.
- The granite mixture was not impacted by the practical (concrete hard enough to support the equipment without marketing) range of sawing conditions. Other than practical saw timing, no equipment restrictions are recommended for similar granite mixtures.
- It is not acceptable or appropriate to use one type of saw blade for all cuts. Blades should be selected for the coarse aggregate present and used accordingly, especially for limestone aggregate.
- Worn blades cause measurable impact to concrete. Contractors should be required to maintain a blade log documenting blade type, depth and distance sawn.
- Early entry sawing equipment should only be allowable on mixtures containing predominantly granite coarse aggregate and should commence only when the concrete is sufficiently hard enough to prevent marring the surface timing/brooming and with minimal raveling, chipping, spalling, or otherwise damaging the pavement. The saws must have diamond blades with functioning blade guards and be equipped with guides or other devices to control cut alignment and depth
- The use of silane produced an improvement in deicer scaling from the test surface samples but worse performance on the joint face for the freeze-thaw core samples. Additional work is recommended before determining the effectiveness of silane in the field.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Joint deterioration has become a renewed concern for concrete pavements in Northern climates. Recently, a large number of relatively young pavements (less than 20 years) have experienced premature joint deterioration requiring disproportionately high amounts of maintenance. While specifications and testing help to identify d-cracking aggregates, optimize mixtures for low shrinkage and permeability, utilize advanced air testing techniques, and help determine potential deicer issues; the current joint deterioration problem spans many states and concrete mixtures and has the potential, if left unchecked, to seriously damage the reputation of concrete pavements as durable, low maintenance options.

This report presents findings from joint durability studies conducted on test specimens extracted from two research test sections specifically built with southern limestone and northern igneous gravel as the predominant coarse aggregates. Transverse saw cuts were made with conventional and early entry saws using a variety of blade types and post-construction timing intervals. The recovered joint specimens were tested for absorption, freeze-thaw durability, and resistance to deicing solutions.

Joint specimens were also recovered from in-service pavements at locations with and without noticeable signs of joint distress. Laboratory testing of absorption and air void distributions were completed to provide comparative measures to the research test sections and to provide additional insight into the field performance and joint durability.

1.2 Types and Mechanisms of Joint Deterioration

There are five primary kinds of joint deteriorations as discussed in the literature. The mechanism, presentation and preventive measures of these joint deteriorations are presented below. Saturated Frost Damage occurs due to expansion of water in the concrete capillaries when it freezes, as illustrated in Figures 1.2.1 and 1.2.2. Continuous cycles of freezing and thawing opens these cracks. These kind of frost damages occur mainly in the paste rather than the aggregates.

Water can be present in pavement system due to inadequate drainage or higher water table. A joint face can also be saturated when a seal fails to prevent water ingress (Taylor et al., 2012a). The ability of the concrete to resist freezing action decreases with the increasing saturation (Spragg et al., 2011), thus causing the damage. Deicing salts can augment frost deterioration. Calcium chloride and magnesium chloride present in deicing salts have a tendency of retaining water (Spragg et al., 2011).

Figure 1.2.1. Slivers from Freezing and Thawing Cycle (Taylor et al., 2012a)

Figure 1.2.2. Saturated Soils due to Inadequate Drainage and Roadside Irrigation (left) Leading to Joints Showing Frost Damage (right) (Source: Snyder and Associates)

Additionally there are some insignificant contributions from expansion of crystalizing salts (Taylor et al., 2012a) and chemical decomposition of calcium silicate hydrate in contact with salts such as magnesium chloride (McCullough et al., 2000). Frost deterioration is first observed as shadowing of a zone which extends a few inches on either side of a joint. A fine network of micro cracks develop near the joint which retain water. This gives rise to shadow effect. Secondary deposit of ettringite in the air void is also observed in many cases. This type of damage is found to be more evident in the saw cut than in the crack. The authors stated three primary strategies to reduce frost damage. By providing adequate drainage and joint seal, water saturation can be prevented. Concrete is provided with entrained small air bubbles that allows pressure relief for expanding water. Finally, use of low permeable concrete can reduce this type of frost damage.

Parallel cracks that form at approximately one inch increments starting from the joint face, known as incremental cracking, is illustrated in Figure 1.2.3. This type of damage also occurs in the paste. This deterioration may be due to exposure of coarse aggregate particles in the interfacial zone. When the joint is flooded, water penetrates and washes away the aggregates from the paste. According to the authors, validity of this hypothesis is still under ongoing investigation.

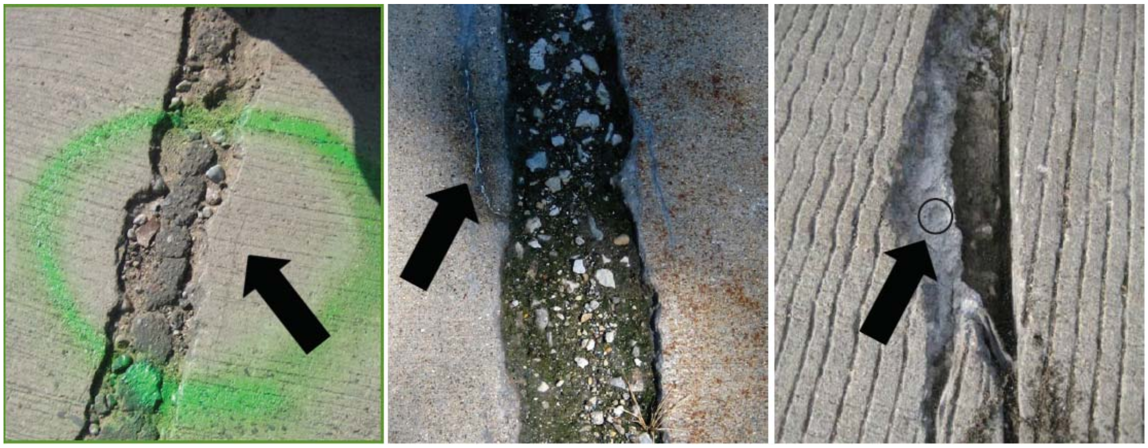

Figure 1.2.3. Incremental Cracking: Note (left to right) the crack parallel to the already patched face, the signs of water passing through the crack, and the exposed aggregate remaining in the concrete (Taylor et al., 2012a)

Incompressible materials like sand, rock and other debris develop localized stress while trapped in the joint and can give rise to mechanical damage, as shown in Figure 1.2.4. Aggregate particles can be dislodged during saw cutting due to the low concrete strength during conventional sawing. This type of spalling type damage is found on the surface and rarely extends through the depth of the slab. Damage during the saw cut may also occur due to worn out bearings or inappropriate blade selection (Taylor et al., 2012). This type of damage is not considered insignificant, as illustrated in Figure 1.2.5.

Figure 1.2.4. Incompressible Materials Causing Mechanical Damage, which can Lead to Further Distress (Taylor, et al. 2012b)

Figure 1.2.5. Raveling due to Poor Sawing Practice (Source: Iowa Department of Transportation)

Deterioration caused by expansion of frozen water inside some aggregate particles is known as D-cracking, as illustrated in Figure 1.2.6. This distress starts near joints and is typically more severe at the bottom of the slab. The preventive measures suggested by authors include use of aggregate materials that are not susceptible to freeze-thaw action. Furthermore, reducing maximum aggregate size can also prevent this type of deterioration.

Figure 1.2.6. D Cracking of High Severity (Source: The Transtec Group)

Differences in moisture content through the depth of the concrete slab may give rise to high stresses, resulting in horizontal cracking as illustrated in Figure 1.2.7. In regions where horizontal cracks intersect vertical cracks, delamination spalling can occur. The severity and timing of delamination spalling varies with the severity of moisture loss at an early age (McCullough et al., 2000). This type of damage is known as early age drying damage.

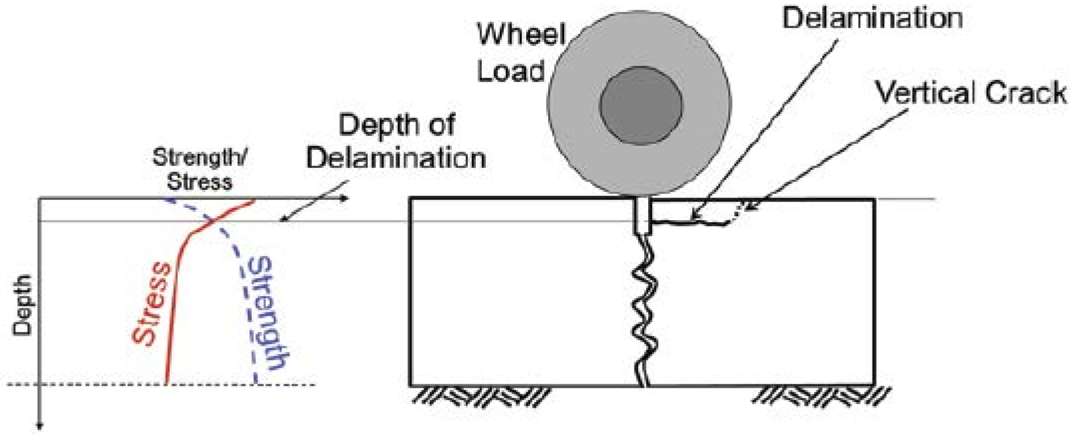

Figure 1.2.7. Early-Age Drying Stresses (left) and Resulting Vertical Cracking and Delamination Spalling (right) due to High Moisture Loss During Placement (Spragg et al., 2011)

1.3 Joint Sawing Techniques

While investigating the causes for premature joint deterioration, focus was emphasized on the recent changes in construction and maintenance techniques. Since the old pavements were found less susceptible to joint damage, even with high concentrations of deicing agents, the focus was shifted towards the joint sawing technique. The sawing plane is weak and develops a near vertical crack just under the saw cut. It also causes slab movement in response to change in temperature and moisture (Krstulovich et al., 2011). The timing of joint sawing is also critical. The ideal time for sawing action is when the concrete attains sufficient strength to allow sawing, but not too late so that internal stresses can cause random cracking (Okamoto et al., 1994).

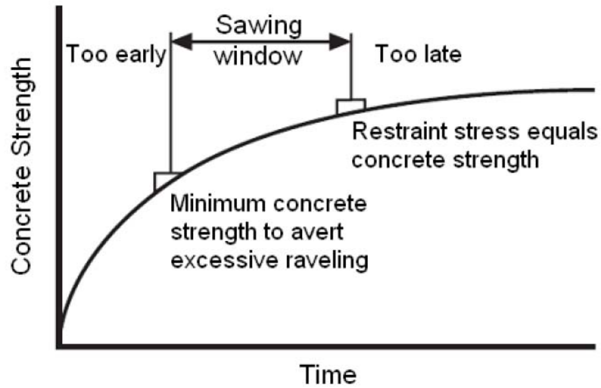

Figure 1.3.1. Concrete Sawing Window in Terms of Strength vs Time (Okamoto et al., 1994)

Conventionally, sawing action is initiated when the concrete reaches its setting period. Various factors like cement content, type, supplementary cementitious materials, admixtures, mixing temperature, and climatic conditions influence the success of sawing the joint in concrete pavements (Krstulovich et al., 2011). The conventional sawing window is typically from 4 hours to 12 hours after placement (Smith, 2007). A new technique, early entry sawing, was introduced in the late 1980s.

1.4 Early Entry Joint Sawing

Early entry joint sawing was introduced in the late 1980s. This technique was adopted in order to reduce the potential risk of early age cracking (Krstulovich et al., 2011). Early entry sawing may be commenced within one to four hours of placement without incurring excessive raveling (Smith, 2007). This type of sawing equipment is lighter than conventional sawing. It has been postulated that the saw cut can be shallower at an early age, taking advantage of the significant changes in moisture and temperature conditions at the surface of the slab to help initiate cracking below the saw cut (Zollinger, et al., 1994). Early entry sawing differs in operation from conventional sawing by being a dry-cut technique. Another significant difference between early conventional sawing is the type of blade used. In early entry sawing the concrete remains much younger. This soft and abrasive material requires a blade with hard, abrasion resistant matrix that firmly holds the embedded diamond cutting teeth to ensure they are fully utilized before shedding away. On the contrary, hardened concrete needs a blade with soft bond to allow for ready exposure of new, sharp diamond cutting teeth (Krstulovich et al., 2011).

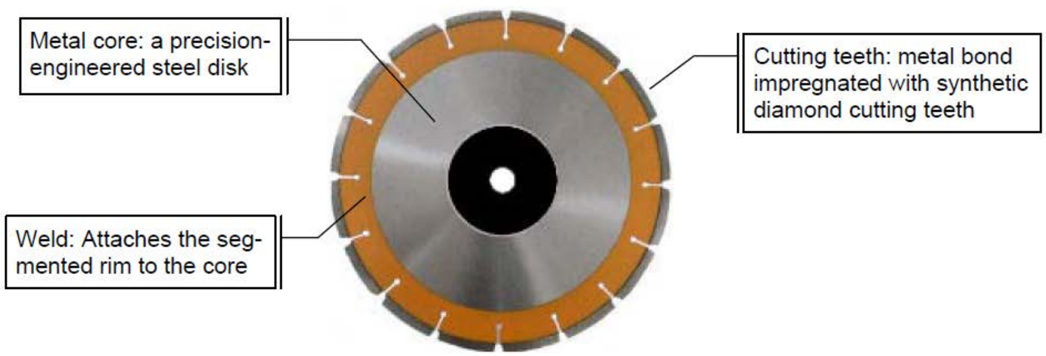

Figure 1.4.1. Concrete Cutting Saw Blade Diagram (Krstulovich et al., 2011)

Early entry saw cuts upward as it advances. It is equipped with an anti-ravel skid plate. Due to upward action of the saw blade, the relatively young concrete aggregates tend to move upward and displace. The skid plate is provided to hold the aggregate in place and prevent unravelling (Krstulovich et al., 2011). The blade is slotted into the skid plate. Initially the gap between blade and the slot edge is very narrow, however normal wear and tear can widen the gap significantly.

The American Concrete Institute (ACI) recommends that saw cuts using conventional equipment be at least one-fourth the slab depth or a minimum of 1 in., whichever is greater (Krstulovich et al., 2011). It also recommends that early entry saw cuts should be 1 to 1.25 inches deep. The reason behind this is the early timing allows joints to be made before significant tensile stress development. This increases the probability of cracks forming at the joint as intended when such stresses eventually do develop (Krstulovich et al., 2011).

1.5 State of Practice

The American Concrete Pavement Association (ACPA) online Database of State DOT Concrete Pavement Practices reports that at least 50 percent of U.S. state departments of transportation (DOTs) allow the use of early-entry sawing for transverse contraction joints (Krstulovich et al., 2011). Table 1.5.1 shows that most states still require conventional sawing depth. Most DOT transverse contraction joint specifications use guidelines similar to West Virginia's Standard Specifications for Roads and Bridges (Krstulovich et al., 2011).

> "Transverse contraction joints shall be sawed to the dimensions shown on the Plans. Initial sawing of joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excess raveling and before uncontrolled shrinkage cracking takes place, but no later than 24 hours after concrete placement. If necessary, sawing operations shall be continuous, through day and night, regardless of weather conditions. In general, all joints should be sawed in sequence. The sawing of any joint shall be omitted if cracking occurs at or near the joint location prior to the time of sawing. Sawing of a joint shall be discontinued when a crack develops ahead of the saw."

Table 1.5.1. State DOT Transverse Contraction Joint Sawing Specifications (Krstulovich et al., 2011)

State	Saw Cut Depth *D = pavement thickness*	Early-Entry Sawing Allowed	Joint Sealant Reservoir Width
Arizona	*D*/3	--	1/8 in.
Arkansas	*D*/3	Yes	3/8 – 1/2 in.
California	*D*/3	Yes	3/8 in.
Delaware	*D*/3	Yes	3/8 in.
Florida	*D*/3, *D*/4	--	1/4 in.
Georgia	*D*/4	Yes	1/4 in.
Hawaii	*D*/4	Yes	1/4 in.
Idaho	*D*/3	Yes	3/8 in.
Indiana	*D*/4	--	1/4 – 3/8 in.
Iowa	*D*/3, *D*/4	Yes	1/4 in.
Kansas	*D*/4 + 0.25 in.	Yes	3/8 in.
Michigan	*D*>7 in., *D*/3; *D*<7 in., *D*/4	--	1/4 in.; 9/16 in.
Minnesota	*D*/3, *D*/4	Yes	--
Missouri	*D*/3	Yes	3/8 in.
Montana	*D*/3	Yes	--
North Carolina	*D*/3 (3 in. min.)	Yes	3/8 in.
Nevada	*D*/3	--	3/8 in.
New York	*D*/3	Yes	10 mm
Ohio	*D*>10 in., *D*/3; *D*<10 in., *D*/4	@ 2-1/4 – 2-1/2 in.	1/2 in.
Oklahoma	*D*/3; 1-1/2 in.*	Yes	1/4 in.
Pennsylvania	*D*/3	Yes	3/8 in.
South Carolina	*D*/4	Yes	1/4 in.
South Dakota	*D*/4	Yes	3/8 in.
Tennessee	*D*/3	Yes	1/4 in.
Texas	*D*/3, *D*/4	--	3/8 in.
Utah	*D*/3	Yes	1/8 in.
Virginia	*D*/3	Yes	varies
Washington	*D*/3	Yes	3/16 – 5/16 in.
West Virginia	*D*/3	Yes	--
Wisconsin	*D*/3	Yes	--
Wyoming	*D*/3, *D*/4	@0.15T	1/8 – 3/8 in.

Most DOT contraction joint specifications include a provision for widening the joint for sealant materials after 72 hours of concrete placement. Also, any damage done to membrane curing compound cover is required to be repaired. Some DOTs make special requirements regarding use of early-entry sawing methods. Kansas, Nebraska, Ohio, Oklahoma, and Wyoming all specify that manufacturer recommendations be followed. Ohio, Oklahoma, and Wyoming also note sawing to approximately 1.5 inches deep when sawing early, unless otherwise recommended by the manufacturer. Furthermore, Oklahoma requires joints to be sawed to one-third of the slab thickness (T/3) if the shallow cut did not initiate cracking within 24 hours. South Carolina requires some raveling of the green concrete to prevent uncontrolled shrinkage cracking (Krstulovich et al., 2011). Wisconsin DOT recommends to begin sawing as soon as the concrete hardens sufficiently to prevent raveling and finish before the initiation of uncontrolled cracking. Hand tools are allowed for use in reducing the potential for early cracking. The skip method, in which every third joint is sawed as soon as possible, is allowed in the WisDOT standard specifications.

1.6 Initiation of Crack in Early Entry Sawed Joints

At the time of early entry sawing, the concrete has just attained initial set and is rapidly gaining strength as hydration products are being formed on the surface of cement grains. These products, usually calcium silicate hydrate or calcium hydroxide, lock the concrete though a porous network. Any disruption of this network at the microstructure level can cause permanent damage to the concrete. Micro-cracks may develop which allow inflow of water or deicing agents. In the presence of freezing and thawing environments this crack can lead to joint deterioration over time (Krstulovich et al., 2011).

During summer, pavement that is placed early is subjected to hot temperatures for a longer period, which increases the hydration of the concrete. The maximum temperature is reached in six to eight hours, after which it begins to drop. At this point the contraction stresses are initiated. These stresses cause pavements to crack. The maximum temperatures of pavements placed at later hours become lower and the contraction stresses gradually diminish, thus reducing the tendency to crack.

Water is not used in early entry sawing technique. The absence of water during sawing action can generate significant heat, which can affect the hydration of young concrete and result in a lowering of strength, which in turn increases the susceptibility of concrete to deicing agents. Furthermore, the skid plate which is used to hold the young concrete particle in place may impart enough downward pressure to initiate cracking at the micro-structure level. This would be true if the coarse aggregate is significantly hard (Krstulovich et al., 2011).

Although several authors suggested initiation of crack formation due to early entry sawing action, the actual reason for damage initiation is still unknown. Concrete near the cut or the crack itself, both has the potential to make a slab susceptible to deterioration. Further studies are required to identify whether it is the timing of sawing or the sawing action itself that causes a negative impact on the durability of the joint.

1.7 Freeze-Thaw Mechanism

Freezing point of water is a function of temperature and pressure. The variation of sizes of pores in concrete influences the freezing mechanism (Zhang, 2013). The water molecule shrinks as the temperature drops, however they expand below 4° C and convert to ice. This ice formation tends to exert pressure on pore walls and a tensile stress is developed. Under normal pressure, freezing temperatures in concrete pores decreases with the pore size, as illustrated in Figure 1.7.1.

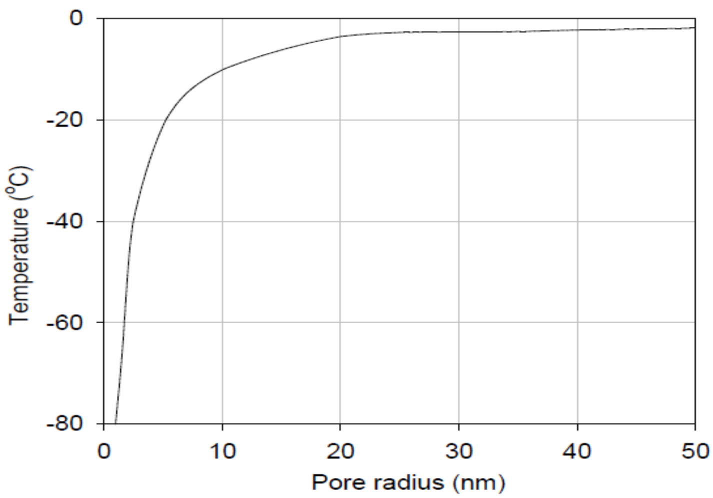

Figure 1.7.1. Relationship Between Capillary Pore Size and the Freeze Temperature (Zhang, 2013)

In the cavities, ice pushes the unfrozen water out into the surrounding network of pores. Ice forms a moving front and pushes water in front of it. This flow occurs under a pressure head and the resistance to the flow is proportional to the length of the flow path and diameter of the pores (Zhang, 2013). In some cases, instances may arise where the volume of the pore is insufficient, obstructing the flow of water. A hydraulic pressure may develop, which can exceed the tensile strength of the concrete and initiate cracking. Furthermore, the water movement during a freeze thaw cycle can enter into the micro cracks caused by excessive tensile stress. In the following freeze cycle, this water can cause cumulative damage to those micro-cracks (Zhang, 2013). The degree of saturation is also a contributing factor to freeze thaw damage in concrete. Figure 1.7.2 demonstrates the relationship between degree of saturation and freeze thaw durability. Concrete that reaches or exceeds the critical degree of saturation is damaged after as few as three to five freeze-thaw cycles, irrespective of the air content (Li, et. Al, 2012).

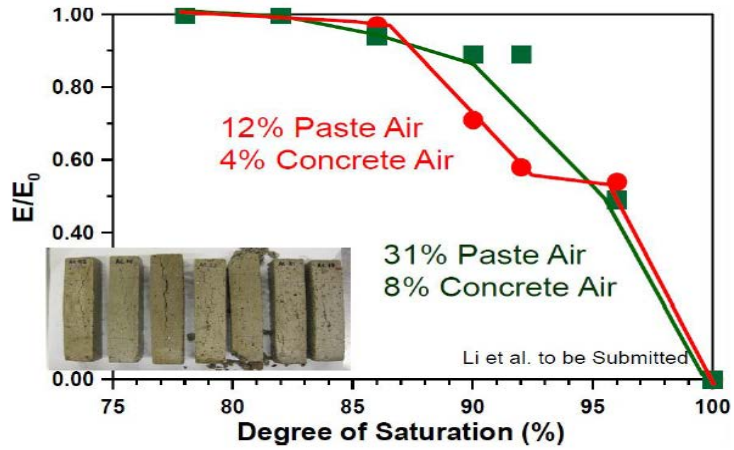

Figure 1.7.2. Relationship Between Degree of Saturation and Freeze-Thaw Durability (Li, et.al, 2012)

Capillary pore water contains alkalis and salts. Ice is produced from the pure water, leaving a concentrated alkali solution in the freezing site. The unfrozen water which is flowing through the pores will move toward the highly concentrated alkali solution in the freezing site as shown in Figure 1.7.3. This will generate an osmotic pressure in the pores. This osmotic pressure can augment the hydraulic pressure and contribute to crack formation (Zhang, 2013).

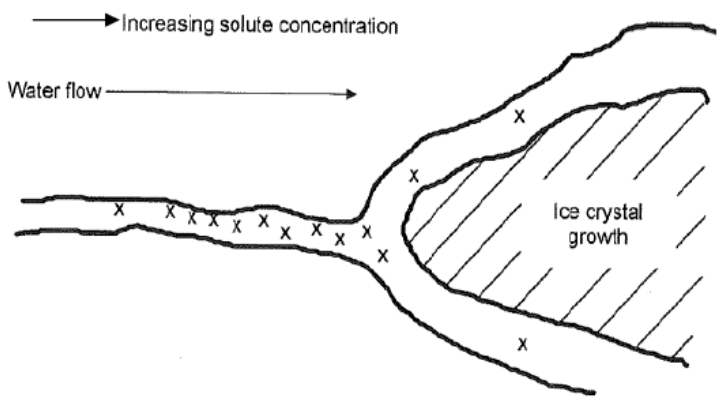

Figure 1.7.3. Conceptual Illustration of the Generation of Osmotic Pressure in Concrete Pores (Zhang, 2013)

1.8 Salt Scaling

Deicing salts are used in the cold region to keep the highway operational during winter. However, this practice of applying salt may lead to salt scaling in these regions, which is a superficial damage caused by the freezing of deicing solutions on the surface of concrete. It is a progressive damage and may remove small chips of binders with very few small aggregates. This phenomena is shown in Figure 1.8.1. Salt scaling makes the concrete susceptible to inflow of water and may also lead to exposure of coarse aggregates (Zhang, 2013).

Figure 1.8.1. Salt Scaled Concrete Surface (Zhang, 2013)

Salt crystallization is a mechanism that causes salt scaling. A supersaturated solution has more potential energy than a corresponding saturated solution. The excess potential energy can be utilized to perform work against an external restraining pressure when the solute crystallizes out of its supersaturated solution. It is not possible to initiate crystallization in unsaturated conditions. Crystals that grow under supersaturated conditions can create enough pressure to disrupt the bulk paste in confined spaces within concrete system (Zhang, 2013). Crystallization can also occur due to evaporation of water, as shown in Figure 1.8.2. Low relative humidity in the warmer weather can escalate evaporation. Salt crystal can grow from the deicing solution.

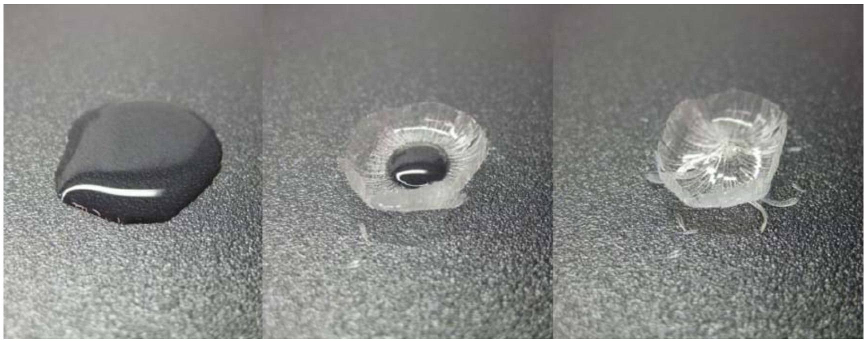

Figure 1.8.2. Salt Crystallization due to Evaporation of Liquid (Zhang, 2013)

1.9 Wetting and Drying of Concrete in Presence of Deicing Agents

Castro attributed the joint deterioration to the preferential absorption of fluids in the joints (Castro et al., 2011). Some observations in the field showed that this deterioration usually occurs at low spots, locations with damaged sealer or accumulated water. This observation gave rise to hypothesis of preferential absorption (Castro et al., 2011). Deicing salts may increase the degree of saturation at joints over time (Taylor et al., 2012a). The deicing salts tends to increase the surface tension. Several authors also suggest that the rate of fluid absorption was found to be related to the surface tension (Castro et al., 2011; Taylor et al., 2012b). Deicing solutions have a relative humidity lower than water. Lower relative humidity of deicing solutions prevents water near the concrete surface to dry. Thus it can be implied that concrete that has been undergoing wetting and drying cycle in presence of deicing salt will be more saturated.

1.10 Filling of Entrained Air Voids and Failure along ITZ Plane

Taylor observed the filling of entrained air void near the sawn surface. Deicing salts convert unhydrated cement and ettringite to Friedel's salt (Taylor, et al., 2012b). This converted product accumulates in the entrained air voids, as shown in Figure 1.10.1. Earlier research showed that the strength, durability and permeability of concrete are influenced by the presence of an air void system (Ng, 2009).

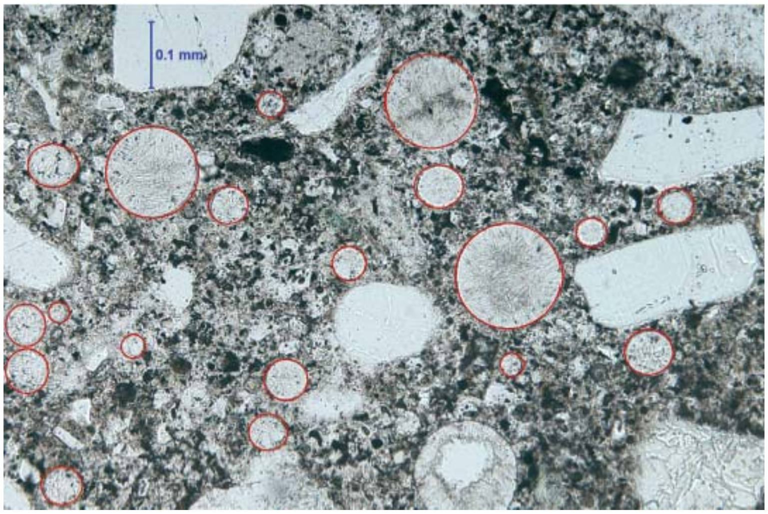

Figure 1.10.1. Secondary Ettringite Deposits in Air Voids (American Engineering Testing, Inc.)

Furthermore, freeze-thaw resistance of the concrete increases with larger size air voids (Ng, 2009). Moisture from the environment penetrates the porous concrete surface and get trapped in the empty spaces. When this water freezes it expands in volume. This expansion causes micro cracking to relive the tensile stress produced. The cyclic nature of freeze thaw action drives the concrete to its fatigue state when permanent damage occurred. Air is entrained in the concrete artificially by air entraining admixtures (AEA). This admixture stabilizes the air bubbles present in the concrete. These stabilized air voids provide water enough space to expand. If these air bubbles are filled, freeze thaw deterioration will damage the joint significantly. Figure 1.10.2 shows a Scanning Electron Microscope (SEM) image of air void in a concrete system before and after freezing.

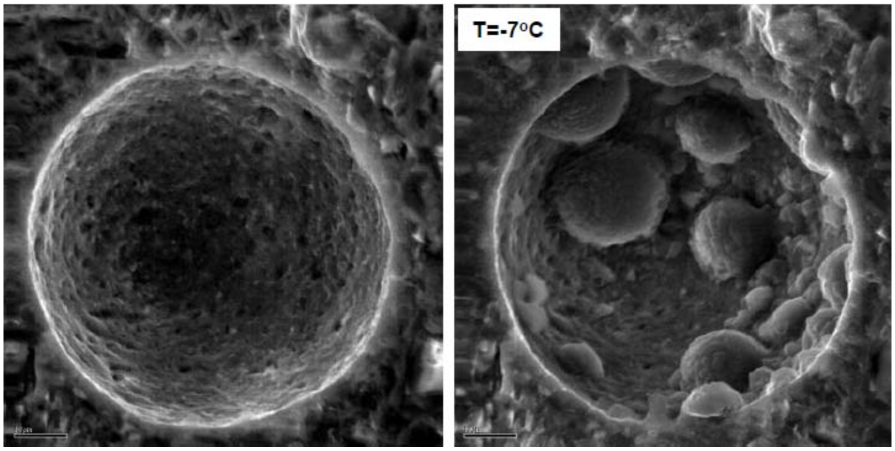

Figure 1.10.2. SEM Image of Air Void Before and After Freezing Occurs in Concrete (Zhang, 2013)

1.11 Failure Along the ITZ Plane

The presence of aggregate in the concrete mix prevents the cement particles to mix properly. This effect is known as "wall effect" (Thomas and Jennings, 2015). The shear stress exerted by larger aggregate particles on the smaller cement paste during mixing causes water to get separated from the cement paste. This results in a narrow region surrounding the aggregate which contains less cement paste and more water. This region has high permeability. Since it is a weakened plane with high permeability, it is safe to assume that joint deterioration can be attributed to ITZ to some extent. Some researcher suggested that joint sawing action of the concrete pavement can expose these high permeable zones in the vicinity of the cut face (Taylor et al., 2012), and can become more susceptible to water ingression which ultimately leads to distress in the joint.

ITZ or aggregate paste zone is the weakest zone in the concrete, affecting the mechanical properties as well as the durability of the concrete. The low strength of ITZ results in a concrete strength somewhere between the strengths of the aggregate and cement paste (Zhang, 2013), as shown in Figure 1.11.1. High porosity of ITZ affects the durability of concrete and influences the transport of water through its high concentration of pores. The ITZ includes large flat $Ca(OH)_2$

crystals which lie perpendicular to the surface of aggregate grains, making the ITZ a highly porous region in concrete which is susceptible to the formation of micro-cracks that may propagate under applied loads (Zhang, 2013).

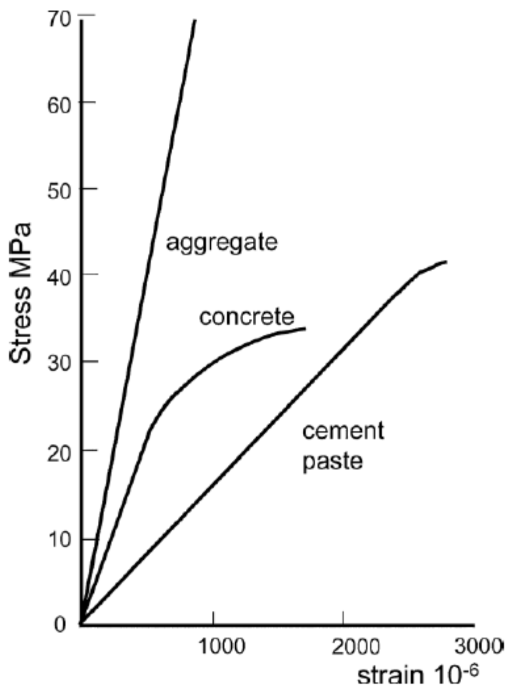

Figure 1.11.1. Comparative Stress Strain Curves for Aggregate, Paste and Concrete (Zhang, 2013)

CHAPTER 2
CONSTRUCTION OF PAVEMENT TEST SECTIONS

2.1 Introduction

Two concrete pavement test sections were designed and constructed to allow for the creation of a wide range of saw-cut joints, including provisions for saw type, saw blade type and quality, depth of saw cut, and saw cut timing. The original test section, constructed immediately after the start of this research project, was located on the grounds of the Zignego Ready-Mix Plant in Waukesha, WI. The second test section, constructed during the project extension period in 2017, is located along the CTH KC EB On-Ramp to STH 16 in Hartland, WI.

2.2 Zignego Ready-Mix Plant Test Section

This concrete test section includes two distinct mix designs, one incorporating southern Wisconsin limestone as the predominant coarse aggregate and the other incorporating northern Wisconsin igneous gravels as the predominant coarse aggregate. Significant pre-project planning was undertaken to allow for the test site construction in early October 2015, very soon after the notice to proceed was obtained. To accomplish this objective, the research staff worked closely with representatives from Zignego Ready Mix to develop appropriate mix designs and paving locations/schedules and with representatives from Husqvarna to ensure that appropriate soft cut saw equipment and trained personnel would be on site during construction. Support was also provided by the Wisconsin Concrete Pavement Association and Trierweiler Construction to identify and transport a sufficient quantity of northern igneous gravels. A pre-construction meeting with POC members was held at the Truax Center on September 30, 2015 to finalize the construction details.

The pavement test section was constructed at the Zignego Ready Mix plant in Waukesha, WI. This location provided for efficient set-up, paving, field curing, and pavement sectioning with no disruptions due to public trafficking. Figures 2.2.1 and 2.2.2 provide location overviews of the test section construction. The constructed test section was 10 ft wide, 100 ft long, and 10 in thick. The 100 ft length was sectioned into two, 50 ft lengths, each section using separate mix designs incorporating coarse aggregates of southern Limestone and Northern Igneous Gravels.

Zignego Ready Mix
W226N2940 Duplainville Road
Waukesha, WI 53186

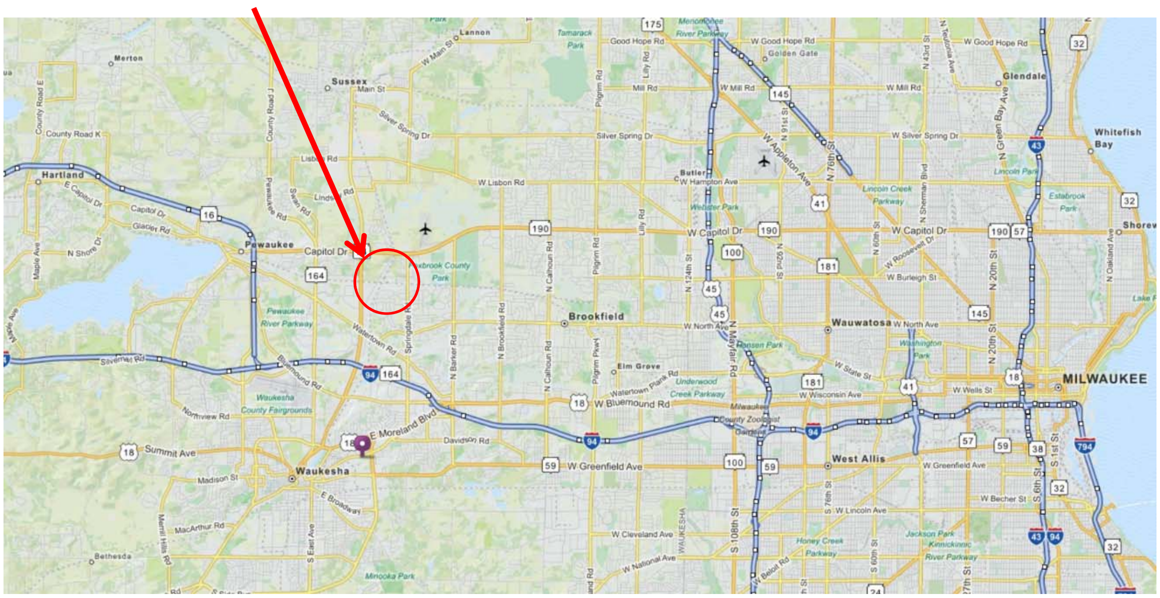

Figure 2.2.1. Location Overview of the Zignego Ready Mix Plant, Waukesha, WI

Figure 2.2.2. Site Details for the Zignego Ready Mix Plant

2.3 Zignego Ready-Mix Plant Test Section Mix Designs

The general mix design utilized for the constructed test section was originally proposed by Zignego Ready Mix and is identified as their WI A/FA 30% L/CHRT 1&2 Handpour mix design. This mix design utilizes a w/cm ratio of 0.42 and has target air contents and slumps of 6.0% and 2-4 inches, respectively. Figure 2.3.1 provides additional details on this particular mix design. The aggregate gradation proposed for this mix design was analyzed using the CP Tech aggregate system analysis procedure developed at Iowa State University. Figures 2.3.2 and 2.3.3 provide analysis results for this Limestone aggregate gradation. As shown, the gradation fits nicely within the limits of the Tarantula Curve (Figure 2.3.2) and falls within the desired well graded Zone II of the Shilstone Coarseness Factor plot (Figure 2.3.3).

For the WI A/FA 30% L/CHRT 1&2 Handpour mix design discussed above, the #1 Limestone coarse aggregate was also replaced with a northern igneous gravel supplied by Trierweiler Construction and Supply Company. Figure 2.3.4 provides gradation information on this gravel coarse aggregate obtained from the Boone Pit in Clark County. Using this gravel source as a replacement for the #1 Stone in the Limestone mix, a suitable gradation was developed for use in the project. Figures 2.3.5 and 2.3.6 provide analysis results for this developed Gravel aggregate gradation. As shown, the gradation fits nicely within the limits of the Tarantula Curve (Figure 2.3.5) and falls within the desired well graded Zone II of the Shilstone Coarseness Factor plot (Figure 2.3.6).

Zignego Ready Mix
W226 N2940 Duplainville Road
Waukesha, WI 53186

July 22, 2015

MIX WORKSHEET

Account #: **ZI02**

ZIGNEGO READY MIX INC
W226 N2940 DUPLAINVILLE ROAD
WAUKESHA WI 53186

Fax # (262)542-3965

Project: Mix design

Material	Type	Manufacturer	Notes
Cement	Type I Portland	St. Mary's Cement	ASTM C-150 (Cement)
Flyash	Class "C"	LaFarge North Am.	ASTM C-618 (Fly Ash)
Slag	N/A	N/A	N/A
Sand	Torpedo	Lannon Stone Products	ASTM C-33 (torpedo)
Stone #1	Limestone	Lannon Stone Products	ASTM C-33 67(#1 stone)
Stone #2	Limestone	Lannon Stone Products	ASTM C-33 - 4 (#2 stone)
Admix 1	Air Entrainment	Sika	ASTM C-260 (AE 260)
Admix 2	Water Reducer	Sika	ASTM C-494 (161)
Admix 3	N/A	N/A	N/A

Mix #	Cement Lb.	Flyash Lb.	Slag Lb.	Sand Lb.	Stone #1 Limestone	Stone #2 Limestone	Water Gal.	Admix 1	Admix 2	Admix 3
P2 979	395	170	0	1,371	998	816	28.6	4.24	28 oz	0

Mix #	Mix Description	Air %	Slump	W/C Ratio	Mix Placement
P2 979	WI A/FA 30% L/CHRT 1&2	6.0%	2 - 4	.42	Handpour Pavement

Figure 2.3.1. Basic Mix Design Used for Test Section Construction

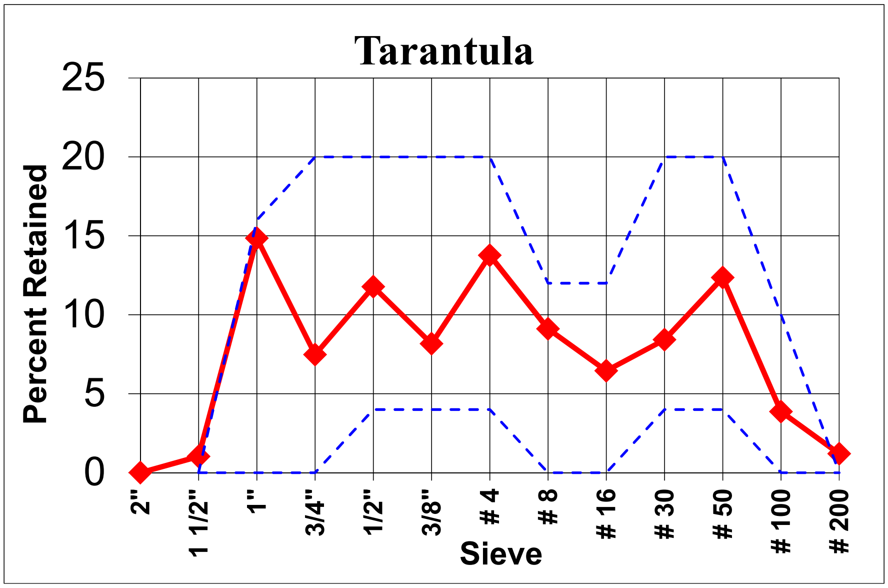

Figure 2.3.2. Combined Aggregate Analysis – Limestone Mixture

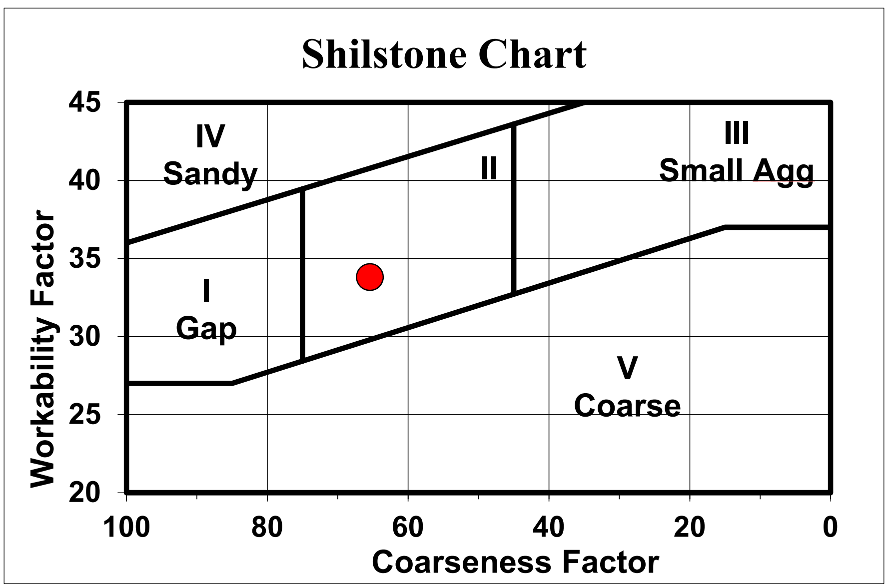

Figure 2.3.3. Coarseness Factor Analysis – Limestone Mixture

TRIERWEILER
CONSTRUCTION & SUPPLY CO. INC.

2916 S. Cherry Street
Marshfield, WI 54449
Phone: (715) 305-5748 Fax: (877) 387-6865

Material Source: Boon (Haske Quarry)			
Sampled By: Mel Boon, observed by Steve Rappe		(P) Production, (S) Stockpile, (A) Average:	P
Date Sampled: 08/01/11	Time Sampled: 8:50 AM	Sample #:	080111-1

Sieve Analysis:		
Washed: X	Unwashed:	Weight, gms: 11440.6
Fine:	Coarse #1: X	Coarse #2:

SIEVE	Wt. Ret'd (g)	% Ret'd	% Pass	TARGET SPECIFICATIONS SHILSTONE
2" (50 mm)	0.0	0.0	100.0	-
1 1/2" (37.5 mm)	0.0	0.0	100.0	100
1" (25 mm)	409.1	3.6	96.4	90 - 100
3/4" (19 mm)	4033.1	35.3	64.7	60 - 80
1/2" (12.5mm)	8191.7	71.6	28.4	35 - 60
3/8" (9.5 mm)	9400.5	82.2	17.8	20 - 45
#4 (4.75 mm)	10973.8	95.9	4.1	0 - 25
#8 (2.36 mm)	11312.5	98.9	1.1	0 - 15
#16 (1.16 mm)	11335.5	99.1	0.9	-
#30 (0.6 mm)	11346.0	99.2	0.8	-
#50 (0.3 mm)	11353.8	99.2	0.8	-
#100 (0.15 mm)	11361.8	99.3	0.7	-
#200 (0.075 mm)	11372.7	99.4	0.6	-
Wt in Pan =	11378.7			

Remarks:

Date of test	8/1/2011	Tested/Calculated by:	Steve Rappe	Checked by:	M. Hammitt

Figure 2.3.4. Boone Pit - Northern Igneous Gravel Gradation

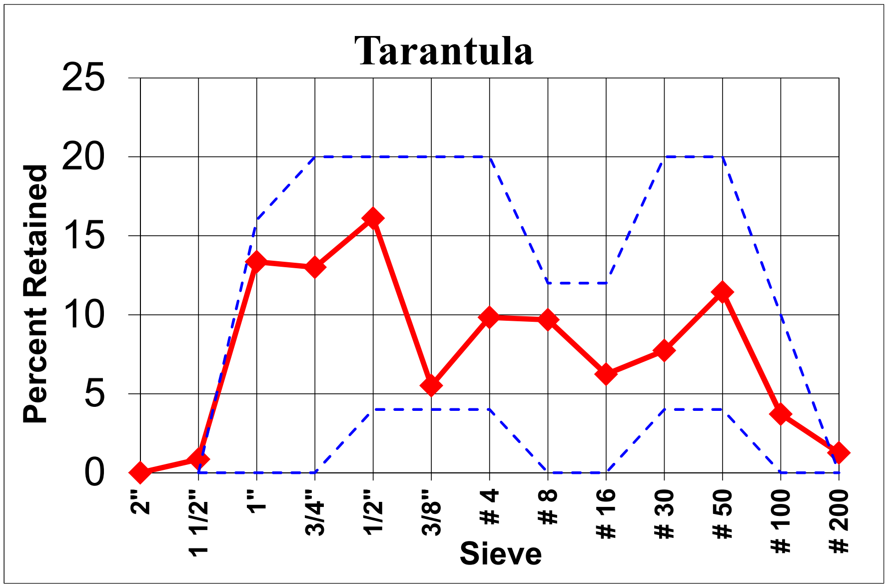

Figure 2.3.5. Combined Aggregate Analysis – Gravel Mixture

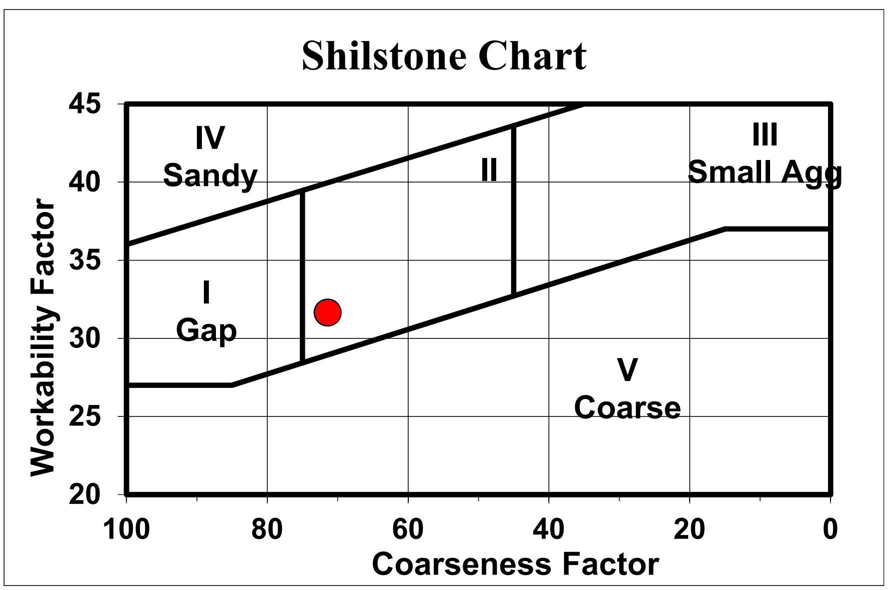

Figure 2.3.6. Coarseness Factor Analysis – Gravel Mixture

2.4 Zignego Ready-Mix Plant Test Section Concept Design

The overall test section was designed to allow for the installation of numerous partial-depth saw cut joints, using a variation in saw type, saw blade type, saw cut timing, and concrete pavement type. The full 100 ft test section was divided into two, 50 ft test sections All partial-depth saw cuts were made to a depth of 3.33 inches, which represents the WisDOT standard of D/3 used for contraction joint formation (D=10 in.).

The overall saw cutting research factorial design includes the primary factor of mix design type (Limestone or Gravel coarse aggregate). Two doweled and two un-dowelled control joints were established within each mix design, representing optimal saw-cut timing using conventional and early entry saws. Each test section also incorporates four additional factors over un-doweled concrete pavement locations as follows:

- Factor 2 – Saw Type (Early Entry or Conventional) – 2 Levels
- Factor 3 – Saw Timing (Early or Late in Allowable Window) – 2 Levels
- Factor 4 – Blade Type (Hard or Soft Aggregate) – 2 Levels
- Factor 5 – Blade Wear (New or Aged) – 2 Levels

Transverse saw cuts were made at longitudinal spacings of 2 – 3 ft, with each transverse cut timed appropriately to provide sufficient separation to mitigate temperature effects from adjacent saw cuts. Figure 2.4.1 provides an overview sketch of the saw cut layout within each mix design. The numbers in black represent the designated joint number, with those in boxes representing joints cut with the early entry saw. The numbers in red represent the longitudinal position of each saw cut, in feet, beginning at the location of the start of concrete pouring. Blue stars indicate locations of mid-depth temperature probes. As indicated by the black joint numbers, transverse joint saw cutting progressed in the direction opposite to paving, thereby shortening the time between paving and the start of early entry saw cutting.

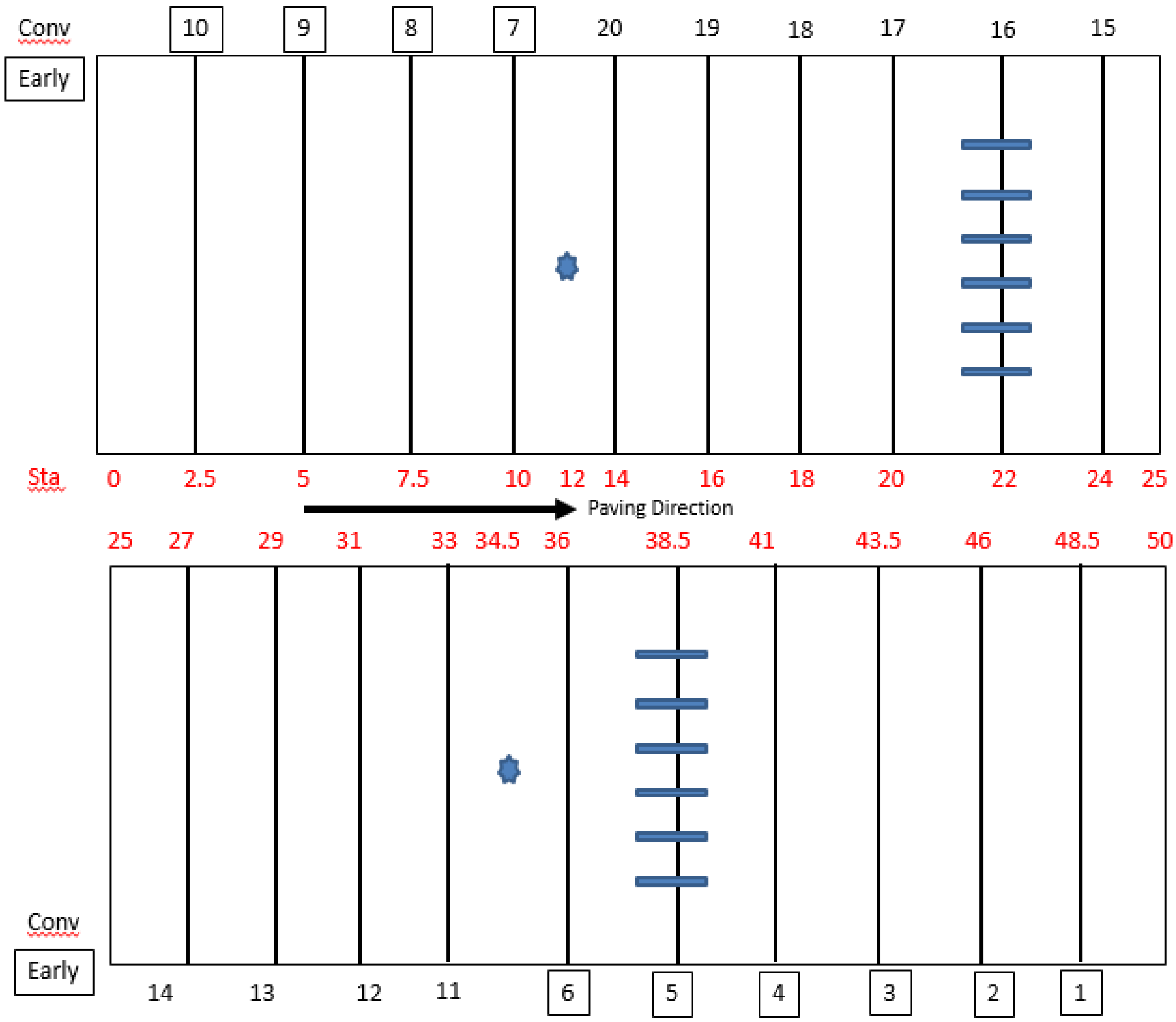

Figure 2.4.1. Layout Sketch of Saw Cut Joints Within Each Mixture Type (Note: Conv = Conventional Wet Saw Cut)

The factorial design for the transverse saw cutting incorporates four factors, each with 2 design levels, resulting in a 2x2x2x2=16 factorial. Each of these 16 factorial cells represents a unique combination of saw timing, saw type, blade type and blade wear. Table 2.4.1 and 2.4.2

provide a full listing of the factorial cell designations for each of the 20 transverse saw cut locations within each mix design.

Table 2.4.1. Transverse Saw Cut Designations – Limestone Mixture

Saw Type	Saw Cut Timing	Joint Number	Station (ft)	Blade Type	Blade Condition	Doweled Joint
Early Entry	Early	1	48.5	SOFT	NEW	NO
		2	46	SOFT	OLD	NO
		3	43.5	HARD	OLD	NO
		4	41	HARD	NEW	NO
	Optimal	5	38.5	SOFT	NEW	YES
		6	36	SOFT	NEW	NO
	Late	7	10	SOFT	NEW	NO
		8	7.5	SOFT	OLD	NO
		9	5	HARD	OLD	NO
		10	2.5	HARD	NEW	NO
Conventional	Early	11	33	SOFT	NEW	NO
		12	31	OLD	OLD	NO
		13	29	HARD	NEW	NO
		14	27	OLD	OLD	NO
	Optimal	15	24	SOFT	NEW	NO
		16	22	SOFT	NEW	YES
	Late	17	20	HARD	NEW	NO
		18	18	OLD	OLD	NO
		19	16	SOFT	NEW	NO
		20	14	OLD	OLD	NO

Table 2.4.2. Transverse Saw Cut Designations – Gravel Mixture

Saw Type	Saw Cut Timing	Joint Number	Station (ft)	Blade Type	Blade Condition	Doweled Joint
Early Entry	Early	1	48.5	HARD	NEW	NO
		2	46	HARD	OLD	NO
		3	43.5	SOFT	OLD	NO
		4	41	SOFT	NEW	NO
	Optimal	5	38.5	HARD	NEW	YES
		6	36	HARD	NEW	NO
	Late	7	10	HARD	NEW	NO
		8	7.5	HARD	OLD	NO
		9	5	SOFT	OLD	NO
		10	2.5	SOFT	NEW	NO
Conventional	Early	11	33	OLD	OLD	NO
		12	31	HARD	NEW	NO
		13	29	OLD	OLD	NO
		14	27	SOFT	NEW	NO
	Optimal	15	24	HARD	NEW	NO
		16	22	HARD	NEW	YES
	Late	17	20	OLD	OLD	NO
		18	18	SOFT	NEW	NO
		19	16	HARD	NEW	NO
		20	14	OLD	OLD	NO

2.5 Zignego Ready-Mix Plant Test Section Construction

Paving of the concrete test sections was completed on October 7, 2015, which was the day after the notice to proceed on this research study was received. In anticipation of this accelerated schedule, significant pre-planning was undertaken to ensure that all necessary equipment and personnel were on site and prepared for construction activities.

Actual paving was initiated using the Limestone mixture, with the first 8.50 CY batch arriving at the test section at 7:13 AM. The second 8.50 CY batch of Limestone mix arrived at 7:28 AM. The two batches of the Limestone mix were placed, consolidated and finished by 7:48 AM. A standard PAMS membrane-forming curing compound was spray applied at 8:15 AM. The prevailing air temperatures during this time period ranged from 52 - 54 ^{o}F.

Paving was then sequenced to the Gravel mixture, with the first 8.50 CY batch arriving at the test section at 8:40 AM. The second 8.50 CY batch of Gravel mix arrived at 8:54 AM. The two batches of Gravel were placed, consolidated and finished by 9:08 AM. The same PAMS curing compound was spray applied at 9:35 AM. The prevailing air temperature during this time period was 55 ^{o}F.

Figures 2.5.1 through 2.5.8 provide representative phots taken during construction. During the paving operations, each truckload of concrete was sampled and tested by two HTCP certified technicians from R.A. Smith National following applicable ASTM and AASHTO Testing Standards and in accordance with the WisDOT Construction and Materials Manual, Chapter 8. Figures 2.5.9 through 2.5.12 provide the summary results from all field tests performed. The full report provided by R.A. Smith National is provided in Appendix A. Note that the batch ingredients provided in Figure 2.5.9 – 2.5.12 were supplied by Scott Zignego soon after paving operations were complete.

Figure 2.5.1. Test Site Preparations Prior to Paving

Figure 2.5.2. Paving and Test Crews Awaiting Delivery of First Batch

Figure 2.5.3. Paving Operations Within Limestone Mixture

Figure 2.5.4. Application of Curing Compound Over Limestone Mixture

Figure 2.5.5. Paving Operations Within Gravel Mixture Near Dowel Basket

Figure 2.5.6. Application of Curing Compound Over Gravel Mixture

Figure 2.5.7. Overview of Completed Test Sections with Joint Location Markings

Figure 2.5.8. Preparations for Initial Saw Cutting in Limestone Mixture

Mix Data:	Limestone – Load #1		4000psi	Testing: 7:15am	TK#358
	WI A/FA 30% FA 1&2			Temperature	66°
	Load Size =	8.50 CY		Air	7.4%
				Air w/0.3 correction	7.1%
		Actual		Slump	3.125"
	Torp Sand	12100	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Low Chert	8500	lbs		
	#2 Limestone	6940	lbs		
	Cement (St Marys)	3355	lbs		
	Fly Ash	1465	lbs		
	Water	184	gal		
	E260 AE	40	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33351.3	lbs		
	w/cm	0.32			

Figure 2.5.9. As Delivered Mix Properties – Limestone Batch 1 (R.A. Smith National)

Mix Data:	Limestone – Load #2		4000psi	Testing: 7:32am	TK#398
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	6.0%
				Air w/0.3 correction	5.7%
		Actual		Slump	1.625"
	Torp Sand	12120	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Low Chert	8480	lbs		
	#2 Limestone	6880	lbs		
	Cement (St Marys)	3380	lbs		
	Fly Ash	1450	lbs		
	Water	184	gal		
	E260 AE	40	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33442.9	lbs		
	w/cm	0.32			

Figure 2.5.10. As Delivered Mix Properties – Limestone Batch 2 (R.A. Smith National)

Mix Data:	Gravel - Load #1		4000psi	Testing: 8:43am	TK#358
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	7.5%
				Air w/0.3 correction	7.2%
		Actual		Slump	4.75"
	Torp Sand	11400	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Shilstone	11300	lbs		
	#2 Gravel	4560	lbs		
	Cement (St Marys)	3335	lbs		
	Fly Ash	1475	lbs		
	Water	184	gal		
	E260 AE	41	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33327.8	lbs		
	w/cm	0.33			

Figure 2.5.11. As Delivered Mix Properties – Gravel Batch 1 (R.A. Smith National)

Mix Data:	Gravel - Load #2		4000psi	Testing: 8:57am	TK#389
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	6.6%
				Air w/0.3 correction	6.3%
		Actual		Slump	2.75"
	Torp Sand	11400	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Shilstone	11420	lbs		
	#2 Gravel	4540	lbs		
	Cement (St Marys)	3385	lbs		
	Fly Ash	1450	lbs		
	Water	184	gal		
	E260 AE	41	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33427.8	lbs		
	w/cm	0.32			

Figure 2.5.12. As Delivered Mix Properties – Gravel Batch 2 (R.A. Smith National)

In addition to the mix testing performed by R.A. Smith National, other tests were performed on site to aid in the establishment of the saw cut timing windows for the early entry and conventional saws. Mid-depth concrete temperature readings and resistance to penetration tests were performed by Marquette University research staff to help establish the time to initial set. Ultrasonic pulse velocity (UPV) and calorimetry tests were conducted by Xuhao Wang of the CP Tech Center at Iowa State University to provide comparative measures for predicting the time to initial set and optimal saw cut timing. Super air meter tests were also performed by Xuhao Wang to provide comparative measures for the air meter tests performed by R.A. Smith National.

Figure 2.5.13 provides plots of the mid-depth temperature readings within the Limestone and Gravel mixtures during the first 12 hours after paving. Figure 2.5.14 provides a plot of the resistance to penetrations readings obtained for each mixture type. The results presented in Figure 2.5.14 were used to aid in the identification of the initial set time, when early timing saw cutting could begin, and final set, to establish optimal timing for saw cutting. Early timing windows were preliminarily established once penetration resistance exceeded 500 psi. Optimal timing windows were preliminarily established once penetration resistance exceed 1,400 psi. These timing windows were adjusted slightly based on the field experience of the saw cutting crews. The actual saw cut times for each transverse cut are provided in Tables 2.5.1 and 2.5.2.

Data collected by the CP Tech staff were provided after construction was completed. These values were provided as comparative measures for the initial set times and optimal saw cut times. These comparative readings are provided in Table 2.5.3.

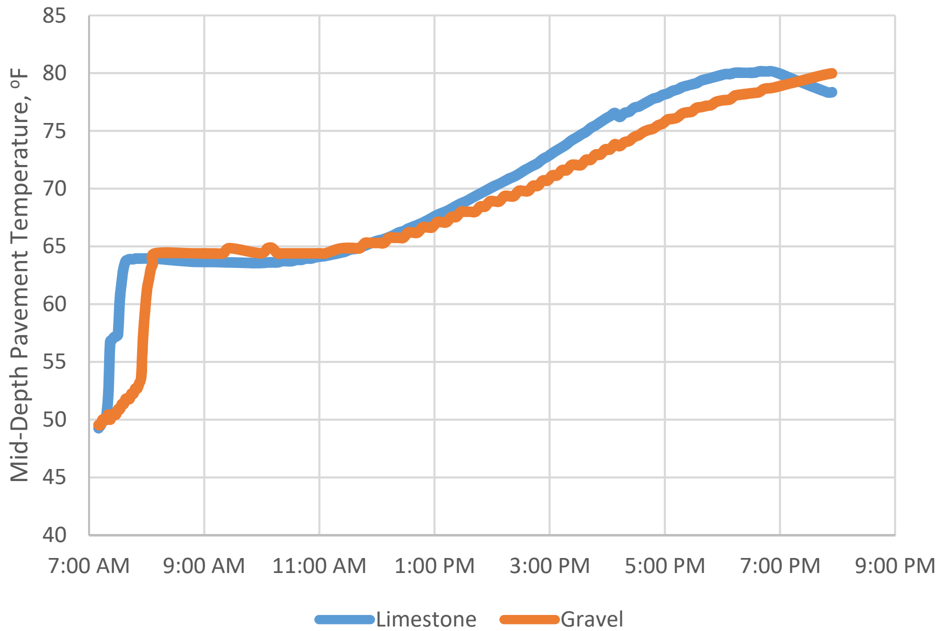

Figure 2.5.13. Mid-Temp Temperature Probe Readings After Paving

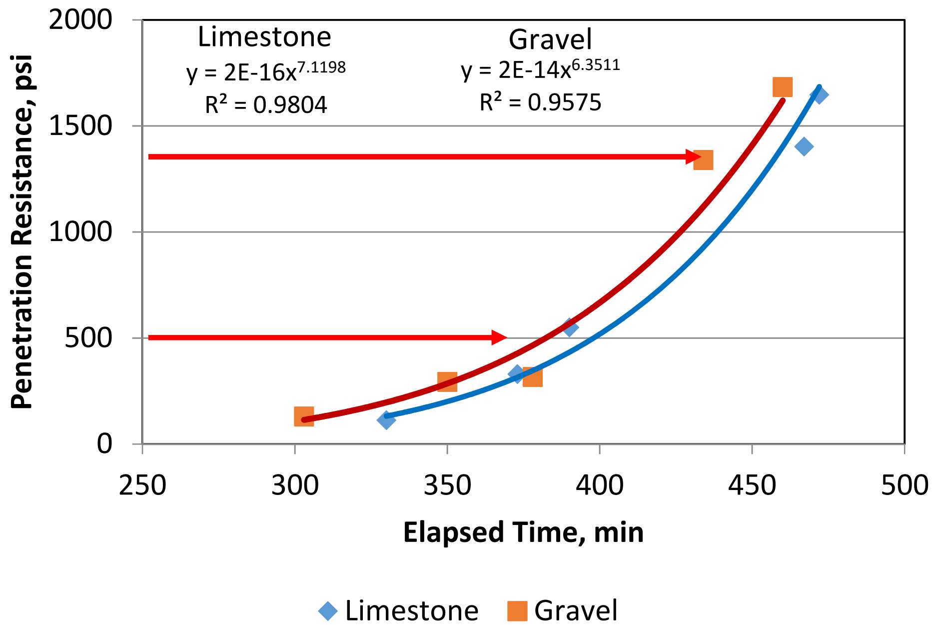

Figure 2.5.14. Resistance to Penetration Readings After Paving

Table 2.5.1. Transverse Saw Cut Timing – Limestone Mixture

Joint Number	Saw Type	Saw Cut Timing	Pour Start Time	Saw Cut Time	Elapsed Time min	Penetration Reading, psi
1	Early Entry	Early	7:48:00 AM	12:43:00 PM	295	113
2			7:48:00 AM	12:49:00 PM	301	
3			7:48:00 AM	12:54:00 PM	306	
4			7:48:00 AM	12:59:00 PM	311	
5		Optimal	7:48:00 AM	3:00:00 PM	432	1403
6			7:48:00 AM	3:03:00 PM	435	
7		Late	7:13:00 AM	5:53:00 PM	640	n.a.
8			7:13:00 AM	5:56:00 PM	643	
9			7:13:00 AM	5:59:00 PM	646	
10			7:13:00 AM	6:02:00 PM	649	
11	Conventional	Early	7:48:00 AM	5:31:00 PM	583	1647+
12			7:48:00 AM	5:34:00 PM	586	
13			7:48:00 AM	5:37:00 PM	589	
14			7:48:00 AM	n.a.	n.a.	
15		Optimal	7:13:00 AM	7:45:00 PM	752	n.a.
16			7:13:00 AM	7:46:00 PM	753	
17		Late	7:13:00 AM	7:02:00 AM	1429	n.a.
18			7:13:00 AM	6:50:00 AM	1417	
19			7:13:00 AM	7:05:00 AM	1432	
20			7:13:00 AM	n.a.	n.a.	

Table 2.5.2. Transverse Saw Cut Timing – Gravel Mixture

Joint Number	Saw Type	Saw Cut Timing	Pour Start Time	Saw Cut Time	Elapsed Time min	Penetration Reading, psi
1	Early Entry	Early	8:54:00 AM	1:45:00 PM	291	131
2			8:54:00 AM	1:49:00 PM	295	
3			8:54:00 AM	1:52:00 PM	298	
4			8:54:00 AM	1:56:00 PM	302	
5		Optimal	8:54:00 AM	4:20:00 PM	446	1684
6			8:54:00 AM	4:23:00 PM	449	
7		Late	8:40:00 AM	6:43:00 PM	603	n.a.
8			8:40:00 AM	6:46:00 PM	606	
9			8:40:00 AM	6:50:00 PM	610	
10			8:40:00 AM	6:53:00 PM	613	
11	Conventional	Early	8:54:00 AM	n.a.	n.a.	n.a.
12			8:54:00 AM	6:32:00 PM	578	
13			8:54:00 AM	6:35:00 PM	581	
14			8:54:00 AM	6:38:00 PM	584	
15		Optimal	8:40:00 AM	8:31:00 PM	711	n.a.
16			8:40:00 AM	8:33:00 PM	713	
17		Late	8:40:00 AM	6:48:00 AM	1328	n.a.
18			8:40:00 AM	6:46:00 AM	1326	
19			8:40:00 AM	6:43:00 AM	1323	
20			8:40:00 AM	n.a.	n.a.	

Table 2.5.3. Comparative Readings Provided by CP Tech

	Limestone	Gravel
Pouring start time	7:13	8:40
Calorimetry start time	7:30	8:53
Air Content (R.A. Smith National)	7.40%	7.50%
Air Content (Super air meter)	7.70%	7.40%
SAM number	0.08	0.31
Calorimetry predicted initial set time, mins	285	215
UPV predicted initial set time, mins	327	-
UPV predicted optimal saw cutting time, mins	542	-

All early entry saw cuts were produced with a Husqvarna SOFF-CUT 5000 portable saw operated by trained Husqvarna field staff. New saw blades optimized for soft and hard aggregates were used as appropriate for each transverse cut (Tables 2.5.1 & 2.5.2). For the "New" blade conditions (Tables 2.5.1 & 2.5.2), a new shoe was used on the portable saw, which provides optimal restraint for the concrete surface during the upcut operations. For the "Old" blade conditions (Tables 2.5.1 & 2.5.2), a worn shoe with an elongated saw blade portal was used, which provides poor restraint for the concrete surface during the upcut operations. This simulation of "old" blade conditions was deemed by Husqarna field staff as being more representative of less than optimal contractor quality control during routine saw cutting operations. Figure 2.5.15 provides a side-by-side comparison of the shoes used during early entry saw cutting operations. Figure 2.5.16 provides a representative photo of the first six early entry saw cuts in the Limestone mixture.

Figure 2.5.15. Old (Left) and New (Right) Plates Used During Early Entry Sawing

Figure 2.5.16. First Six Early Entry Saw Cuts in Limestone Mixture

All conventional saw cuts were produced with a conventional portable saw operated by Zignego field staff. Figure 2.5.17 provides a photo of this equipment in preparation for the initial saw cut in the Limestone mixture (Joint 11). New saw blades optimized for soft and hard aggregates were used as appropriate for each transverse cut (Tables 2.5.1 & 2.5.2). For the "Old" blade conditions (Tables 2.5.1 & 2.5.2), the same severely worn saw blade was used for both the Limestone and Gravel mixtures, thus eliminating two transverse saw cut locations in each mixture (Tables 2.5.1 & 2.5.2).

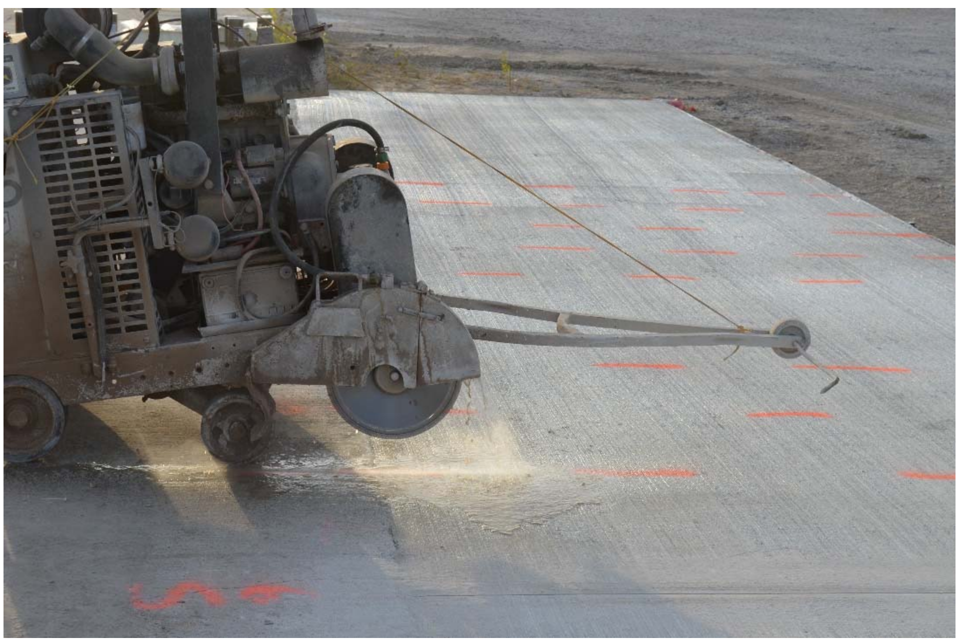

Figure 2.5.17. Initial Conventional Saw Cut in Limestone Mixture (Joint 11)

2.6 Zignego Ready-Mix Plant Post-Construction Test Section Sectioning

The central 6 feet of each transverse joint needed to be sectioned into discrete 12 in. x 24 in. specimens for laboratory analysis. Figure 2.6.1 illustrates typical full-depth saw cut patterns (dashed lines) for adjacent un-dowelled and doweled joints within the Limestone mix section (Joints L05 and L06). As shown, the outer 2 feet on each end of the transverse saw cut were excluded from the laboratory analysis due to edge restrictions that were in place during the research saw cutting operations. Also shown is a 6 in. long waste section running the full width of the test section. These full-width waste sections varied in width from 0 to 3 ft, depending on joint location. Full-depth saw cutting was completed by Interstate Sawing on October 22, 2015, ultimately producing 144 discrete laboratory sections, i.e., four specimens from each of the 36 saw cut joints. Figures 2.6.2 and 2.6.3 provide representative pre- and post-sawing views of the test sections.

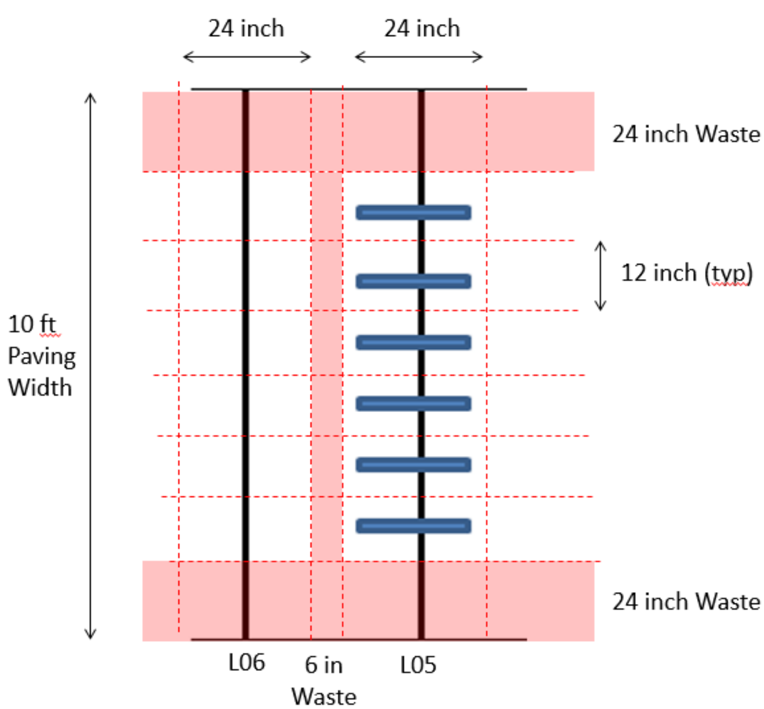

Figure 2.6.1. Typical Full-Depth Sawing Pattern

Figure 2.6.2. Layout Markings For Full-Depth Sawing

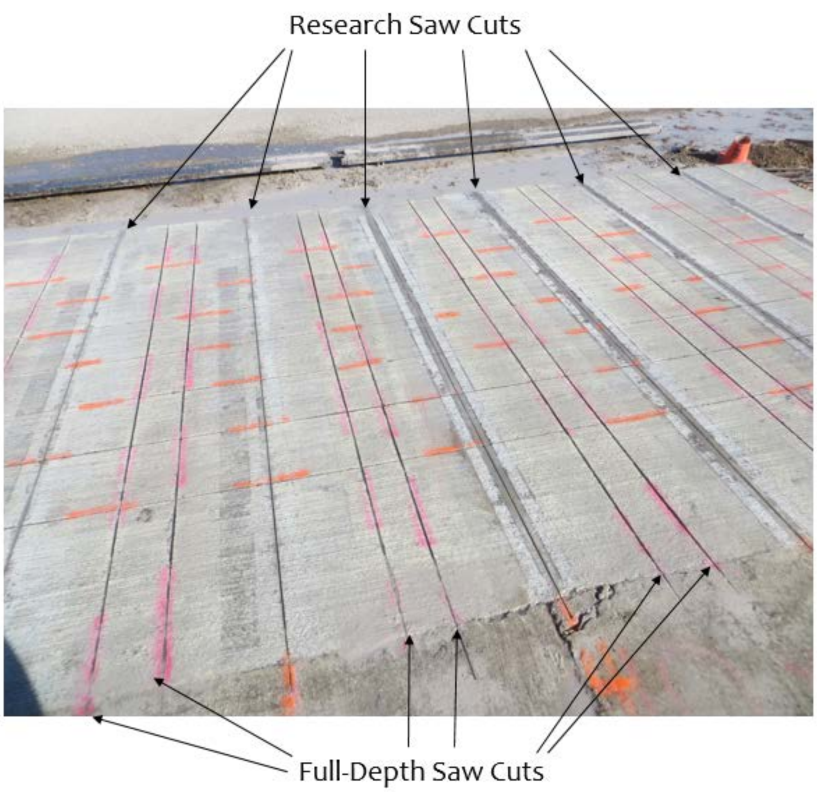

Figure 2.6.3. Full-Depth Sawing Pattern

After full-depth sawing, the test section was allowed to cure for a full 28 days prior to palletizing for shipment to UM-KC (one joint per pallet). Table 2.6.1 provides comparative flexural (MOR) and compressive (f'c) strength measures obtained from load testing at Marquette University, using beam and cylinder specimens produced by R.A. Smith National during test section paving operations.

Table 2.6.1. Results of Concrete Strength Tests Performed at Marquette University

Age, days	Mix Batch	Type	Load, lb	MOR, psi	f'c, psi
8	L1	Beam	4,400	365	
8	L2	Beam	6,000	498	
8	G1	Beam	5,840	485	
8	G2	Beam	6,160	511	
8	L1	Cylinder	77,415		2,738
8	L2	Cylinder	83,270		2,945
8	G1	Cylinder	87,820		3,106
8	G2	Cylinder	89,305		3,159
29	L1	Beam	7,600	631	
29	L2	Beam	6,400	531	
29	G1	Beam	4,720	392	
29	G2	Beam	9,600	797	
29	L1	Cylinder	110,510		3,908
29	L1	Cylinder	117,295		4,148
29	L2	Cylinder	115,960		4,101
29	L2	Cylinder	111,135		3,931
29	G1	Cylinder	92,100		3,257
29	G1	Cylinder	97,430		3,446
29	G2	Cylinder	107,310		3,795
29	G2	Cylinder	116,990		4,138

After field curing, the concrete joint sections were separated using a forklift provided by Zignego Ready Mix. The four separated joint sections obtained from a single transverse joint saw cut were placed on the same pallet and marked for identification. Palletized specimens were wrapped in preparation for shipment to UM-KC. A total of 36 pallets were loaded onto a flatbed trailer on November 9, 2015 and shipped to UM-KC. Figures 2.6.4 and 2.6.5 provide representative photos from this process. All samples were received by UM-KC intact, with no shipping damage noted.

Figure 2.6.4. Pallets of Joint Specimens Ready for Wrapping

Figure 2.6.5. Pallets of Joint Specimens Prepared for Transport

2.7 CTH KC EB On-Ramp Test Section

This concrete test section includes one concrete mix design incorporating both southern Wisconsin limestone and northern Wisconsin igneous gravels as the coarse aggregates, various joint saw depths, and field applied silane penetrating joint sealer. A pre-construction meeting with POC members and contractors was held at the WisDOT Southeast Region Offices June 19, 2017 to discuss project objectives and to finalize construction details.

The pavement test section was constructed by the Zignego Company as part of the STH 16 Improvement Project, State Project Number 1370-15-71. Figure 2.7.1 provides a location overview of the test section construction. Actual paving took place on July 27, 2017 and included an 8-inch doweled, non-reinforced concrete pavement over a reclaimed asphaltic base layer. The 900 ft long test section (15 contiguous transverse joints) incorporated transverse contraction joints sawn to depths of D/3 (Control), D/4, and 1.25 +/- 0.25 inches. The saw depth variations were selected based on findings from an early-entry saw study conducted by the Illinois Center for Transportation (Krstulovich, Jr, et al, 2011). The constructed test section was 15 ft wide and included three sub-sets of 20 contiguous joints sawn to the same saw depth.

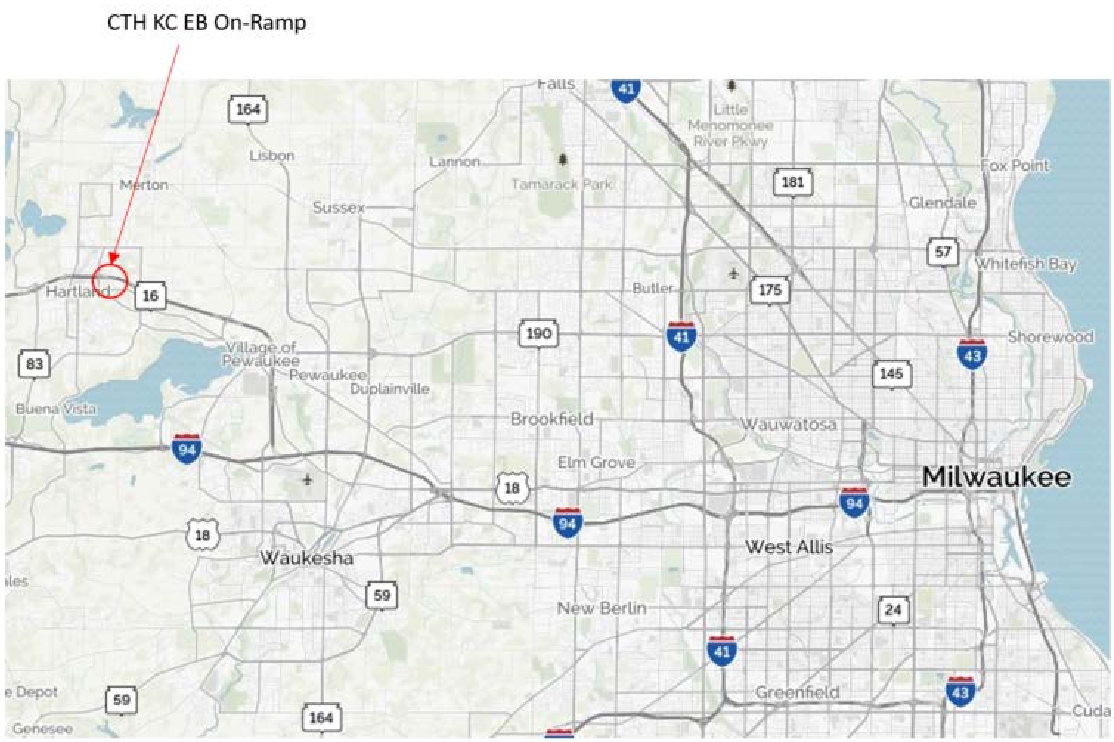

Figure 2.7.1 Location Overview of the CTH KC EB On-Ramp, Hartland, WI

2.8 CTH KC EB On-Ramp Test Section Mix Design

The basic mix design utilized for the constructed test section is identified as a WI A/FA 30% L/CHRT 1&2 Slipform mix design. This mix design utilizes a w/cm ratio of 0.37 and has target air content and slump of 6.0% and 1.5 inches, respectively. Figure 2.8.1 provides additional details on this particular mix design. The aggregate gradation used for this mix design was analyzed using the CP Tech aggregate system analysis procedure developed at Iowa State University. Figures 2.8.2 and 2.8.3 provide analysis results for this aggregate gradation. As shown, the gradation fits nicely within the limits of the Tarantula Curve (Figure 2.8.2) and falls within the desired well graded Zone II of the Shilstone Coarseness Factor plot (Figure 2.8.3). Figure 2.8.4 provides aggregate gradation information.

2.9 CTH KC EB On-Ramp Test Section Concept Design

The CTH KC EB On-Ramp test section was designed to allow for the installation of numerous partial-depth saw cut joints, using a variation in saw type and saw cut depth. Partial-depth saw cuts were made using early-entry saws to depths of 2.67 inches, which represents the WisDOT standard of D/3 used for contraction joint formation (D=8 in.), 2.0 inches (D/4) and 1.25 +/- 0.25 inches. The full 900 ft test section was divided into three, 300 ft sub-sections, each comprised of 20 consecutive transverse joints cut to one of the selected saw depths.

Within each of the three sub-sections, half of the joints were left unsealed and remaining half were sealed with field-applied silane penetrating joint sealer.

Mix Design
Volumetric, Absolute Volume Method TRIAL BATCH 1
Scott Wall PCCII, Kent Corrigan PCCII
315 76th Street
Franksville, WI. 53126 Calculated
Mix ID: 1R2S-AS60-ZG17 5/27/2017

Materials Information

	Source	Name	SP.GR	Abs. %
Fine Aggregate	Lafarge Colgate		2.674	1.163%
#1 Stone	Lafarge Colgate		2.736	0.827%
#2 Stone	Lafarge Colgate		2.736	0.827%
Cement	St. Mary's	Type I	3.15	
Fly Ash/Slag	St. Mary's	CemPlus	2.90	
Water	Municipal	Potable		
Air Entrainment	Sika	Air 360		
Water Reducer	Sika	Plastocrete 161		

Mix Target Values

Max W/C	0.37
Air Content	6.0%
Agg. Nom. Max.	1.5
Cement/CY	395
Slag/CY	170
Vol. Coarse:Unit Vol.	67.67%

Coarse Agg. Unit Weight: 106 (lbs / cu.ft.)
Fine Agg. Fineness Modulus: 2.9
Aggregate Correction Factor: 0.3%

Agg. Proportions

F.A.	40.00%
C.A.	60.00%
#1 Stone	63.3%
#2 Stone	36.7%

Moisture Contents

	Wet Wt.	Dry Wt.	Moist%
Fine Agg	564	535	5.4%
no.1	5694	5558	2.4%
no.2	16716	16527	1.1%

Moist Batch Weights

Fine Agg	1361	LBS/YD³
#1 Stone	1257	LBS/YD³
#2 Stone	718	LBS/YD³

Trial Batch Vol: 2.5 cu.ft.

Dry Batch Weights

	weight	volume
Cement	395	2.0
Slag	170	0.9
H_2O	209	3.4
Fine Agg	1291	7.7
#1 Stone	1227	7.2
#2 Stone	710	4.2
Air	6.0%	1.6
AE admix	2 oz	
WR admix	23 oz	

total: 27 cu.ft.

Dry Trial Batch Weights

Cement	36.6 lbs	
Slag	15.7 lbs	
Water	19.4 lbs	2.3 Gal
Fine Agg	119.5 lbs	
no.1	113.6 lbs	
no.2	65.8 lbs	
AE admix	0.185 oz	5.477 mL
WR admix	2.13 oz	62.981 mL

Moist Trial Batch Weights

Cement	36.6 lbs	
Slag	15.7 lbs	
Water	12.2 lbs	1.5 Gal
Fine Agg	126.0 lbs	
no.1	116.3 lbs	
no.2	66.5 lbs	
AE admix	0.19 oz	5.477 mL
WR admix	2.13 oz	62.981 mL

Trial Batch Test Results

	design	actual
Air Content	6.0%	5.3%
Slump	1.5"	1.5"
Mix Temp	50-90	78
Amb Temp	50-90	69
Yield	100%	99.3%

Yield Calculation

Gross WT, measure & conc.	46.1
Tare WT, measure	8.5
Net WT of concrete	37.6
Volume of measure (cu.ft.)	0.25
Measured Unit Weight / CY	4061
Calculated Unit Weight / CY	4033

Project Various 2017 Projects	ID #	County Various
Description	Contractor Zignego Company	
PCC II TECHNICIAN signature	PROJECT ENGINEER signature	

Figure 2.8.1. Basic Mix Design Used for CTH KC EB On-Ramp Test Section Construction

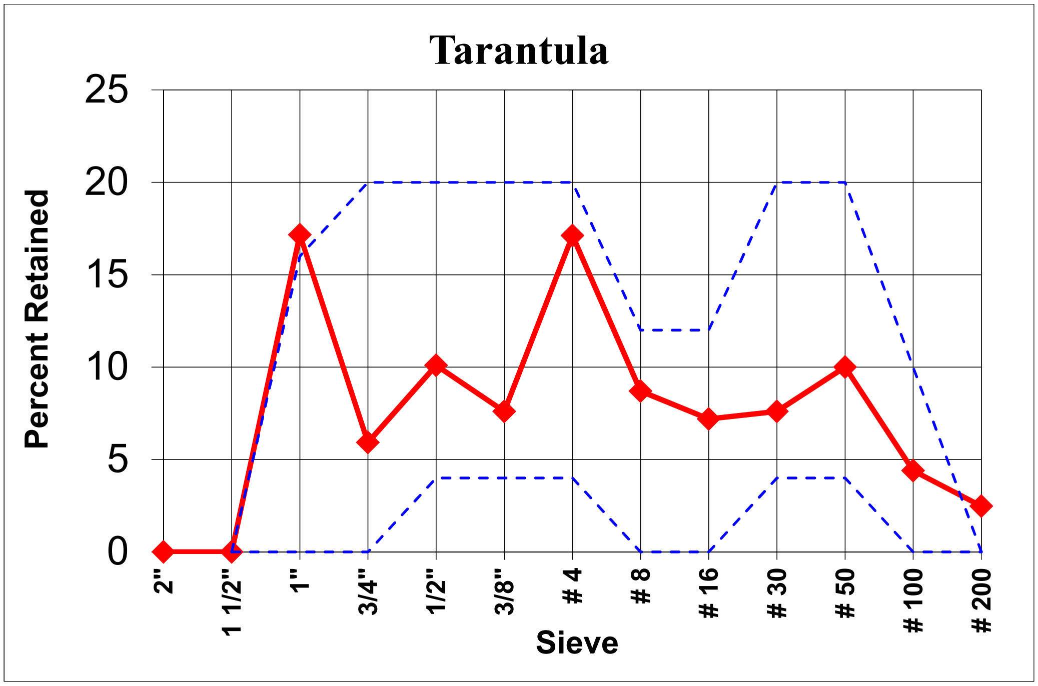

Figure 2.8.2. Combined Aggregate Analysis – CTH KC EB On-Ramp Mixture

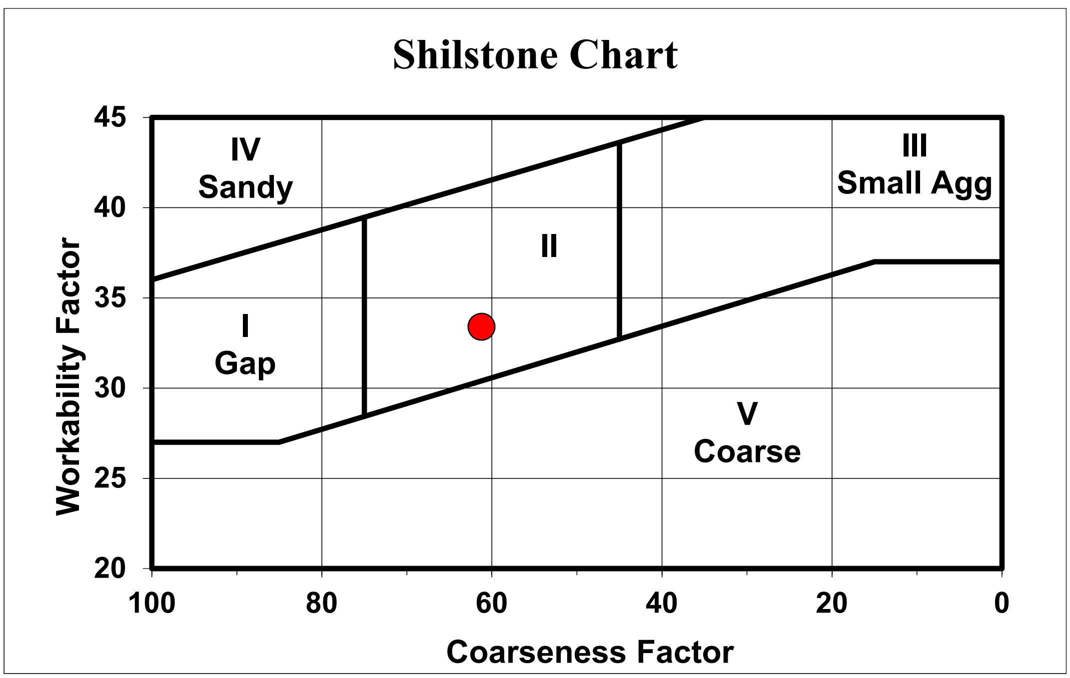

Figure 2.8.3. Coarseness Factor Analysis – CTH KC EB On-Ramp Mixture

CONCRETE AGGREGATE GRADATION

QC Tech Inc
Construction Materials Testing

Project # 1060-21-71		SAMPLED BY:
STH 16		**Andy Diderrich**
SOURCE :		TESTED BY:
Zignego Co.		**Sue Wall**
Date Sampled	Date Tested	Contractor
7/27/2017	**7/27/2017**	**Zignego Co.**

Fine Aggregate WASHED Sample # *3*

Wt. of sample wet	**593**	Moist. loss	43
Wt. of sample dry	**550**	% Moist.	7.8

Sieve	Wt. Ret.	% Ret.	% Pass
3/8"		0	**100**
# 4	7	1	**99**
# 8	100	18	**82**
# 16	196	36	**64**
# 30	304	55	**45**
# 50	442	80	**20**
# 100	500	90.9	**9**
F.M.		**2.82**	
# 200	532	96.7	**3.3**

% material in concrete mix	11		
fine agg.	40.0%	#2 stone	22.0%
		#1 stone	38.0%

 # One Stone WASHED Sample # *3*

Wt. of sample wet	**5425**	Moist. loss	148
Wt. of sample dry	**5277**	% Moist.	2.8

Sieve	Wt. Ret.	% Ret.	% Pass
1"		0	**100**
3/4"	229	4	**96**
1/2"	1559	30	**70**
3/8"	2644	50	**50**
# 4	4975	94	**6**
# 8	5206	98.7	**1**
# 200	5241	99.3	**0.7**

 # Two Stone WASHED Sample # *3*

Wt. of sample wet	**15880**	Moist. loss	172
Wt. of sample dry	**15708**	% Moist.	1.1

Sieve	Wt. Ret.	% Ret.	% Pass
2"		0.0	**100**
1 1-2"	1456	9.3	**91**
1"	12356	78.7	**21**
3/4"	15240	97.0	**3**
1/2"	15586	99.2	**1**
3/8"	15602	99.3	**1**
# 4	15607	99.4	**1**
# 200	15650	99.6	**0.4**

combination gradation compilation

	fine	#1	#2	fine	#1	#2	total
1 1-2"	100.0	100.0	90.7	40.0	38.0	20.0	**98**
1"	100.0	100.0	21.3	40.0	38.0	4.7	**83**
3/4"	100.0	95.7	3.0	40.0	36.3	0.7	**77**
1/2"	100.0	70.5	0.8	40.0	26.8	0.2	**67**
3/8"	100.0	49.9	0.7	40.0	19.0	0.1	**59**
no. 4	98.7	5.7	0.6	39.5	2.2	0.1	**42**
no. 8	81.8	1.3		32.7	0.5	0.0	**33**
no. 16	64.4			25.7	0.0	0.0	**26**
no.30	44.7			17.9	0.0	0.0	**18**
no.50	19.6			7.9	0.0	0.0	**8**
no. 100	9.1			3.6	0.0	0.0	**4**
no. 200	3.3	0.7	0.4	1.3	0.3	0.1	**1.6**

Figure 2.8.4. Aggregate Analysis – CTH KC EB On-Ramp Mixture

2.10 CTH KC EB On-Ramp Test Section Construction

Paving of the concrete test sections was completed on July 27, 2017. Paving operations initiated at 7:58 AM and were completed at 10:23 AM. A standard PAMS membrane-forming curing compound was spray applied throughout the paving process. The prevailing air temperatures during paving ranged from the low to mid 70s. Figures 2.10.1 through 2.10.6 provide representative phots taken during construction. During the paving operations, concrete was sampled and tested by HTCP certified technicians from QP Tech, Inc. Figures 2.10.7 and 2.10.8 provide test results of the concrete mixture.

In addition to the mix testing performed by QP Tech, Inc., other tests were performed on site to aid in the establishment of the saw cut timing windows for the early entry saw operations. Mid-depth concrete temperature readings and resistance to penetration tests were performed by Marquette University research staff to help establish the time to initial set. Figure 2.10.9 provides a plot of the mid-depth temperature readings during the first 9 hours after paving. Note that temperatures prior to concrete cover at 8:10 AM represent ambient air temperatures. Resistance to penetrations readings were attempted, but measurements were biased by the presence of larger aggregate particles interfering with the penetration probe. As such, these readings were not useable for estimating time to initial set. Early-entry saw timing windows were ultimately established based on the field experience of the saw cutting crew. The actual saw cut timing for each sub-section is provided in Figure 2.10.10.

Figure 2.10.1. Test Site Preparations Prior to Paving

Figure 2.10.2. Paving Crews After Delivery of First Batch

Figure 2.10.3. Placement of a Dowel Basket in Advance of Mix Placement

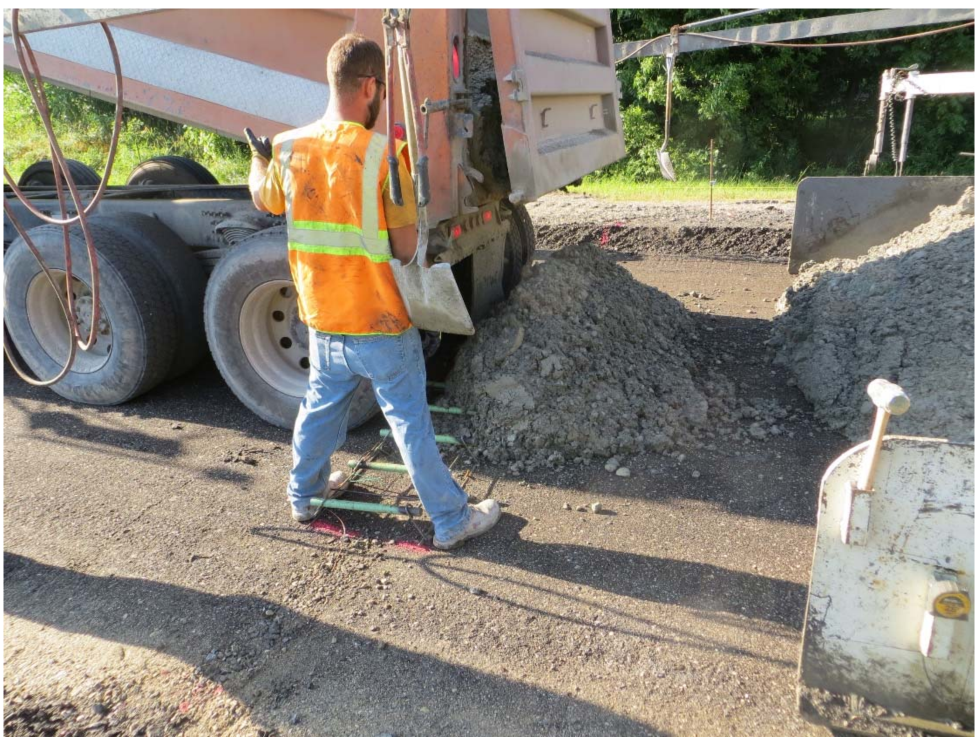

Figure 2.10.4. Placement of Concrete Over Dowel Basket

Figure 2.10.5. Complete Paving Train with Paver, Turf Drag and Tiner/Curing Compound

Figure 2.10.6. Section of Completed Pavement

QC Tech Inc Construction Materials Testing	CONCRETE AGGREGATE GRADATION

Project # 1060-21-71 **STH 16**	SAMPLED BY: **Andy Diderrich**	
SOURCE : **Zignego Co.**	TESTED BY: **Sue Wall**	
Date Sampled **7/27/2017**	Date Tested **7/27/2017**	Contractor **Zignego Co.**

# One Stone	WASHED	Sample #	3
Wt. of sample wet	5425	Moist. loss	148
Wt. of sample dry	5277	% Moist.	2.8%

Sieve	Wt. Ret.	% Ret.	% Pass
1"	0	0	**100**
no. 4	4975	94	**6**
no. 200	5241	99.3	**0.7**

Fine Aggregate	WASHED	Sample #	3
Wt. of sample wet	593	Moist. loss	43
Wt. of sample dry	550	% Moist.	7.8%

Sieve	Wt. Ret.	% Ret.	% Pass
3/8"	0	0	**100**
no. 4	7	1	**99**
no. 200	532	96.7	**3.3**

# Two Stone	WASHED	Sample #	3
Wt. of sample wet	15880	Moist. loss	172
Wt. of sample dry	15708	% Moist.	1.1%

Sieve	Wt. Ret.	% Ret.	% Pass
2"	0	0.0	**100**
1"	12356	78.7	**21**
no. 4	15607	99.4	**1**
no. 200	15650	99.6	**0.4**

% Material In Concrete Mix 11

fine agg.	40.0%	#2 stone	22.0%
		#1 stone	38.0%

% absorb.			
fine agg.	1.140%	Course	1.490%

combined gradation compilation

	fine	#1	#2
2"	100.0	100.0	100.0
1"	100.0	100.0	21.3
no. 4	98.7	5.7	0.6
no. 200	3.3	0.7	0.4

	fine	#1	#2	total	UCL
2"	40.0	38.0	22.0	**100**	100
1"	40.0	38.0	4.7	**83**	89
no. 4	39.5	2.2	0.1	**42**	42
no. 200	1.3	0.3	0.1	**1.6**	2.3

Batch wt. Adjustments with moisture

11 batch wts. Dry		moist wts.
fine agg	1267	1366
#1 stone	1203	1237
#2 stone	697	705

Field Batch Weights - Pounds

Material	Dry	Wet	Moisture Total	Moisture Absorb.	Moisture Free
Fine Agg.	1267.00	1366.06	99.06	14.44	84.6
No. 1 C.A.	1203.00	1236.74	33.74	17.92	15.8
No. 2 C.A.	697.00	704.63	7.63	10.39	-2.8
				Total	**97.7**

NOTE:

Total free moisture in gallons -

11.7 gal.

Figure 2.10.7. Aggregate Properties – (QP Tech, Inc)

QC TECH MATERIALS TESTING

QMP CONCRETE PAVEMENT — 315 76th Street, Franksville, WI 53126

Project Name:	STH 16 Oconomowoc - Waukesha		
Project #:	1370-15-71	**Contractor:**	Zignego Company
County:	Waukesha	**Pavement Type:**	Mainline
Technician:	Andy Diderrich - 105702	**Pour Date:**	7/27/2017
Weather:	70-78, sunny	**Estimated CY:**	450
Start Pour:	7:00 AM	**Actual CY:**	483
End Pour:	11:30 AM	**Load Size:**	10

Random Sample Calculations:

Lot	Sublot	Sublot Range	Random Number	Sublot Length	Test Sta	Quantity Satisfied	Cumul. Test Quantity
2	2-1	42500 - 43600	0.786	1100	865	42500	43365

Note: Random numbers generated by computer.

Startup Testing:

	Slump (in)	Air (%)	CY Out	Time	Concrete Mix	Conc Temp (°F)	Amb Temp (°F)
	SF	6.2	2	7:30 AM	11	84	70

Test Location:	42505
Source:	Zignego Company Mobile
Truck #:	T52
Placement Method:	Slipform
# of Breaker Cylinders:	4
Notes:	Initial air at batch plant 7.5%.

Random Sample # **2-1**

	Slump (in)	Air (%)	Test Sta	Time	Concrete Mix	Conc Temp (°F)	Amb Temp (°F)
	SF	7.2	43365	10:15 AM	11	82	75

Location:	43365
Source:	Zignego Company Mobile
Truck #:	T78
Placement Method:	Slipform
# of Breaker Cylinders:	0
Notes:	

CYLINDER TEST DATA

Cylinder ID	Age (days)	Tested By	Test Date	Area	Fracture	Load (lbs)	Strength (psi)
2-1-A	28	Sue Wall	8/24/2017	28.416	cone	121100	4262
2-1-B	28	Sue Wall	8/24/2017	28.397	cone	121050	4263
2-1-C	28						

Figure 2.10.8. Concrete Mixture Properties – (QP Tech, Inc)

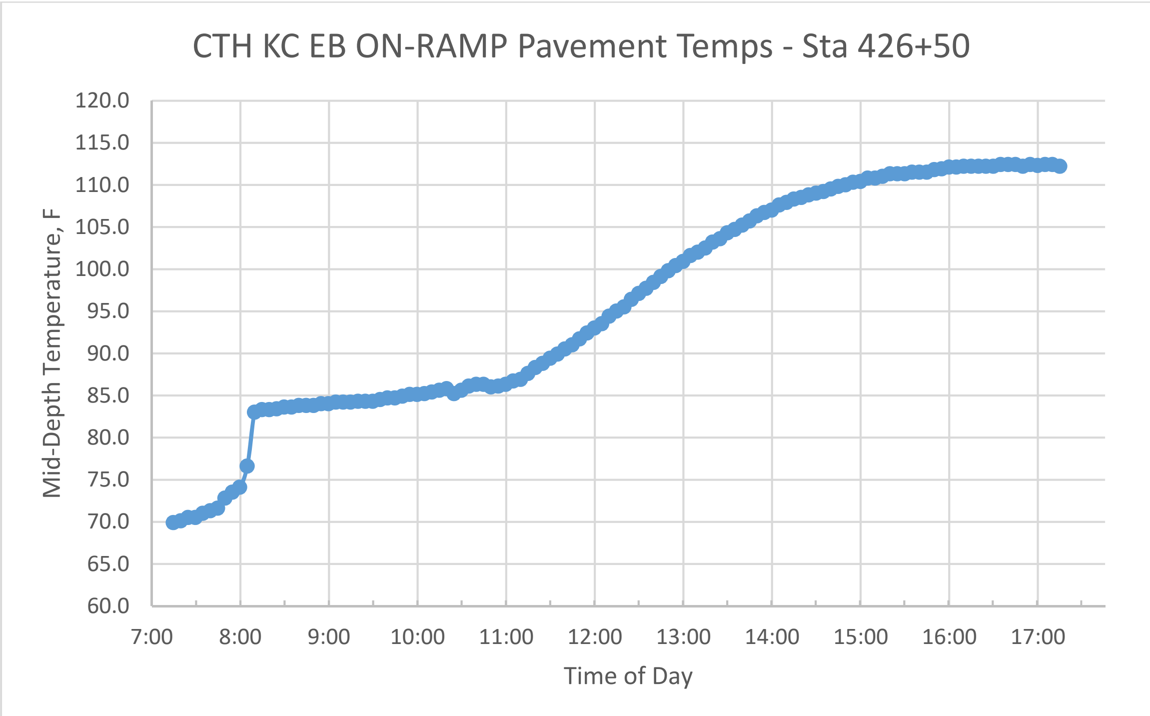

Figure 2.10.9. Mid-Temp Temperature Probe Readings After Paving

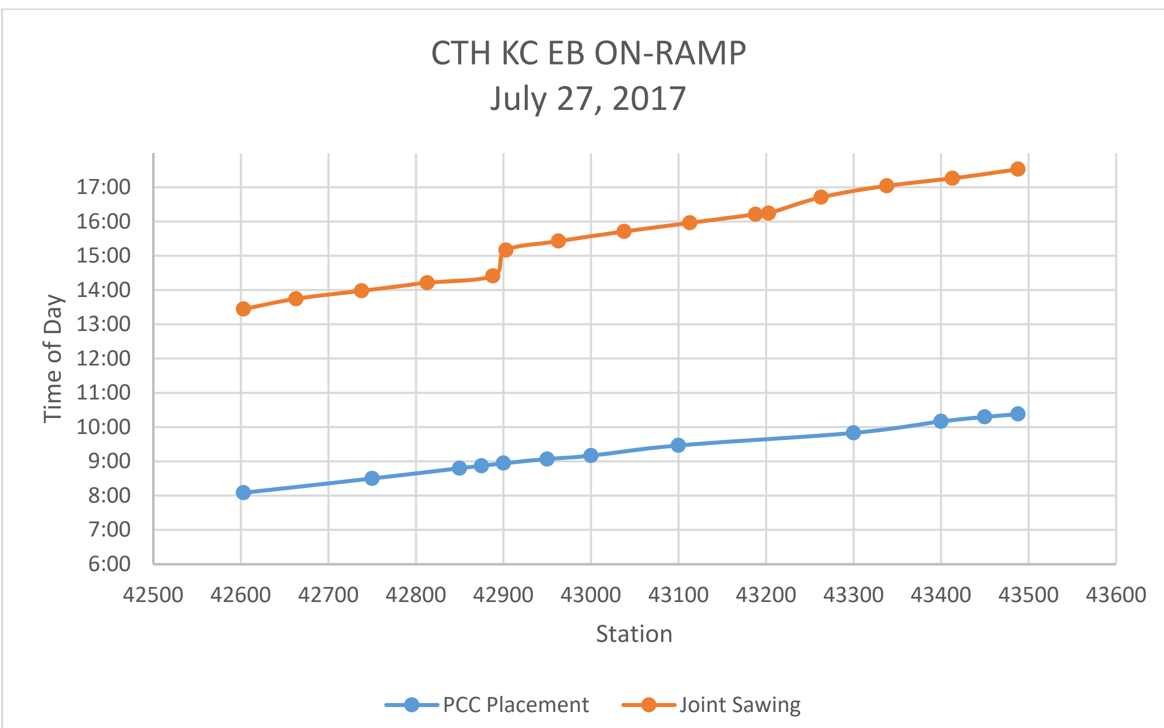

Figure 2.10.10. PCC Placement and Saw Cut Timing

All early entry saw cuts were produced with Husqvarna SOFF-CUT portable saws operated by Zignego Company field staff. For the initial shallow cuts targeted for a depth of 1.25 inches, a lightweight Husqvarna SOFF-CUT Model 2000 saw provided by Husqvarna. Representative from Husqvarna were on site to provide expertise and guidance during this sawing operation. Figures 2.10.11 and 2.10.12 provide photos of the Model 2000 SOFF-CUT saw.

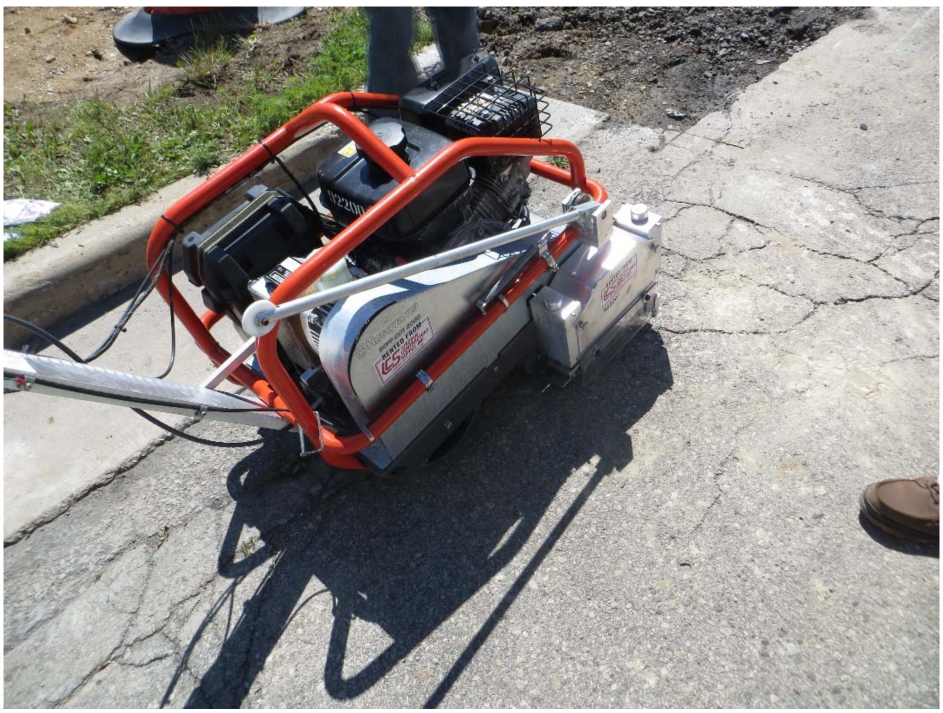

Figure 2.10.11. Husqvarna SOFF-CUT Model 2000 Early Entry Saw

Figure 2.10.12. Husqvarna SOFF-CUT Model 2000 Early Entry Sawing Operations

The deeper cuts to D/4 and D/3 were completed using a Husqvarna Soff-Cut Model 4000 saw owned and operated by the Zignego Company. Figures 2.10.13 and 2.10.14 provide representative photos of this early entry saw. The saw cuts that were to be sealed with field-applied silane penetrating sealer were pressure washed by Marquette staff on the morning on Sunday, July 30th . At the time of pressure washing, a joint crack survey was conducted to determine the width and depth of the saw cuts and the percentage of joints that had activated, i.e. a full-depth crack was observed under the saw cut. For the 1.25”, D/4 and D/3 cut sections, it was observed that 85%, 100% and 85% of the joints, respectively, had activated. Tables 2.10.1 through 2.10.3 provide the results of the joint width/depth measurements. As shown, the actual saw depths in the 1.25” , D/4 and D/3 sub-sections averaged 1.47” , 2.12” and 2.71”, respectively.

Figure 2.10.13. Husqvarna SOFF-CUT Model 4000 Early Entry Saw

Figure 2.10.14. Husqvarna SOFF-CUT Model 4000 Early Entry Sawing Operations

Table 2.10.1. Results of Transverse Joint Measurements – 1.25” Saw Depth Section

Test Section	Joint Sealed	Joint Number	Joint Sta	Probe Depth, in			Probe AVG	Joint Width
				LWP	CEN	RWP		
1.25"	No	1	41603	1.43	1.45	1.54	1.47	0.15
	No	2	41618	1.67	1.60	1.50	1.59	0.21
	No	3	41633	1.26	1.63	1.40	1.43	0.17
	No	4	41648	1.45	1.17	1.56	1.39	0.15
	No	5	41663	1.48	1.55	1.44	1.49	0.15
	No	6	41678	1.55	1.55	1.55	1.55	0.18
	No	7	41693	1.56	1.54	1.57	1.56	0.15
	No	8	41708	1.54	1.56	1.29	1.46	0.18
	No	9	41723	1.61	1.48	1.58	1.56	0.18
	No	10	41738	1.53	1.56	1.58	1.56	0.15
	Yes	1	41753	1.49	1.57	1.62	1.56	0.20
	Yes	2	41768	1.50	1.64	1.39	1.51	0.16
	Yes	3	41783	1.36	1.44	1.51	1.44	0.15
	Yes	4	41798	1.52	1.54	1.38	1.48	0.20
	Yes	5	41813	1.48	1.38	1.40	1.42	0.17
	Yes	6	41828	1.37	1.38	1.38	1.38	0.15
	Yes	7	41843	1.26	1.27	1.40	1.31	0.15
	Yes	8	41858	1.41	1.13	1.48	1.34	0.21
	Yes	9	41873	1.35	1.34	1.31	1.33	0.15
	Yes	10	41888	1.50	1.48	1.44	1.47	0.16
			AVG	1.47	1.46	1.47	1.47	0.17
			STD	0.11	0.14	0.10	0.08	0.02
			COV	7.3%	9.9%	6.6%	5.7%	13.0%

Table 2.10.2. Results of Transverse Joint Measurements – D/4 Saw Depth Section

Test Section	Joint Sealed	Joint Number	Joint Sta	Probe Depth, in			Probe AVG	Joint Width
				LWP	CEN	RWP		
D/4	Yes	1	41903	2.18	2.02	2.05	2.08	0.22
	Yes	2	41918	2.38	2.16	2.15	2.23	0.20
	Yes	3	41933	2.35	2.18	2.18	2.24	0.20
	Yes	4	41948	2.02	2.11	1.96	2.03	0.17
	Yes	5	41963	2.13	2.08	2.17	2.13	0.18
	Yes	6	41978	2.08	2.06	1.96	2.03	0.18
	Yes	7	41993	2.20	2.20	2.25	2.22	0.17
	Yes	8	42008	2.35	2.17	2.00	2.17	0.16
	Yes	9	42023	2.11	2.06	2.18	2.12	0.22
	Yes	10	42038	1.95	2.02	2.10	2.02	0.19
	No	1	42053	2.00	2.01	2.23	2.08	0.18
	No	2	42068	2.31	2.28	2.01	2.20	0.20
	No	3	42083	2.10	1.78	2.15	2.01	0.21
	No	4	42098	2.22	2.20	2.20	2.21	0.18
	No	5	42113	2.24	2.15	2.16	2.18	0.16
	No	6	42128	2.27	2.21	2.08	2.19	0.23
	No	7	42143	2.20	2.20	1.91	2.10	0.16
	No	8	42158	1.85	2.12	1.94	1.97	0.18
	No	9	42173	2.13	2.30	2.04	2.16	0.18
	No	10	42188	1.87	1.98	1.99	1.95	0.16
			AVG	2.15	2.11	2.09	2.12	0.19
			STD	0.15	0.12	0.10	0.09	0.02
			COV	7.2%	5.6%	5.0%	4.3%	11.6%

Table 2.10.3. Results of Transverse Joint Measurements – D/3 Saw Depth Section (Control)

Test Section	Joint Sealed	Joint Number	Joint Sta	Probe Depth, in			Probe AVG	Joint Width
				LWP	CEN	RWP		
D/3	Yes	1	42203	2.56	2.84	2.92	2.77	0.23
	Yes	2	42218	2.56	2.72	2.90	2.73	0.18
	Yes	3	42233	2.74	2.72	2.80	2.75	0.27
	Yes	4	42248	2.88	2.71	2.76	2.78	0.18
	Yes	5	42263	2.60	2.65	2.63	2.63	0.18
	Yes	6	42278	2.73	2.67	2.98	2.79	0.24
	Yes	7	42293	2.65	2.71	2.85	2.74	0.16
	Yes	8	42308	2.68	2.66	2.91	2.75	0.26
	Yes	9	42323	2.58	2.78	2.72	2.69	0.16
	Yes	10	42338	2.63	2.82	2.83	2.76	0.18
	No	1	42353	2.67	2.95	2.88	2.83	0.25
	No	2	42368	2.63	2.81	2.82	2.75	0.17
	No	3	42383	2.57	2.48	2.84	2.63	0.20
	No	4	42398	2.60	2.72	2.92	2.75	0.18
	No	5	42413	2.64	2.64	2.69	2.66	0.26
	No	6	42428	2.44	2.52	2.85	2.60	0.17
	No	7	42443	2.88	2.64	2.87	2.80	0.18
	No	8	42458	2.46	2.45	2.89	2.60	0.26
	No	9	42473	2.51	2.74	2.53	2.59	0.18
	No	10	42488	2.55	2.66	2.80	2.67	0.18
			AVG	2.63	2.69	2.82	2.71	0.20
			STD	0.12	0.12	0.11	0.07	0.04
			COV	4.4%	4.5%	3.9%	2.7%	19.1%

Half of the transverse joints within each sub-section were sealed with a Silane penetrating sealer on the morning of Monday, July 31st using equipment, materials and personnel provided by Interstate Sealant & Concrete, Inc. At the time of sealing, contractor staff confirmed the cleanliness of the joint faces by observation that the coarse aggregates could be clearly seen with the naked eye. Joint sealing operations were completed in less than 30 minutes, with each joint taking approximately 15 seconds to seal. Figures 2.10.15 and 2.10.16 provide photos of the joint sealing equipment and operations.

Figure 2.10.15. Truck-Mounted Joint Sealing Equipment

Figure 2.10.16. Joint Sealing Operations

Full-depth cores were obtained from 6 randomly selected joints (3 sealed and 3 unsealed) and one center slab location within each sub-section on Wednesday, Aug 2nd (21 cores total). A portable core rig was supplied and operated by the Wisconsin Concrete Pavement Association with support from WisDOT and Marquette research staff. At the time of coring, a second crack survey was conducted, indicating that 95% of the joints (19/20) in the 1.25” section had activated and that 100% of the other joints (20/20) had activated.

Cores were transported to Marquette University and allowed to cure under water for a period of 21 additional days. After curing, all cores were catalogued and photographed. One core from each sealed and unsealed section as well as one of the mid-slab cores (7 cores total) were randomly selected for absorption testing at Marquette University. These cores were sectioned into test specimens as previously done for the in-service field projects and conditioned following ASTM protocol. The 14 remaining cores were packaged and prepared for shipping to UM-KC.

2.11 CTH KC EB On-Ramp Test Section Preliminary Laboratory Testing

Cores recovered from the CTH KC EB On-Ramp were transported to Marquette University and allowed to cure under water for a period of 21 additional days. After curing, all cores were catalogued and photographed. One core from each sealed and unsealed section as well as one of the mid-slab cores (7 cores total) were randomly selected for absorption testing at Marquette University. These cores were sectioned into test specimens and conditioned following ASTM C1585 protocol. The 14 remaining cores were packaged and shipped to UM-KC for detailed freeze-thaw and deicer scaling resistance testing. Absorption testing methods and results are presented in Chapters 3 and 4, respectively.

The hardened air void analysis, following ASTM C457 Procedure B protocol, was conducted on the mid-slab core samples after absorption testing was completed. Table 2.11.1 provides the results of the analysis. Because of the smaller size of joint faces, it is best to consider the average results which essentially combine the results from both exposed faces. As shown, the average results are in general agreement with the usual ranges provided within the ASTM specification. The spacing factor, which may be regarded as the most significant indicator of durability, is near the bottom end of the usual range, as is desired for concrete in contact with deicing chemicals.

Table 2.11.1. CTH KC EB On-Ramp Test Results – Hardened Air Voids Analysis

Test Parameter	Face 1	Face 2	Average	Usual Ranges
Air Content, %	4.2	10.0	7.1	
Void Frequency	11.3	18.2	14.7	
Paste Content, %	17.7	33.1	25.4	
Paste-Air Ratio	4.2	3.3	3.7	4 - 10
Ave Chord Length	0.0037	0.0055	0.0046	
Specific Surface, a	1069	726	898	600 - 1100 in^{-1}
Spacing Factor, L	0.0039	0.0046	0.0042	0.004 - 0.008 in

CHAPTER 3

SAMPLE PREPARATION AND TEST METHODS

3.1 Introduction

Samples used to investigate the effects of saw timing, technique, and equipment (TTE) were field-cut and shipped to UMKC and immediately transferred inside. For the duration of storage, preparation, and testing all samples were stored in conditioned space and did not experience any unnecessary wetting and drying or freezing and thawing. Figure 3.1.1. shows the palletized and protected samples upon receiving. No damage was observed for any sample from shipping. The observed samples were nominally 12 in. by 12 in. by 10 in. (large) for the undoweled sections and 24 in. by 12 in. by 10 in. (extra-large) for the doweled specimens. The concrete samples were then cut horizontally using a gas-powered dry concrete saw (Stihl TS800) to remove the bottom 5 inches, which initially was in contact with the ground and below the saw cut zone. At this point specimens were 12 in. by 12 in. by 5 in. (medium) and of sufficient size to allow final cutting on a slab saw (Husqvarna MS510) as shown in Figure 3.1.2. All cutting was performed using blades appropriately selected for either soft aggregate or hard aggregate. The dowels were cut from the bottom of the slabs using a blade appropriate for rebar. Ultimately samples were 4 in. by 4 in. by 4 in. for absorption testing, 3 in. by 4 in. by 12 in. for freeze-thaw testing with a 4 in. by 12 in. include the saw cut face, and 9 in. by 9 in. by 4 in. for deicer scaling testing (Figure 3.1.4).

Figure 3.1.1. Samples Upon Initial Receiving

Figure 3.1.2. Final Sizing on Concrete Slab Saw

Figure 3.1.3. Range of Sample Sizes During Preparation

Figure 3.1.4. Final Sample Size Before Testing

The keys for mixture designation and cutting variables are shown in Table 3.1.1 for the limestone mixture and Table 3.1.2 for the granite mixture.

Table 3.1.1. Condition Designation for Limestone Samples

Cut	Saw	Timing Window	Blade Type	Blade Condition	Doweled
L01	Soft-Cut	Early	S	N	N
L02	Soft-Cut	Early	S	O	N
L03	Soft-Cut	Early	H	O	N
L04	Soft-Cut	Early	H	N	N
L05	Soft-Cut	Optimal	S	N	Y
L06	Soft-Cut	Optimal	S	N	N
L07	Soft-Cut	Late	S	N	N
L08	Soft-Cut	Late	S	O	N
L09	Soft-Cut	Late	H	O	N
L10	Soft-Cut	Late	H	N	N
L11	Wet	Early	S	N	N
L12	Wet	Early	S	O	N
L13	Wet	Early	H	N	N
L15	Wet	Optimal	S	N	N
L16	Wet	Optimal	S	N	Y
L17	Wet	Late	H	N	N
L18	Wet	Late	H	O	N
L19	Wet	Late	S	N	N

Table 3.1.2. Condition Designation for Granite Samples

Cut	Saw	Timing	Blade	Condition	Doweled
G01	Soft-Cut	Early	H	N	N
G02	Soft-Cut	Early	H	O	N
G03	Soft-Cut	Early	S	O	N
G04	Soft-Cut	Early	S	N	N
G05	Soft-Cut	Optimal	H	N	Y
G06	Soft-Cut	Optimal	H	N	N
G07	Soft-Cut	Late	H	N	N
G08	Soft-Cut	Late	H	O	N
G09	Soft-Cut	Late	S	O	N
G10	Soft-Cut	Late	S	N	N
G12	Wet	Early	H	N	N
G13	Wet	Early	S	O	N
G14	Wet	Early	S	N	N
G15	Wet	Optimal	H	N	N
G16	Wet	Optimal	H	N	Y
G17	Wet	Late	S	O	N
G18	Wet	Late	S	N	N
G18	Wet	Late	H	N	N

The terminology used for Tables 3.1.1. and 3.1.2. is as follows:

Saw

Soft-Cut – Sawn using an early entry (green, dry) saw.

Wet – Sawn using a conventional water-cooled saw

Timing Window

Early – Sawn early in the sawing window which equipment track marks and footprints were left on the surface.

Optimal – Sawn at the optimal timing for the type of saw as determined by the experience operator.

Late – Sawn very late in the sawing window. Late sawing for the soft-cut saw corresponded to early sawing for the conventional saw.

Blade Type

S – Blade designed for the soft limestone coarse aggregate.

H – Blade designed for the hard granite coarse aggregate.

Blade Condition

N – Sawn using a new blade. Blades were broken in by sawing 100 linear feet.

O – Sawn using an old saw blade. Old blades were just beyond the recommended cut area

Doweled

N – Not doweled

Y - Doweled

Samples used to investigate the influence of sawing depth and field silane sealing **(DS)** were taken from the pavement in 6 in. diameter cores. Cores were recovered from the CTH KC EB On-Ramp and transported to Marquette University and allowed to cure under water for a period of 21 additional days. After curing, all cores were catalogued and photographed.

Sawing was performed at depths of 1.5 in., T/4 (2 in.) and T/3 (2.7 in.). Figure 3.1.5 shows each of the joint sawn depths. All joints had activated and each core sample produced two individual samples. In addition to core samples obtained from the joint locations of concern, unjointed core samples from the center of the T/3 and T/4 section were also included as control samples. Core samples were wet-sawn to a width of 3 in. as shown in Figure 3.1.6. The center specimens were first sawn in half lengthwise before sawing into a prism for testing. Absorption and freeze-thaw durability were tested on separate sets of core samples.

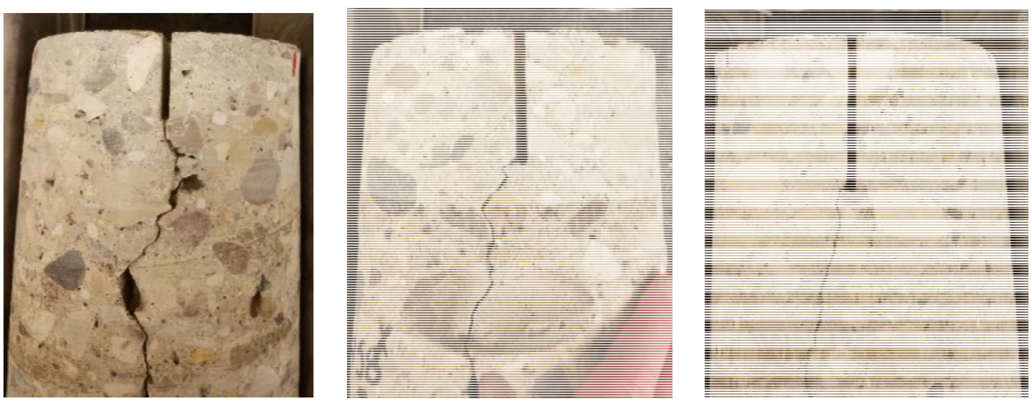

Figure 3.1.5. Core Samples Prior to Cutting for Freeze-Thaw Testing: left 1.5 in., middle 2.0 in., and right 2.7in.

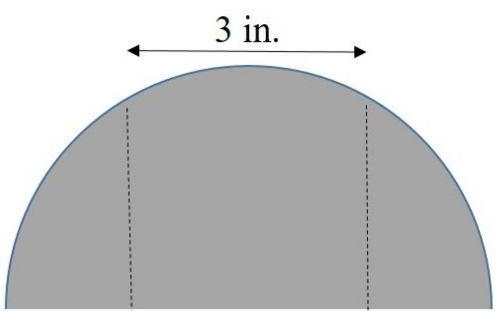

Figure 3.1.6. Sawing Diagram from Core Sample Into Prism for Testing

3.2 Absorption Testing (ASTM C1585)

Absorption was measured on 4 in. cubes according to ASTM C1585 for the TTE samples at UMKC. The sawn face was left exposed with all other faces sealed with 2.0 mil aluminum foil tape. Specimens were supported on plastic rebar stands and deionized water used for testing (Figure 3.2.1). Absorption testing was performed for one week beyond that specified in ASTM C1585 so data is reported to 15 days. The infiltration I is reported in mm and calculated using equation 3.2.

$$I = \frac{m_t}{a/d} \quad (3.2)$$

Where: I is the absorption, m_t is the change in mass in grams at time t, a is the exposed area of the specimen in mm^2, and d is the density of water at the lab temperature (23°C) in g/mm^3.

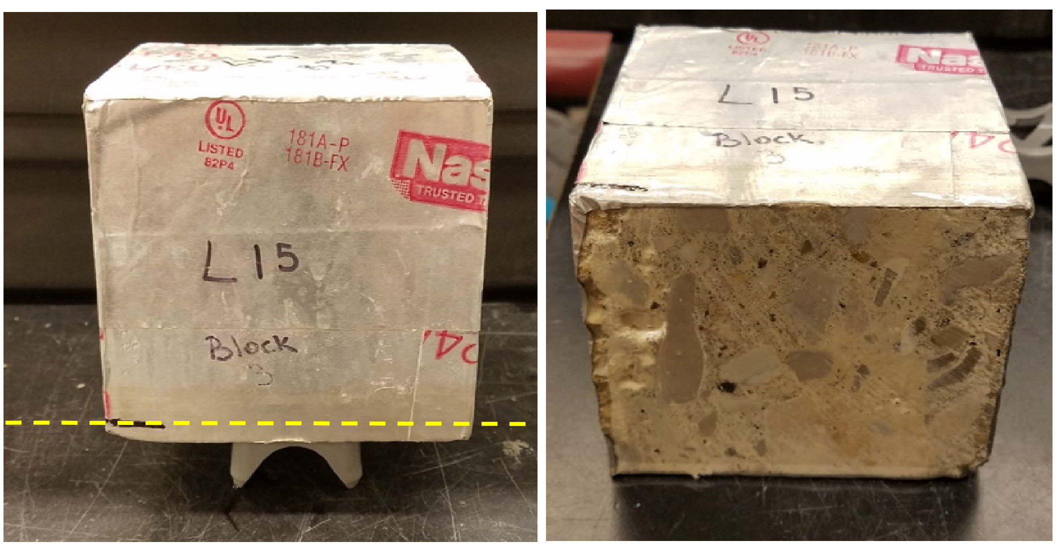

Figure 3.2.1. Sample for Absorption Testing

A portion of samples which showed high absorption were coated with a solvent-based silane (Prosoco SL100) at 200 sf/gallon. Samples were dried at 73°F and 50% RH for 14 days prior to coating with silane. After coating samples were allowed to dry 24 hrs before retesting.

For the DS testing, one core from each sealed and unsealed section as well as one of the mid-slab cores (7 cores total) were randomly selected for absorption testing at Marquette University. DS cores were sectioned into test specimens which only included the portion of the sawn face and conditioned following ASTM C1585 protocol.

Absorption testing was initially completed at Marquette University using both joint faces from each recovered core. For the center slab core, the core was saw cut in half vertically and then each half was sectioned near the top to simulate the exposed joint face from the 1.25" saw cut sub-section from which the center slab core was recovered. All core halves were then sectioned to provide an exposed joint face approximately 4 inches wide by the full depth of sawing.

After the initial round of absorption testing was completed, the joint core samples from the unsealed sub-sections were lab-sealed with silane penetrating sealer using a foam brush to coat the surface. After 48 hours of drying, the samples were again tested for water absorption.

3.3 Freeze-Thaw Durability (ASTM C666A)

Freeze-thaw durability was tested according to ASTM C666A, the fully saturated rapid testing procedure for samples investigating timing, technique, and equipment. Relative dynamic modulus and mass were measured every 30 cycles according to ASTM C215 (Figure 3.3.1). Since the samples extracted in the field had a maximum length of 12 inches the freeze-thaw samples were nominally 3 in. by 4 in. by 12 in. Since the standard testing pans are designed for 16 inch specimens, high performance concrete dummy blocks were inserted at either end of beams being tested for consistent mass and exposure. Figure 3.3.2 shows soft-cut sample sawn very early in the sawing window on the right with the track mark visible from the foot with a sample sawn later in the sawing window on the left.

Figure 3.3.1. Dynamic Modulus Testing

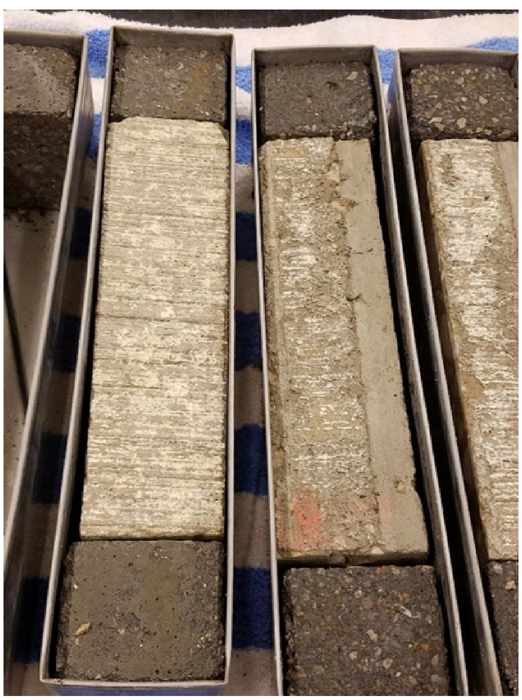

Figure 3.3.2. Freeze-Thaw Testing Setup

3.4 Modified Freeze-Thaw Durability (Modified ASTM C666) – (DS)

Since freeze-thaw durability of the field-sawn concrete was excellent, it was not possible to differentiate between any sawing permutations. A modified freeze thaw test was employed on the field core samples field to better differentiate performance. Testing was performed using standard ASTM C666A equipment and cycle timing except deicing fluid was introduced through one-dimensional capillary absorption from the bottom. After sawing to a width of 3 in., the sides and top of the sample were covered in aluminum tape used for absorption testing with the bottom of the specimen left uncovered. The concrete specimens were then supported on small stands in a 3% NaCl solution consistent with testing for deicer scaling as shown in Figure 3.4.1. The deicer solution was changed every 30 cycles. Relative dynamic modulus and weight testing were measured every 30 cycles until 300 cycles. Figure 3.4.2 shows dynamic modulus testing. All measurements were taken with the accelerometer placed on the smooth, sawn face.

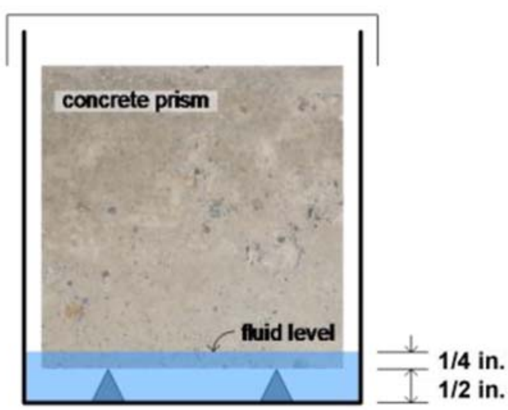

Figure 3.4.1. Schematic Diagram of the Modified Freeze-Thaw Test Employed on the Core Samples

Figure 3.4.2. Dynamic Modulus Testing

3.5 Deicer Scaling (ASTM C672) – (TTE)

Deicer scaling was tested using a version of ASTM C672 adapted to the specifics of testing joint performance. Typically the test setup is used to only determine the visual surface scaling index. Since the current study incorporated the joint, exposure included both the surface and the vertical joint face. Samples were first cleaned using an ultrasonic bath and dried at 73°F and 50% RH for 14 days prior to testing. For each permutation one sample was tested in the as-received condition and one coated with 40% silane. Silane-coated samples were allowed to dry a minimum of 24 hours before submersing in the deicer solution. Since this research was intended to investigate the influence sawing had on the physical properties, a 3% NaCl solution was used instead of $CaCl_2$ to prevent additional joint damage caused by calcium oxychloride formation. A concentration of 3% was selected to follow recommendations from RILEM TC 176-IDC *Internal damage of concrete due to frost action*. Figure 3.5.1 shows the test setup where a gap was left adjacent to the sawn joint face to allow full contact and horizontal deicing salt penetration through the joint face. Figure 3.5.2 shows two samples of the same permutation with the only difference that the left sample was coated with silane while the right was not coated. Visibly the right specimen has darkened where the deicing solution has soaked through the PAM curing compound and into the concrete. The left sample appears dry due to the water repellency of the silane penetrating sealer.

Figure 3.5.1. Deicer Scaling Sample Showing the Gap Along the Joint to Provide Deicing Solution Access

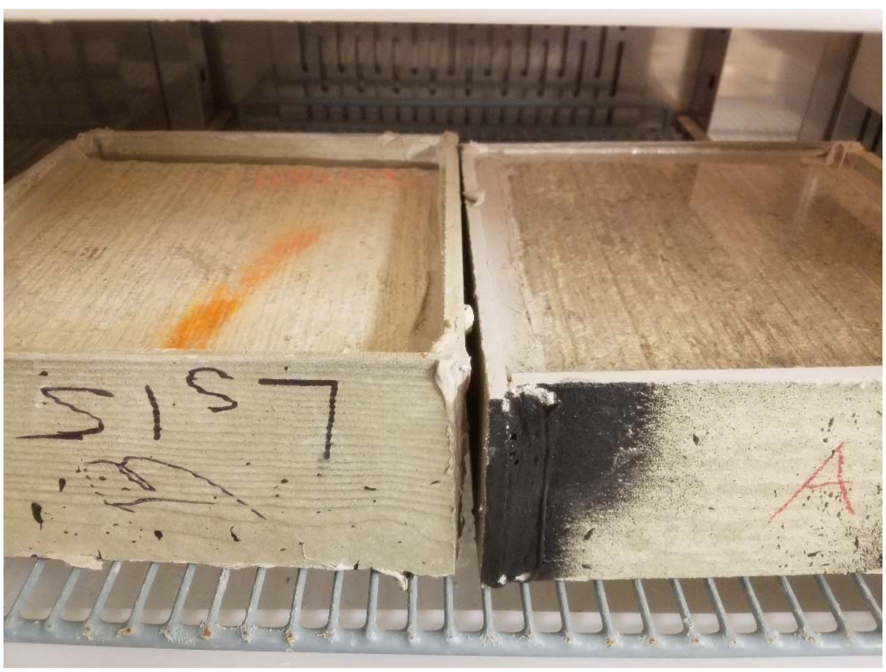

Figure 3.5.2. Deicer Testing with Silane (left) and Uncoated (right) Samples

All samples were tested until 50 cycles at a rate of one cycle per day. Once finished, testing samples were sawn perpendicular to the field-sawn joint face. Silver nitrate was applied to the perpendicular face as a chloride depth indicator. Silver nitrate forms silver chloride when the chloride concentration is above 165 ppm. Silver chloride is white and otherwise silver hydroxide will form, which is brown. Figure 3.5.3 shows the bisected field-cut face of L15 after applying silver nitrate. The joint face is located on the left-hand side of the picture and it can be clearly observed that penetration depth was greater through the joint face than from the surface. Penetration data is an average of three points measured from either the surface or joint face.

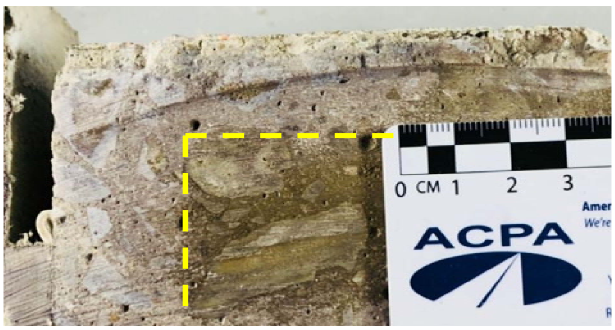

Figure 3.5.3. Silver Chloride Indication

CHAPTER 4

LABORATORY STUDY RESULTS

4.1 Introduction

The results reported are separated by the two different field placements. The first placement investigated saw timing, technique, and equipment **(**TTE**)** on both limestone and granite mixtures. For the TTE portion of the work absorption was used as the primary selection tool to rank samples for subsequent freeze-thaw and deicer scaling testing. The supporting hypothesis was that if absorption increased, then more durability distresses would be observed at the joint face. The second placement occurred at the CTH KC EB On-Ramp and investigated the impacts sawing depth and silane sealing **(DS)** had on absorption and freeze-thaw durability. All results shown for TTE evaluation are the average of three specimens from prisms created in the lab from larger field-sawn specimens. All results show for DS evaluation are an average of two prisms created in the lab from core specimens. Testing was based on the appropriate ASTM or AASHTO methods with any deviations previously described in Chapter 3.

4.2 General Sample Observations

All specimens for both TTE and DS evaluation arrived at UMKC without any notable damage observed from the shipping process. PAM curing compound was clearly visible on the broomed surface of all specimens. Limestone samples from the TTE portion of the research are shown in Figures 4.2.1 to 4.2.6. The samples sawn early in the sawing window for the early entry equipment all possessed marks where the shoe completely removed any tining (bottom of Figure 4.2.1) and where the tire compressed the surface (middle of Figure 4.2.1). While the research was intended to quantify impacts of very early sawing, in practice the surface marring would be unacceptable to an owner and traveling public. For the early entry sawing, the condition of the joint improved with progression in the timing window along with less impact to the surface texture. Figure 4.2.2 represents the gold standard technique for early entry. While the quality of the joint has improved, some marring of the surface was experienced. Figure 4.2.3 shows the late sawing window for the early entry equipment where both the joint and surface texture have not been impacted. Figure 4.2.4 to Figure 4.2.6 show the same timing progression for the conventional sawing equipment. All samples appear similar with generally better joint appearance than any of the early entry cuts.

Figure 4.2.1. TTE Limestone Sample of L01, Early Window Sawing for Early Entry (surface wet)

Figure 4.2.2. TTE Limestone Sample of L06, Gold Standard for Early Entry

Figure 4.2.3. TTE Limestone Sample of L10, Late Window Sawing for Early Entry Sawing

Figure 4.2.4. TTE Limestone Sample of L11, Early Window Sawing for Conventional Sawing

Figure 4.2.5. TTE Limestone Sample of L15, Gold Standard for Conventional Sawing

Figure 4.2.6. TTE Limestone Sample of L18, Late Window Sawing for Conventional Sawing (wet surface)

The granite surface condition is shown in Figures 4.2.7 to 4.2.10. The early entry sawing surface condition mirrored the limestone samples with some shoe and tire depression at the earliest age (Figure 4.2.7) and improvement in joint condition, yet surface marring at the gold standard for timing (Figure 4.2.8). No visual difference was observed between the conventionally-sawn granite mixture samples.

Figure 4.2.7. TTE Granite Sample of G01, Early Sawing Window for Early Entry Sawing (wet surface)

Figure 4.2.8. TTE Granite Sample of G06, Gold Standard for Early Entry Sawing

Figure 4.2.9. TTE Granite Sample of G15, Gold Standard for Conventional Sawing

Figure 4.2.10. TTE Granite Sample of G19, Late Sawing Window for Conventional Sawing

Often a comment and concern related to early entry sawing is the potential damage caused by disturbing aggregate within the concrete before the cement paste has gained strength. The timing of this research was able to capture very early age damage. Figure 4.2.11 shows typical damage for the early timing window and early entry-sawn limestone samples. For the limestone samples the aggregate did appear to have been disturbed and pulled towards the surface where the aggregate fractured against the shoe. The disturbance for the limestone mixture occurred directly beneath the sawing shoe. Figure 4.2.12 shows the typical early age damage for the granite mixture where movement of the coarse aggregate caused a crack directly adjacent to the shoe.

Figure 4.2.11. Joint Damage Observed for the Early Sawn Limestone Samples

Figure 4.2.12. Joint Damage Observed for the Early Sawn Granite Samples

The as-received core samples for the DS investigation are shown in Figures 4.2.13 to 4.2.15. The joint on all samples had activated and were free from debris or cutting fluid (Figure 4.2.16). The joint initiated near the saw tip in all cases and advanced around a majority of the adjacent coarse aggregate pieces. Generally, the tortuosity of the activated joint decreased as the saw depth increased.

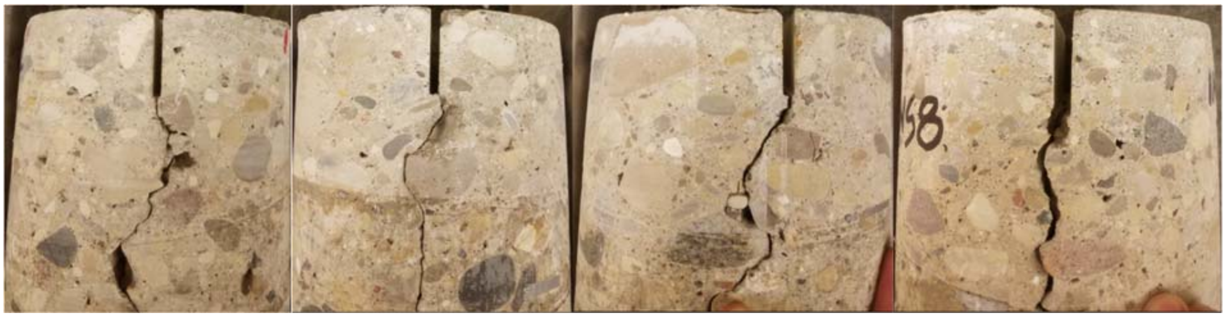

Figure 4.2.13. Core Samples Sawn to a Depth of 1.5 in.

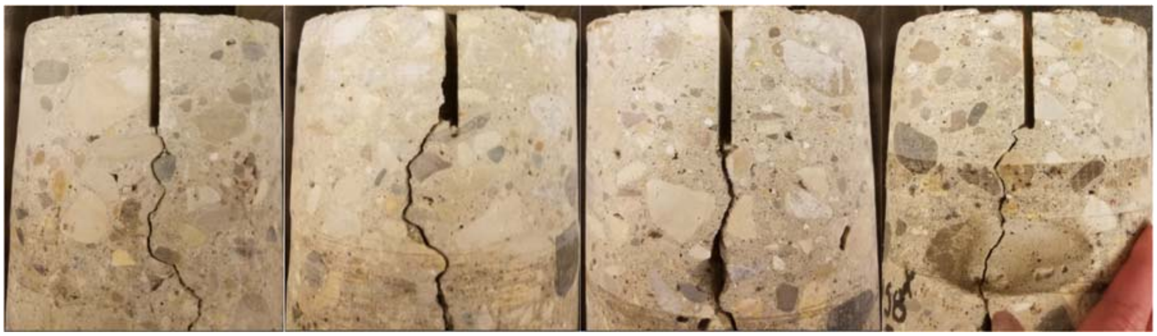

Figure 4.2.14. Core Samples Sawn to a Depth of 2.0 in. (D/4)

Figure 4.2.15. Core Samples Sawn to a Depth of 2.67 in. (D/3)

Figure 4.2.16. Core Samples Sawn to a Depth of 2.0 in. (D/4)

A 40% silane solution from the approved products list was applied at 150-200sf/gallon in the field to each of the saw depths. Figure 4.2.17 shows water beading on a sealed sample prior to freeze-thaw testing. Figure 4.2.18 attempts to show water absorption on a sealed sample after freeze-thaw testing. In general, the core samples had sufficiently deteriorated in freeze-thaw such that any material originally coated with silane was no longer present.

Figure 4.2.17. Sealed Core Sample Showing Hydrophobic Nature Before Testing

Figure 4.2.18. Sealed Core Sample Showing no Hydrophobic Nature After Freeze-Thaw Testing

4.3 Absorption Testing Results (ASTM C1585) – (TTE)

A sample of absorption testing results are shown in Figure 4.3.1 and Figure 4.3.2. Water is drawn into the samples one-dimensionally from the sawn face. Initially water absorbs very quickly which defines the initial absorption slope up to 6 hours. Absorption then enters a much slower absorption phase which defines the secondary absorption slope from 24 hours to seven days. Figures 4.3.1 and 4.3.2 are examples of the collected data and show a comparison between absorption performance of the limestone mixture with soft-cut sawing, performed very early in the sawing window for either a new limestone blade or an old limestone blade. One-dimensional absorption was able to distinguish between the equipment conditions with the new blade producing much lower and less variable absorption than the old blade. The entirety of the individual absorption results are provided in Appendices B and C. The following provides an analysis based on the averages of the triplicate testing along with ultimate absorption values.

Figure 4.3.3 shows the average absorption results comparing all permutations and specimens for soft-cut, conventional, early sawing window, and late sawing window. Not including the silane-treated specimens, the average absorption after two weeks was 3.99 mm with a standard deviation of 0.71 mm. The lowest absorption permutation was 2.75 mm and the highest was 5.04 mm. Comparisons were made against the mean using an analysis of variance on the final bulk absorption with $\alpha=0.05$. Four permutations were statistically significant for low absorption (L01, L09, L17, and L18). Interestingly enough, these were either soft-cut very early in the sawing window or conventionally cut late in the sawing window. Three permutations were statistically significant for high absorption (L8, L10, and L15). Two of which were soft-cut late in the sawing window, the other was cut at the optimal timing using the conventional saw and a new blade. Although only the optimally-timed saw cuts were placed with and without dowels, in all cases the doweled cuts had significantly less absorption than the undoweled versions cut under the same conditions.

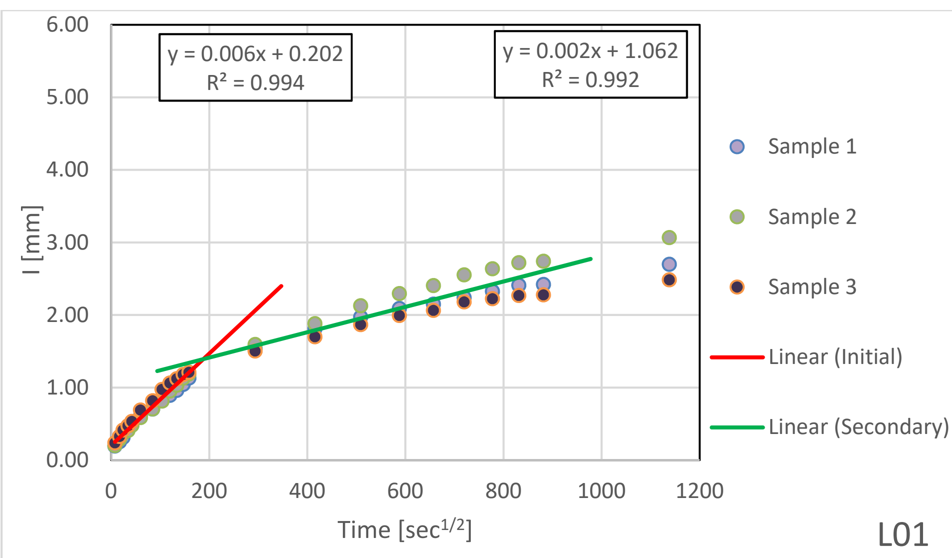

Figure 4.3.1. Absorption Results for L01 – Soft Cut Saw, Early Sawing Window, New Limestone Blade

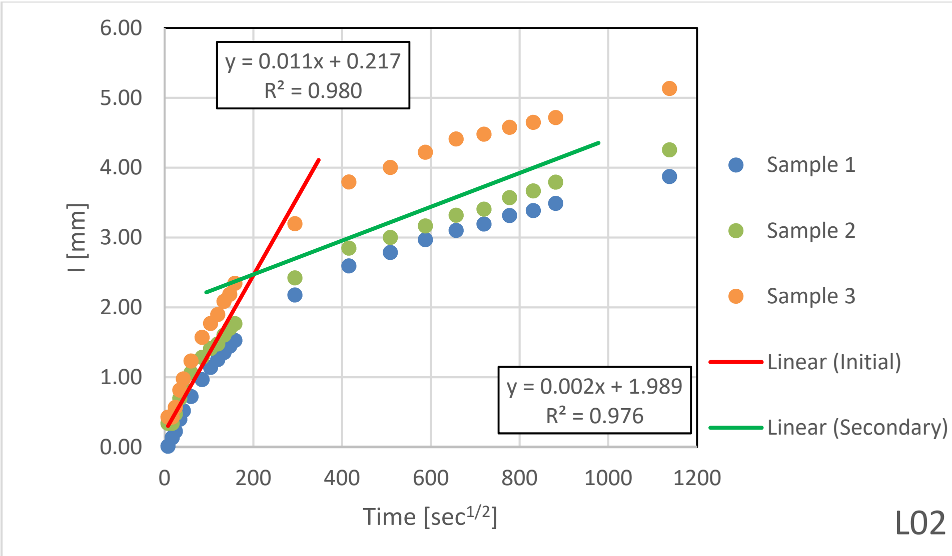

Figure 4.3.2. Absorption Results for L02 – Soft Cut Saw, Early Sawing Window, Old Limestone Blade

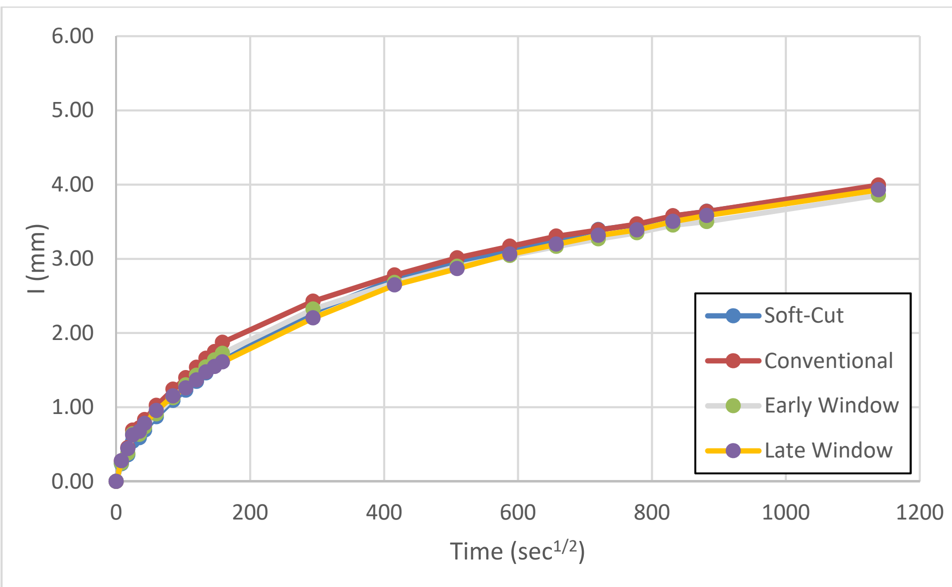

Figure 4.3.3. Average Performance Across Permutations for Equipment and Timing for the Limestone Aggregate

Figure 4.3.4 shows the results for all of the soft-cut limestone samples, with Figure 4.3.5 showing the conventional cut results. For the soft-cut results, two permutations produced statistically low absorption (L01 and L09) and two produced high absorption (L08 and L10). Across the results, sawing very early in the sawing window (for either soft-cut or conventional equipment) with new blades consistently produced lower absorption. Likewise, sawing with a worn blade consistently produced higher absorption with greater variability. For the conventionally sawn samples and for the limestone aggregate mixture, sawing late in the window with a granite blade produced the best results followed by sawing early in the window with either blade type. For either type of equipment the optimal saw timing produced comparatively high absorption.

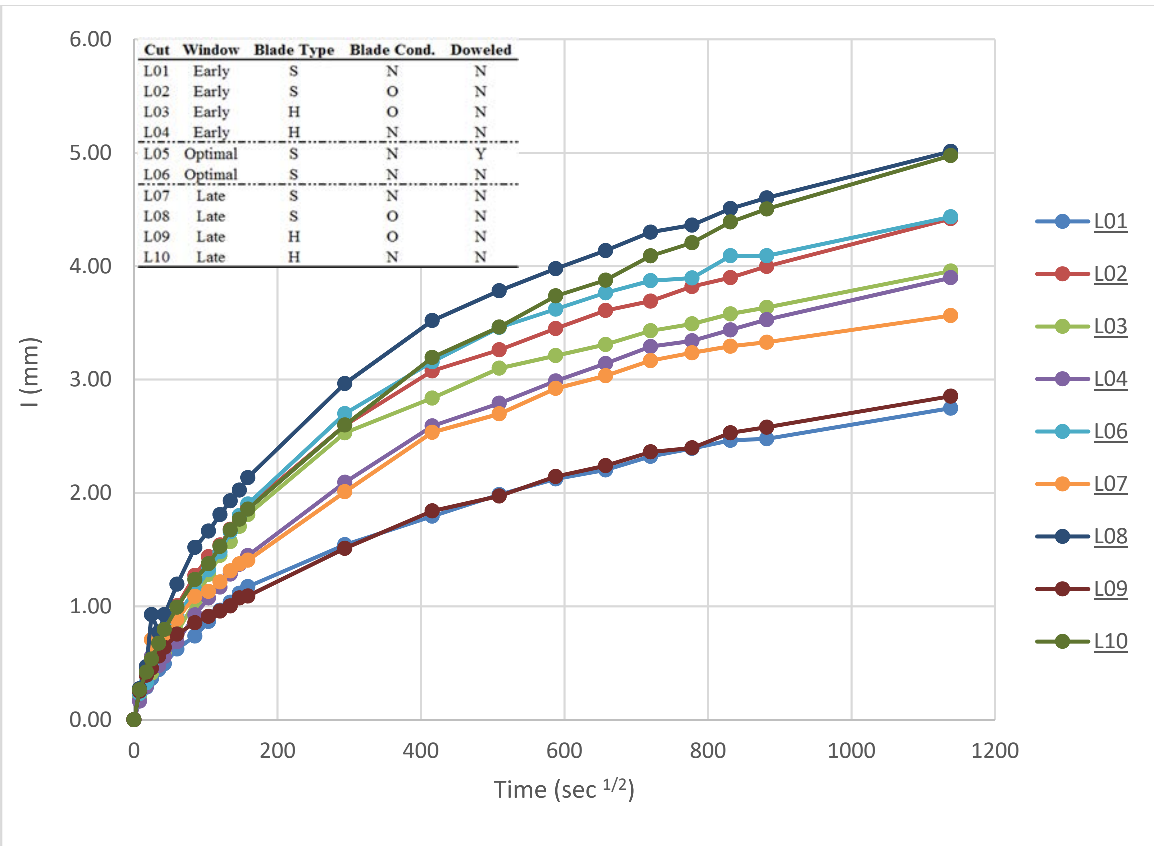

Figure 4.3.4. Comparison of Results for Soft-Cut Sawing of the Limestone Aggregate Mixture

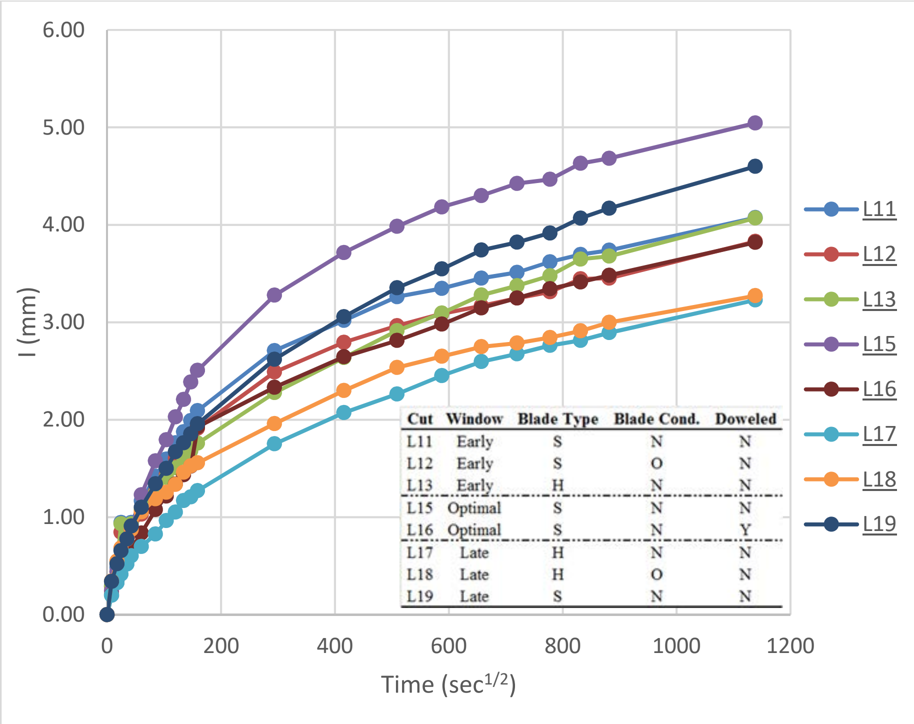

Figure 4.3.5. Comparison of Results for Conventional Sawing of the Limestone Aggregate Mixture

Figure 4.3.6 shows the comparison of all joints sawn early in the timing window for the limestone aggregate mixture. Other than L01, none of the permutations produced any difference and all were very near the average for the limestone samples. The results for joints sawn late in the timing window are shown in Figure 4.3.7, where results are either grouped together and significantly greater than the mean, or dispersed and less than the mean. L10 and L08, which were both were soft-cut late in the sawing window, had higher absorptions than the mean. L09, L17 and L18 all had absorptions less than the mean. Generally the granite blade produced better results.

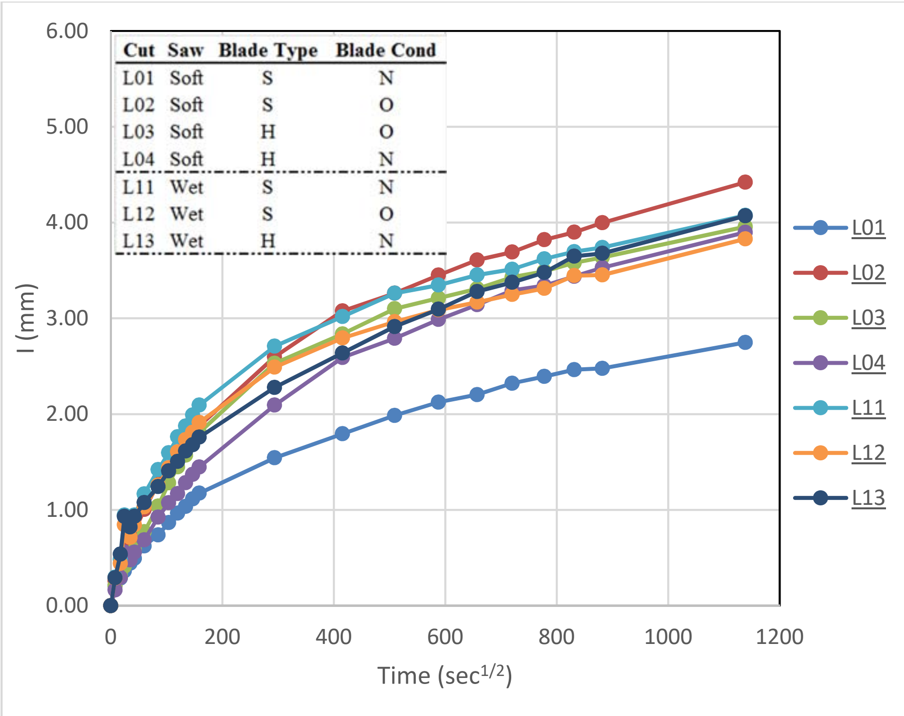

Figure 4.3.6. Comparison of Results for Early Sawing in the Timing Window of the Limestone Aggregate Mixture

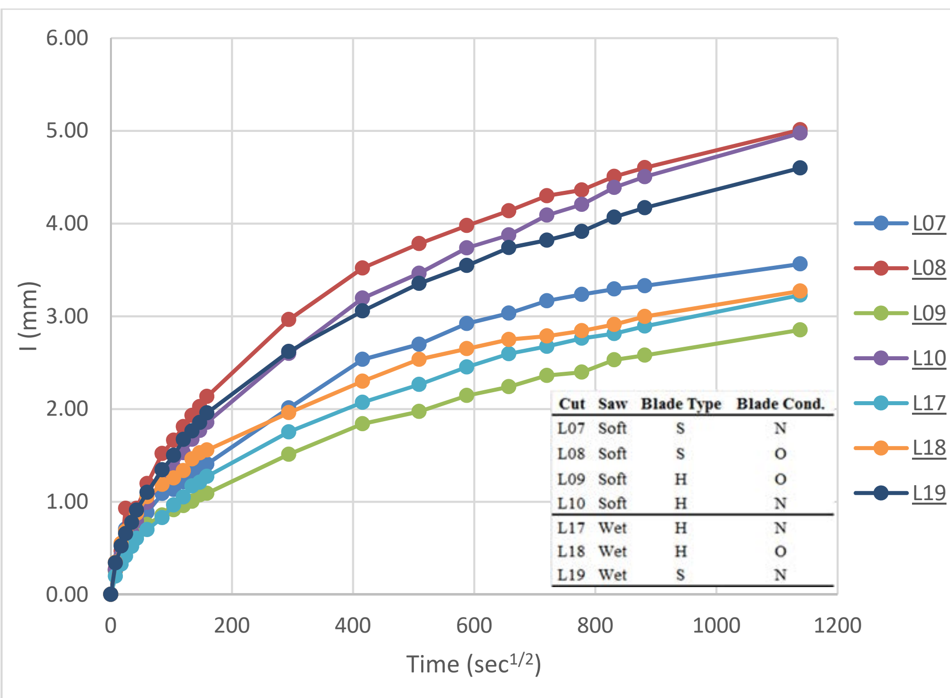

Figure 4.3.7. Comparison of Results for Late Sawing in the Timing Window of the Limestone Aggregate Mixture

After testing, the best performing permutation (L01) and the worst performing (L15) were coated with silane and retested. Figure 4.3.8 shows the untreated and treated results for the best performing L01 where silane treatment reduced the absorption by 72%. Figure 4.3.9 shows the same progression for the worst performing L15 permutation. For L15 the silane treatment reduced absorption by 62% and if compared to the untreated samples, took the worst performing mixture to the best.

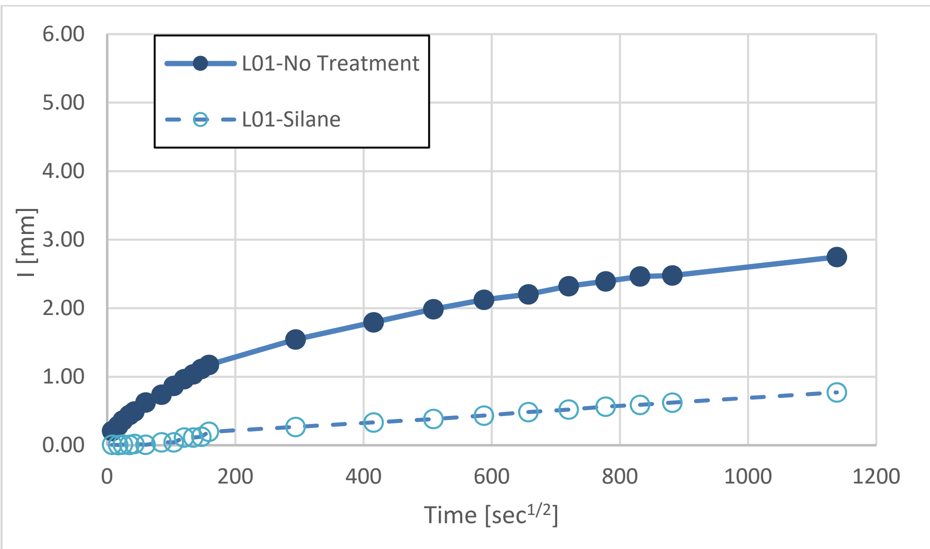

Figure 4.3.8. Absorption Results for L01 – Soft Cut Saw, Early Sawing Window, New Limestone Blade -Before and After Coating with Silane

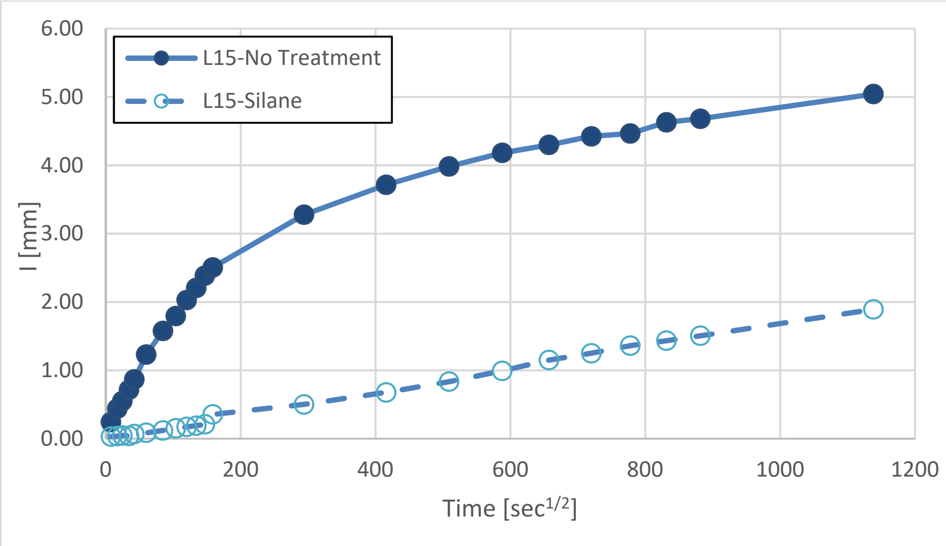

Figure 4.3.9. Absorption Results for L15 – Conventional Saw, Optimal Sawing Window, New Limestone Blade - Before and After Coating with Silane

Figures 4.3.10 and 4.3.11 show sample absorption results for the granite coarse aggregate mixture sawn using a soft-cut saw, early in the timing window with an appropriate blade in either new or old condition. Much like for the limestone aggregate mixture the new blade produced less absorption and lower variability. The average absorption for the granite permutations was lower at 3.34 mm with a standard deviation of 0.84 mm. Figure 4.3.12 shows the average results across permutations and samples for soft-cut, conventional, early timing window, and late timing window for the granite aggregate mixture. On average, sawing early in the window produced the lowest absorption followed by the soft-cut sawing. Two individual permutations had statistically significant low absorption (G01 and G03) and three with high absorption (G06, G15, G19). The two with the lowest absorption were soft-cut early in the sawing window. Of the three with the highest absorption, two were conventionally cut optimal to late in the sawing window and the other cut at the optimal time for the soft-cut equipment, all with new blades. As with the limestone aggregate mixture, the highest absorption occurred in the sample conventionally sawn optimal in the sawing window with a new blade appropriate for the coarse aggregate type.

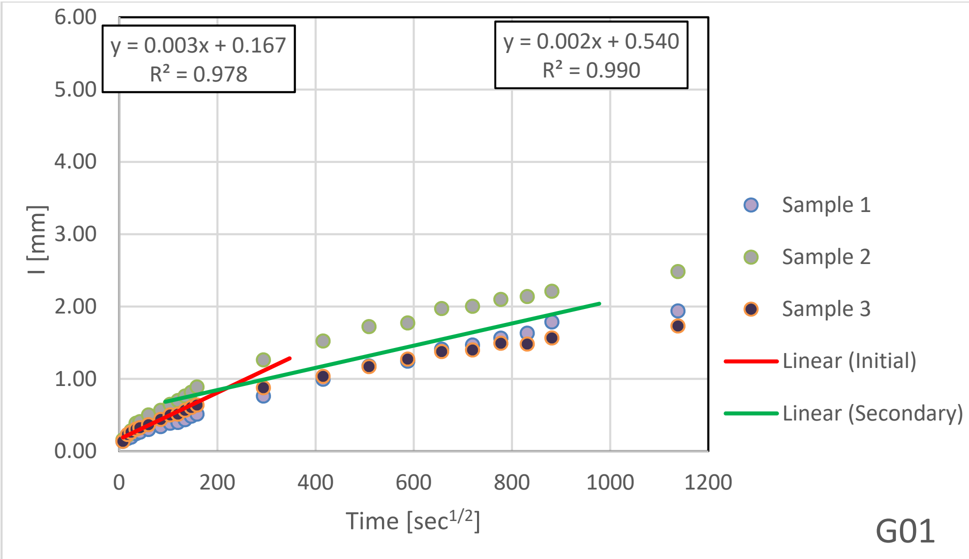

Figure 4.3.10. Absorption Results for G01 – Soft-Cut Saw, Early Timing Window, New Granite Blade

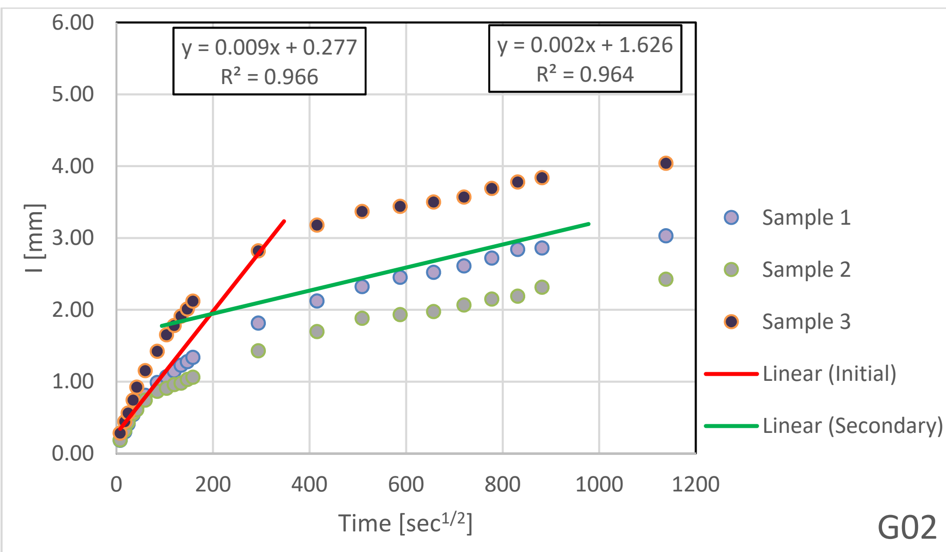

Figure 4.3.11. Absorption Results for G02 – Soft-Cut Saw, Early Timing Window, Old Granite Blade

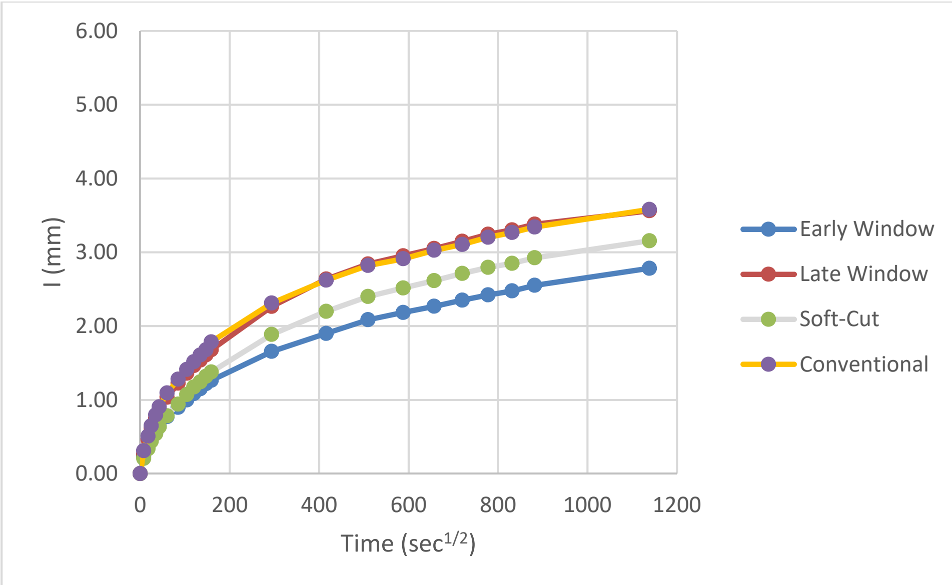

Figure 4.3.12. Average Absorption Results for All Granite Permutations Across Equipment and Timing

Figure 4.3.13 shows the comparison of all joints sawn early in the timing window for the granite aggregate mixture. G01 and G03 had significantly low absorption while G06 had higher absorption. The results for joints sawn late in the timing window are shown in Figure 4.3.14, where only G15 and G19 were different with higher absorption than the mean which were new granite blades sawn optimal to late in the sawing window.

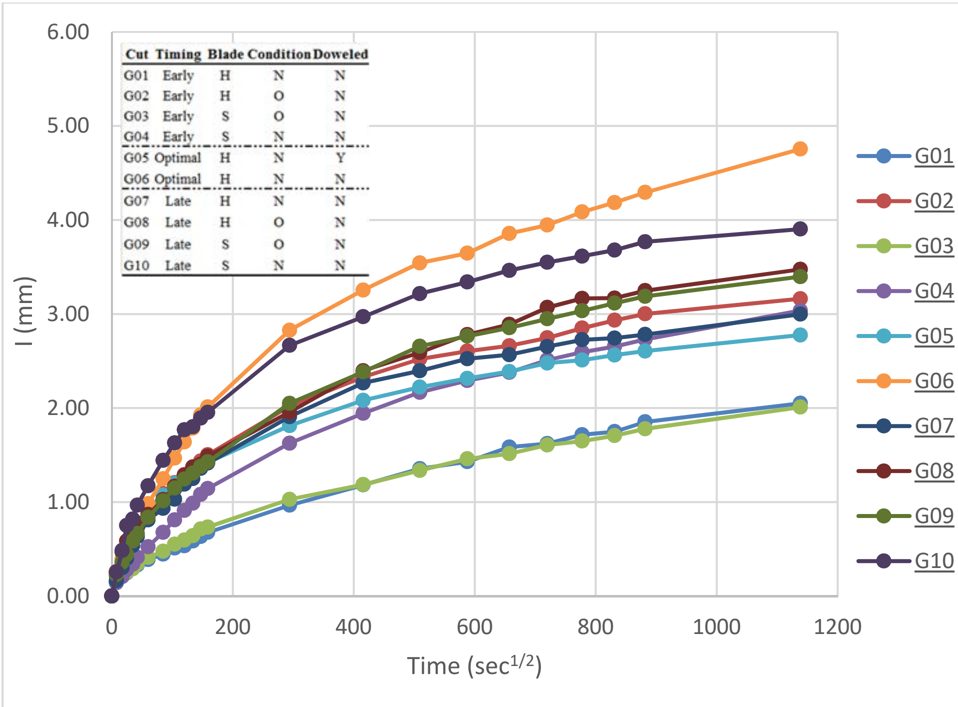

Figure 4.3.13. Absorption Results for Soft-Cut Sawing of the Granite Aggregate Mixture

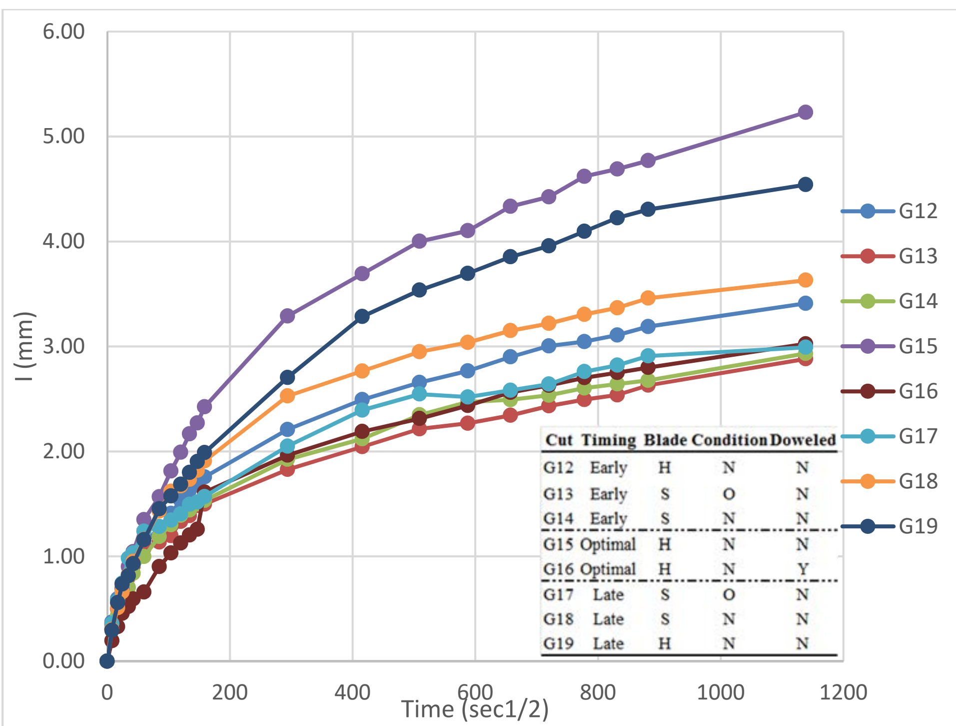

Figure 4.3.14. Absorption Results for Conventional Sawing of the Granite Aggregate Mixture

The effects of sawing timing window for the granite aggregate mixture are shown in Figure 4.3.15 and Figure 4.3.16. On average, sawing early in the sawing window produced the lowest absorption with G01 and G03 having statistically low absorption. Since blades used for harder aggregates (i.e, granites) are softer and more abrasive than ones used for soft aggregates (i.e., limestone), it is reasonable that a worn/old soft aggregate blade would produce similar performance to a new, hard aggregate blade under soft-cut conditions. Generally for the granite mixture, sawing later in the timing window produce higher absorption than when the concrete was sawn early. Permutations G15 and G19 had statistically high absorption compared to the average. Both were sawn at optimal timing or later using new granite blades.

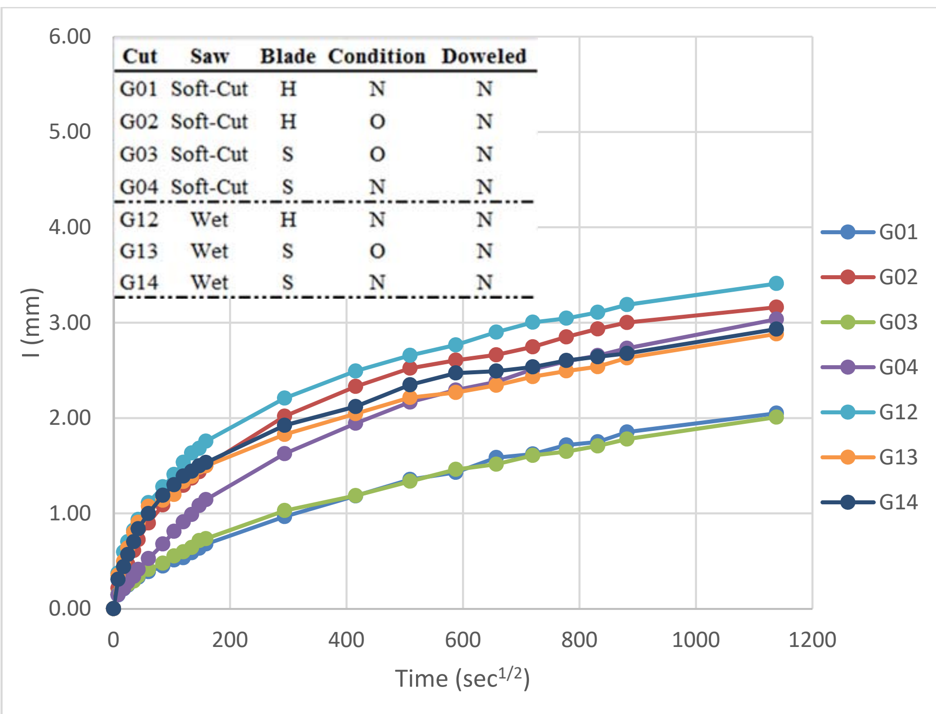

Figure 4.3.15. Absorption Results for Early Sawing Window for the Granite Aggregate Mixture

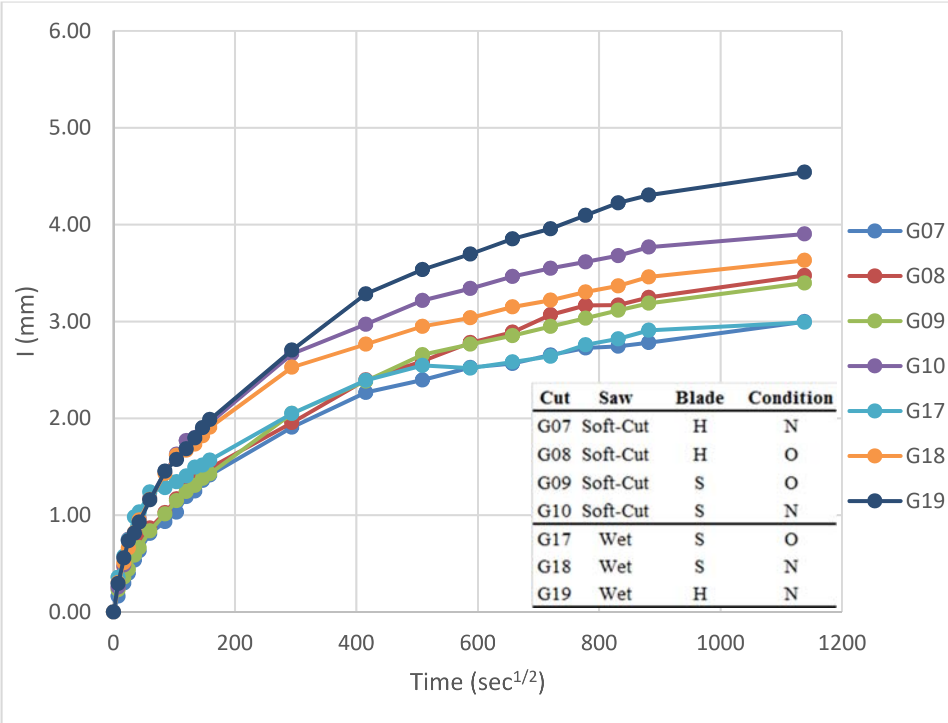

Figure 4.3.16. Absorption Results for Late Sawing Window for the Granite Aggregate Mixture

After testing the best performing sample (G01) and one of the worst performing samples (G19) for absorption were coated with silane and retested. The best permutation G01 (Figure 4.3.17) had a 58% reduction in absorption and G19 (Figure 4.3.18) saw a 66% reduction, again showing that silane coating was able to take one of the worst performing samples to the best.

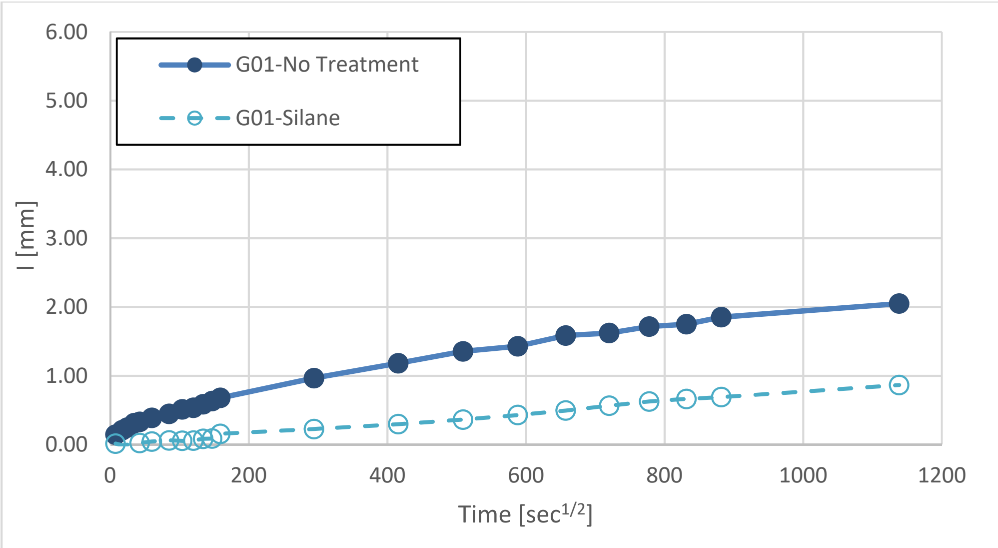

Figure 4.3.17. Absorption Results for G01 – Soft-Cut Saw, Early Timing Window, New Granite Blade – Before and After Coating with Silane

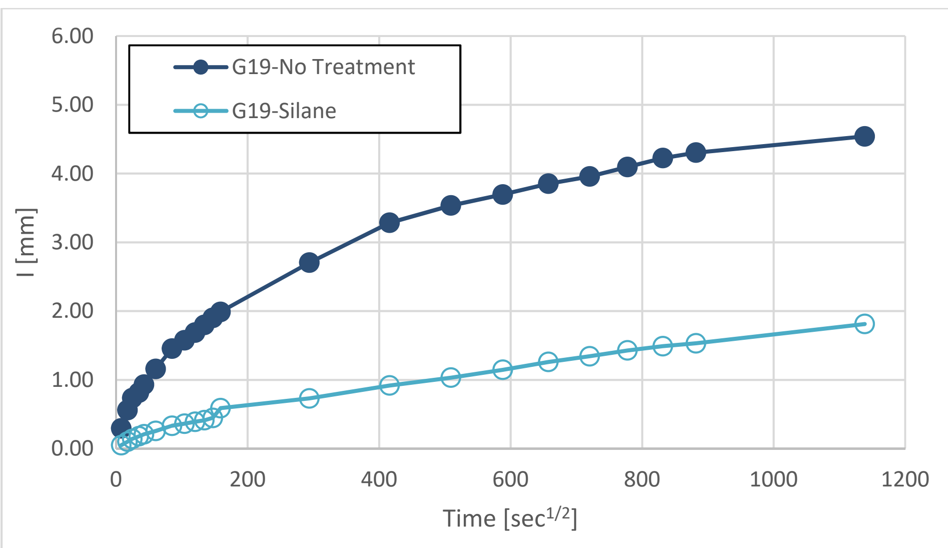

Figure 4.3.18. Absorption Results for G19 – Conventional Saw, Late Timing Window, New Granite Blade – Before and After Coating with Silane

Table 4.3.1 and Table 4.3.2 show the final absorption results for all permutations along with results of the statistical analysis. Samples with significantly higher or lower absorption were considered for long-term freeze-thaw and deicer scaling testing in addition to the gold standard treatments. The limestone mixture was much more sensitive to sawing technique, timing, and equipment (TTE) variables with incorrect combinations for the early entry equipment causing significantly higher absorption. For the limestone mixture, four treatments produced lower than average absorption values while two produced higher than average values. For the granite mixture, two treatments produced lower than average absorption values while only one higher.

Table 4.3.1. Final Absorption and Selection for Durability Testing of Limestone Mixture

Cut	Saw	Timing Window	Blade Type	Blade Condition	Doweled	Final Abs (mm)	Significant?
L01	Soft-Cut	Early	S	N	N	2.75	Yes, low
L02	Soft-Cut	Early	S	O	N	4.42	No
L03	Soft-Cut	Early	H	O	N	3.96	No
L04	Soft-Cut	Early	H	N	N	3.90	No
L05	Soft-Cut	Optimal	S	N	Y		Gold standard
L06	Soft-Cut	Optimal	S	N	N	4.43	Gold Standard
L07	Soft-Cut	Late	S	N	N	3.56	No
L08	Soft-Cut	Late	S	O	N	5.01	Yes, high
L09	Soft-Cut	Late	H	O	N	2.85	Yes, low
L10	Soft-Cut	Late	H	N	N	4.98	Yes, high
L11	Wet	Early	S	N	N	4.07	No
L12	Wet	Early	S	O	N	3.83	No
L13	Wet	Early	H	N	N	4.07	No
L15	Wet	Optimal	S	N	N	5.04	Gold Standard
L16	Wet	Optimal	S	N	Y	3.82	Gold standard
L17	Wet	Late	H	N	N	3.23	Yes, low
L18	Wet	Late	H	O	N	3.27	Yes, low
L19	Wet	Late	S	N	N	4.60	No

Table 4.3.2. Final Absorption and Selection for Durability Testing of Granite Mixture

Cut	Saw	Timing Window	Blade Type	Blade Condition	Doweled	Final Abs (mm)	Significant?
G01	Soft-Cut	Early	H	N	N	2.05	Yes, low
G02	Soft-Cut	Early	H	O	N	3.16	No
G03	Soft-Cut	Early	S	O	N	2.01	Yes, low
G04	Soft-Cut	Early	S	N	N	3.04	No
G05	Soft-Cut	Optimal	H	N	Y	2.78	Gold Standard
G06	Soft-Cut	Optimal	H	N	N	4.75	Gold Standard
G07	Soft-Cut	Late	H	N	N	3.00	No
G08	Soft-Cut	Late	H	O	N	3.47	No
G09	Soft-Cut	Late	S	O	N	3.40	No
G10	Soft-Cut	Late	S	N	N	3.90	No
G12	Wet	Early	H	N	N	3.41	No
G13	Wet	Early	S	O	N	2.88	No
G14	Wet	Early	S	N	N	2.93	No
G15	Wet	Optimal	H	N	N	5.23	Gold Standard
G16	Wet	Optimal	H	N	Y	3.02	Gold Standard
G17	Wet	Late	S	O	N	2.99	No
G18	Wet	Late	S	N	N	3.63	No
G19	Wet	Late	H	N	N	4.54	Yes, high

Interestingly enough, the early entry samples sawn early in the timing window, which experience visual damage (L01 and G01 for example), did not have high absorption. Since the theoretical "I" penetration only ranged between 2 and 5 mm, it is probable that significant damage existed outside of the absorption zone and not captured by absorption.

4.4 Freeze-Thaw Durability Testing Results (ASTM C666A) – Timing, Technique, and Equipment

All tested samples showed good freeze-thaw durability through 300 cycles. No significant impact was observed across the investigated sawing variables. It was been previously noted that for good quality concrete, 300 cycles of freezing and thawing in plain water may not be sufficient to evaluate durability (Kansas, 2012). Results are reported herein to 300 cycles per ASTM C666A/AASHTO T161 for all samples. Testing was performed up to 600 cycles for the gold standard treatments and the permutations with significant differences in absorption as shown in Tables 4.3.1 and 4.3.2.

Observations of deterioration were grouped into aggregate pop-outs (Figure 4.4.1) and paste deterioration (Figure 4.4.2). Generally, the mass loss from the limestone specimens was related to aggregate pop-outs, while mass loss from the granite specimens was limited to deterioration of the paste. However, a portion of the granite coarse aggregate did contain non-freeze-thaw durable aggregate which popped out.

Figure 4.4.1. Aggregate Pop-Out

Figure 4.4.2. Paste Deterioration and Erosion

Freeze-thaw results for the limestone mixture samples are shown in Figures 4.3.3 through 4.3.6, reported as the average for the three beams tested. No specimens failed either mass or relative dynamic modulus criteria at either 300 or 600 cycles. The poorest performing mixture (L01) had low absorption, but exhibited physical damage from the coarse aggregate crushing against the sawing shoe. However, the reduction in performance was not observed until well after the typical 300 cycles.

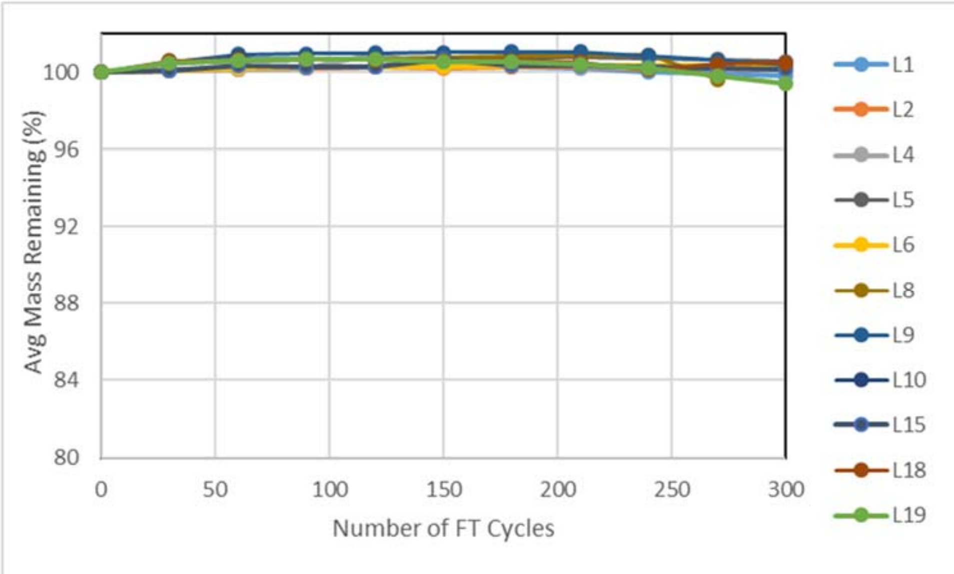

Figure 4.4.3. Limestone Freeze-Thaw Results Reported for Mass through 300 cycles

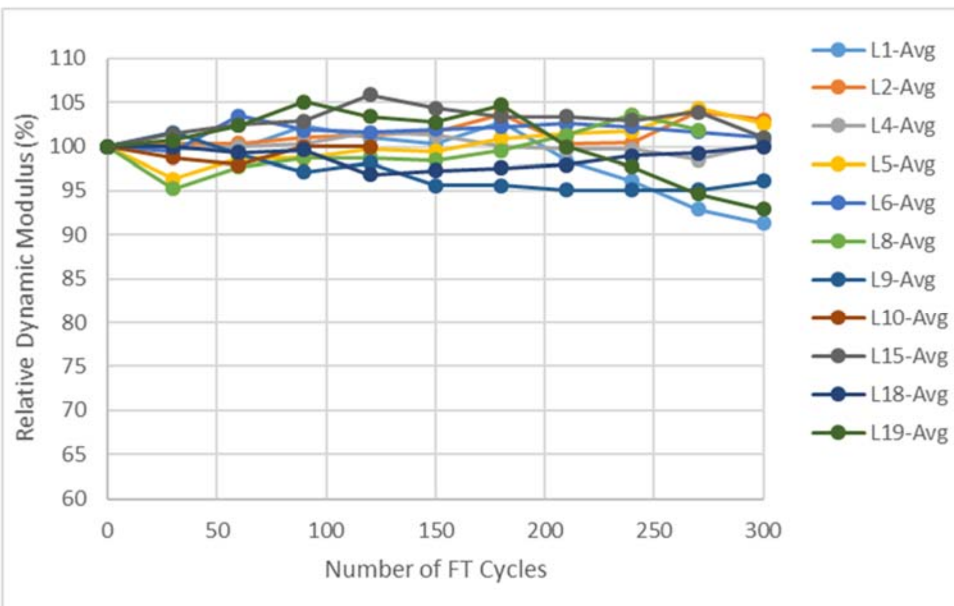

Figure 4.4.4. Limestone Freeze-Thaw Results Reported for Relative Dynamic Modulus through 300 cycles

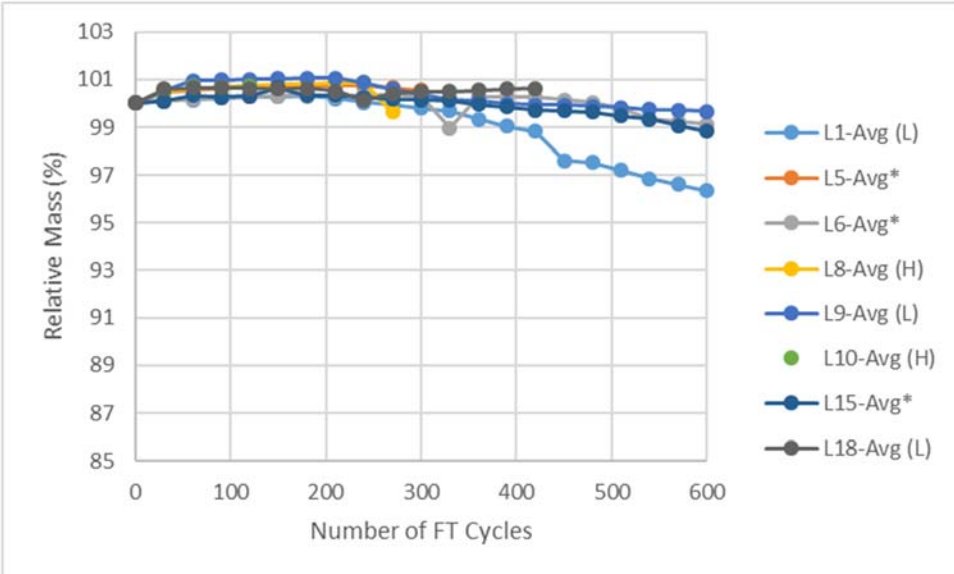

Figure 4.4.5. Limestone Freeze-Thaw Results Reported for Mass through 600 cycles

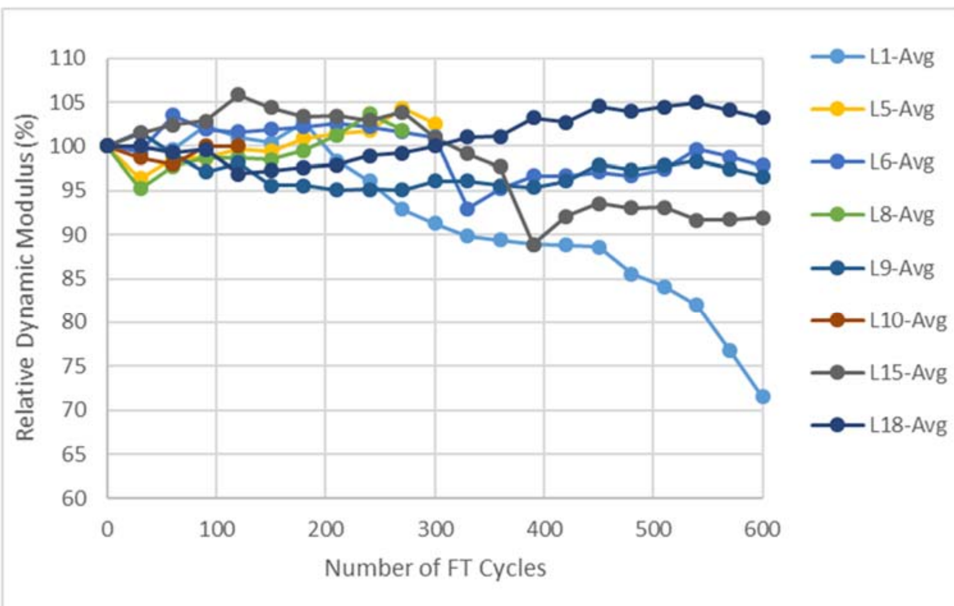

Figure 4.4.6. Limestone Freeze-Thaw Results Reported for Relative Dynamic Modulus through 600 cycles

Freeze-thaw results for the granite mixture samples are shown in Figures 4.4.7 through Figure 4.4.10. No samples failed either the mass or relative dynamic modulus criteria at 300 cycles. At 600 cycles, only G6 (undoweled, gold standard for early entry) failed the relative dynamic modulus criteria with a durability factor of 59.

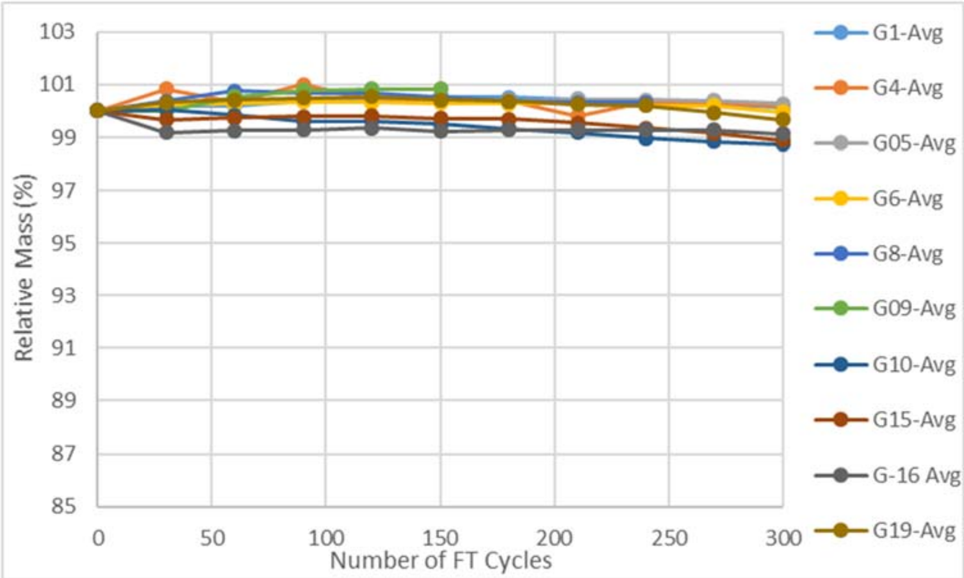

Figure 4.4.7. Granite Freeze-Thaw Results Reported for Mass through 300 cycles

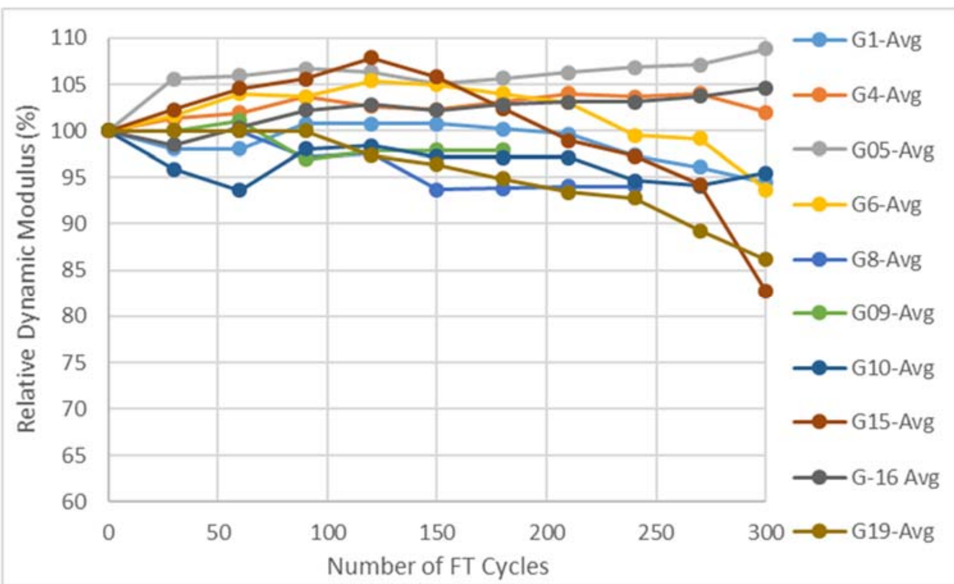

Figure 4.4.8. Granite Freeze-Thaw Results Reported for Relative Dynamic Modulus through 300 cycles

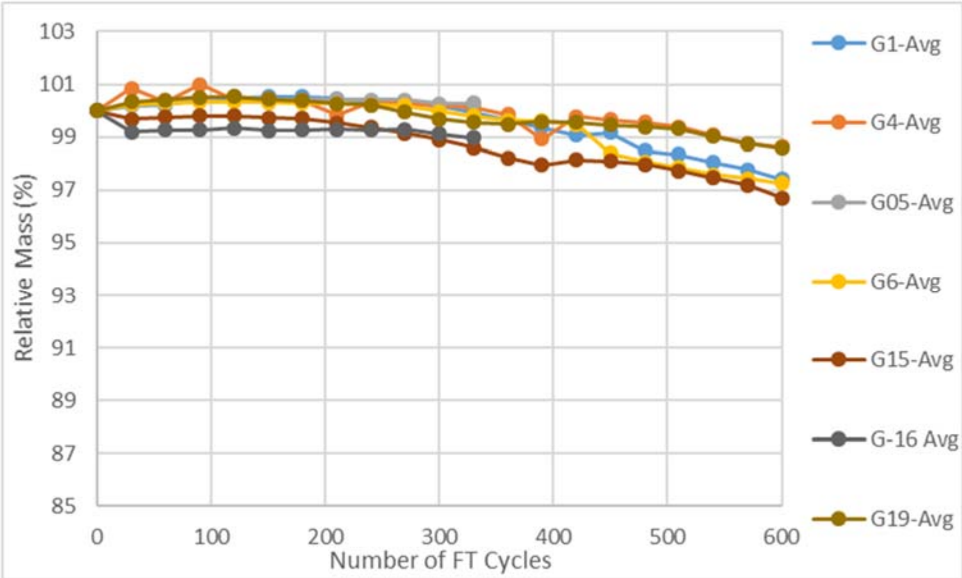

Figure 4.4.9. Granite Freeze-Thaw Results for Mass Through 600 Cycles

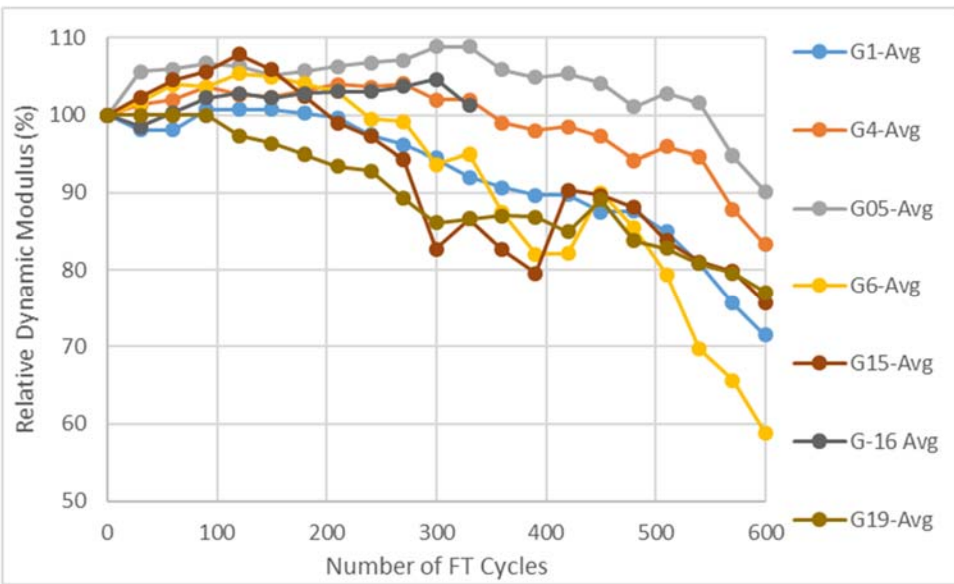

Figure 4.4.10. Granite Freeze-Thaw Results Reported for Relative Dynamic Modulus Through 600 Cycles

Unlike the limestone mixture, the early entry specimen which had visible damage (G01) did not experience abnormal or premature failure. Absorption did not correlate or predict performance in freeze-thaw testing. Figure 4.4.11 shows the worst performing limestone mixture with typical damage after 600 cycles. After 600 cycles, much of curing compound and tining had eroded along with some loss of material at the joint face. In all cases, at 600 cycles more paste had been eroded at the field-sawn face and surface than the sides cut in the laboratory.

Figure 4.4.11. Granite Mixture G06 after 600 Freeze-Thaw Cycles

4.5 Deicer Scaling Testing Results (modified ASTM C672) – (TTE)

Deicer scaling and chloride penetration results for the limestone samples are shown in Table 4.5.1 with untreated samples on top and silane-treated samples on the bottom. Silane significantly improved deicer performance with most coated samples visually having no difference after testing. Figure 4.5.2 shows the worst performing limestone sample before and after testing, while Figure 4.5.3 shows the same sawing permutation after testing, yet coated with silane. As shown in Figures 4.5.4 through 4.5.7, chloride penetration was not uniform and had similar penetration across sawing permutations and sealer treatments. The average chloride penetration along the joint was the same between the untreated and treated samples of 0.50 in. For the limestone samples, the penetration from the surface decreased from 0.50 in. for the untreated samples to 0.38 in. for the treated samples.

Table 4.5.1. Limestone Deicer Testing Results

Sample	Rating at 50 Cycles	Avg Joint Penetration(inches)	Avg Surface Penetration(In.)
L01	2	0.40	0.33
L05	2	0.50	0.40
L06	1-2	0.57	0.43
L08	1	0.73	0.67
L09	2-3		
L10	2-3	0.37	0.77
L15	1	0.52	0.57
L16	3-4		
L17	0	0.53	0.47
L18	2	0.40	0.40
Ls05	0	0.47	0.50
Ls06	0	0.47	0.27
LS08	1-2		
Ls09	1-2	0.63	0.40
Ls10	1	0.33	0.27
Ls15	0	0.63	0.47
Ls16	0	0.23	0.30
Ls17	0	0.63	0.47
Ls18	0	0.50	0.33

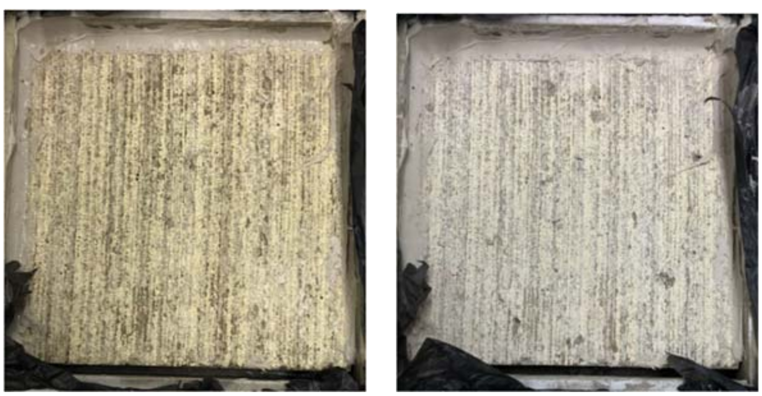

Figure 4.5.1. The Best Performing Limestone Mixture (L17) Before (left) and After (right) 50 Deicer Cycles

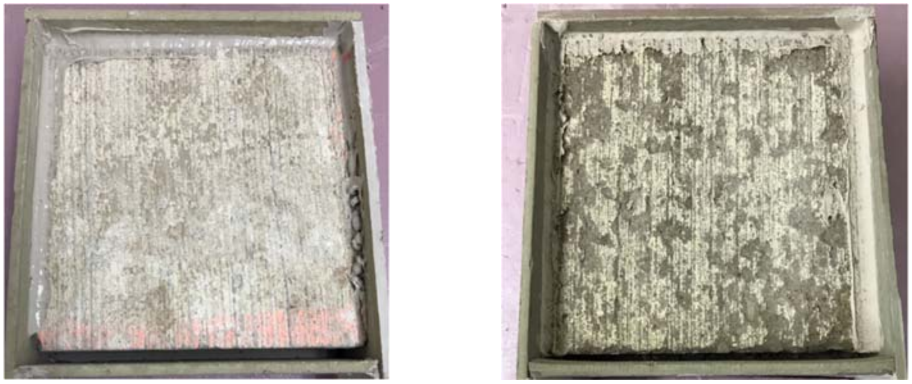

Figure 4.5.2. The Worst Performing Limestone Mixture (L16) Before (left) and After (right) 50 Deicer Cycles

Figure 4.5.3. The Silane-Coated Duplicate Sample to the Worst Performing Limestone Mixture (L16) After 50 Deicer Cycles

Figure 4.5.4. Chloride Penetration of the Best Performing Limestone Mixture (L17)

Figure 4.5.5. Chloride Penetration of Silane Coated Mixture (Ls17)

Figure 4.5.6. Chloride Penetration of Worst Performing Limestone Mixture (L16)

Figure 4.5.7. Chloride Penetration of Silane-Coated (Ls16)

The deicer results for the granite samples are shown in Table 4.5.2. Overall, the granite mixtures had better performance than the limestone mixture, with an improvement in performance between the untreated and silane-treated samples. Figure 4.5.8 shows the worst performing, although good, granite mixture after deicer scaling testing along with the coated version which was marginally better. Unlike the limestone samples, a significant and measurable reduction in chloride penetration was measured. The average penetration along the joint face reduced from 0.50 in. to 0.26 in. and from 0.45 in. to 0.27 in. from the surface. In previous research, silane and siloxane has been shown to reduce the chloride penetration with depth when applied to concrete produced with similar granite aggregate (Sutter and Anzalone, 2016). However, because of the similarly high quality concrete, improvements in the durability of the joints attributed to silane or siloxane sealers were not observed.

Table 4.5.2. Granite Deicer Testing Results

Sample	Rating at 50 Cycles	Avg Joint Penetration(inches)	Avg Surface Penetration(In.)
G01	1	0.80	0.83
G03	2	0.33	0.53
G05	2	0.33	0.33
G15	2	0.37	0.30
G16	2	0.83	0.27
G19	1	0.33	0.43
Gs03	0	0.07	0.07
Gs05	1	0.17	0.07
Gs06	0	0.43	0.73
Gs16	0	0.33	0.27
Gs19	0	0.30	0.23

Figure 4.5.8. The Worst Performing Granite Sample After Deicer Testing G05 Untreated (left) and Silane-Treated (right)

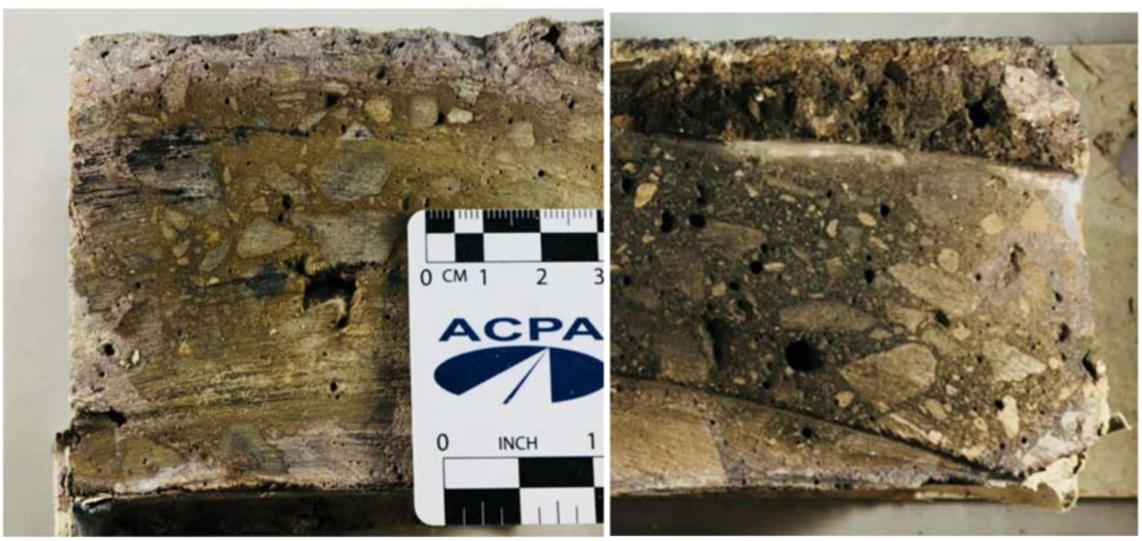

Figure 4.5.9. Chloride Penetration of G05 Untreated (left) and Silane-Treated (right)

4.6 Absorption Testing Results (ASTM C1585) – (DS)

Tables 4.6.1 and 4.6.2 provide the results from all absorption tests conducted at Marquette University. As shown in Table 4.6.1, there is a marked reduction in the initial absorption rates for all cores the were sealed both in the field and in the lab. However, as indicated in Table 4.6.2, there is little effect on the secondary absorption rates for all specimens. In fact, all of the secondary absorption rates for the lab-applied sealer were greater than the values obtained prior to sealing.

Table 4.6.1. CTH KC EB On-Ramp Test Results – Initial Absorption Rates

Test Section	Core ID	Core Location	Penetrating Sealant	I initial $\times10^{-4}$ mm/√sec	I,initial-ave $\times10^{-4}$ mm/√sec	I Ratio Not Sealed / Sealed
1.25"	C1A	Center	None	52.6	47.6	n.a.
	C1B	Center	None	42.5		
1.25"	1NS5A	Joint 5	None	66.5	50.2	n.a.
	1NS5B	Joint 5	None	33.9		
	1S9A	Joint 9	Field-Applied	18.3	18.0	2.8
	1S9B	Joint 9	Field-Applied	17.6		
	1NS5A	Joint 5	Lab-Applied	12.3	14.9	3.4
	1NS5B	Joint 5	Lab-Applied	17.5		
T/3	3NS10A	Joint 10	None	36.5	35.8	n.a.
	3NS10B	Joint 10	None	35.0		
	3S9A	Joint 9	Field-Applied	17.7	12.5	2.9
	3S9B	Joint 9	Field-Applied	7.3		
	3NS10A	Joint 10	Lab-Applied	7.0	9.0	4.0
	3NS10B	Joint 10	Lab-Applied	11.0		
T/4	4NS10A	Joint 10	None	24.5	32.6	n.a.
	4NS10B	Joint 10	None	40.7		
	4S3A	Joint 3	Field-Applied	5.6	9.4	3.5
	4S3B	Joint 3	Field-Applied	13.1		
	4NS10A	Joint 10	Lab-Applied	8.1	8.5	3.9
	4NS10B	Joint 10	Lab-Applied	8.8		

Table 4.6.2. CTH KC EB On-Ramp Test Results – Secondary Absorption Rates

Test Section	Core ID	Core Location	Penetrating Sealant	I, secondary x10^{-4} mm/√sec	I, secondary-ave x10^{-4} mm/√sec	I Ratio Not Sealed / Sealed
1.25"	C1A	Center	None	5.6	5.2	n.a.
	C1B	Center	None	4.7		
1.25"	1NS5A	Joint 5	None	4.8	5.5	n.a.
	1NS5B	Joint 5	None	6.1		
	1S9A	Joint 9	Field-Applied	3.5	4.2	1.3
	1S9B	Joint 9	Field-Applied	4.8		
	1NS5A	Joint 5	Lab-Applied	8.4	7.2	0.6
	1NS5B	Joint 5	Lab-Applied	6.0		
T/3	3NS10A	Joint 10	None	1.1	1.4	n.a.
	3NS10B	Joint 10	None	1.7		
	3S9A	Joint 9	Field-Applied	3.3	2.5	0.6
	3S9B	Joint 9	Field-Applied	1.6		
	3NS10A	Joint 10	Lab-Applied	7.5	4.6	0.5
	3NS10B	Joint 10	Lab-Applied	1.7		
T/4	4NS10A	Joint 10	None	2.9	2.5	n.a.
	4NS10B	Joint 10	None	2.0		
	4S3A	Joint 3	Field-Applied	1.9	2.3	1.1
	4S3B	Joint 3	Field-Applied	2.7		
	4NS10A	Joint 10	Lab-Applied	8.1	8.8	0.3
	4NS10B	Joint 10	Lab-Applied	9.4		

4.7 Modified Freeze-Thaw Durability Testing Results (ASTM C666CDF) – (DS)

Freeze-thaw durability testing results are shown in Table 4.7.1 for mass and 4.7.2 for relative dynamic modulus and are an average of two tests from both halves of the joint. The total mass trended higher with testing age, which was expected as microcracks provided more space to retain the deicer solution before material flakes. Although significant erosion was observed at the sawn joint, the amount of mass lost was not enough to be observed. Two sets of samples had outlying performance observed from relative dynamic modulus testing. The cores obtained from joint 8 had much lower performance than any of the samples.

Table 4.7.1. Mass Loss Results

			Relative Mass (%)								
Saw Depth	Condition	Joint Number	0	30	60	90	120	150	180	240	300
1.5 in.	Not Sealed	2	100	100	101	101	101	101	101	101	101
	Not Sealed	8	100	100	101	101	101	101	101	101	101
	Sealed	4	100	100	101	101	101	101	101	101	100
	Sealed	8	100	100	101	101	101	101	101	101	101
T/4 (2.0 in.)	Center	10	100	101	101	101	101	101	101	102	102
	Not Sealed	3	100	100	101	93	101	101	101	101	101
	Not Sealed	7	100	101	101	101	101	101	101	101	101
	Sealed	1	100	100	101	101	101	101	101	101	101
	Sealed	8	100	100	101	101	101	101	101	101	101
T/3 (2.67 in.)	Center	20	100	101	101	101	101	101	102	102	102
	Not Sealed	5	100	101	101	101	101	102	102	102	102
	Not Sealed	2	100	100	101	101	101	101	101	101	102
	Sealed	8	100	101	101	101	101	101	101	101	100
	Sealed	6	100	100	101	101	101	101	101	101	101

Table 4.7.2. Relative Dynamic Modulus Results

			Relative Dynamic Modulus (%)								
Saw Depth	Condition	Joint Number	0	30	60	90	120	150	180	240	300
1.5 in.	Not Sealed	2	100	98	95	96	99	96	97	93	93
	Not Sealed	8	100	96	95	96	94	91	92	79	93
	Sealed	4	100	98	97	97	98	96	98	97	100
	Sealed	*8*	*100*	*100*	*97*	*98*	*78*	*77*	*76*	*81*	*69*
T/4 (2.0 in.)	Center	10	100	99	99	100	102	100	99	97	99
	Not Sealed	3	100	98	98	107	100	97	99	100	100
	Not Sealed	7	100	98	97	98	98	96	99	97	98
	Sealed	1	100	98	92	98	98	98	98	98	100
	Sealed	8	100	98	98	89	102	100	102	96	98
T/3 (2.67 in.)	Center	20	100	98	98	98	93	97	94	97	97
	Not Sealed	5	100	99	98	100	100	100	98	95	93
	Not Sealed	2	100	97	97	99	98	97	97	99	100
	Sealed	*8*	*100*	*97*	*97*	*97*	*98*	*96*	*95*	*72*	*76*
	Sealed	6	100	97	98	97	98	95	100	98	99

Although tested in NaCl solution, performance was very good through 300 cycles for both mass and relative dynamic modulus. Figure 4.7.1 presents the data as a function of treatment and Figure 4.7.2 of sawing depth. No statistical difference can be observed between any treatment or sawing depth when the two outlying sets of data are omitted.

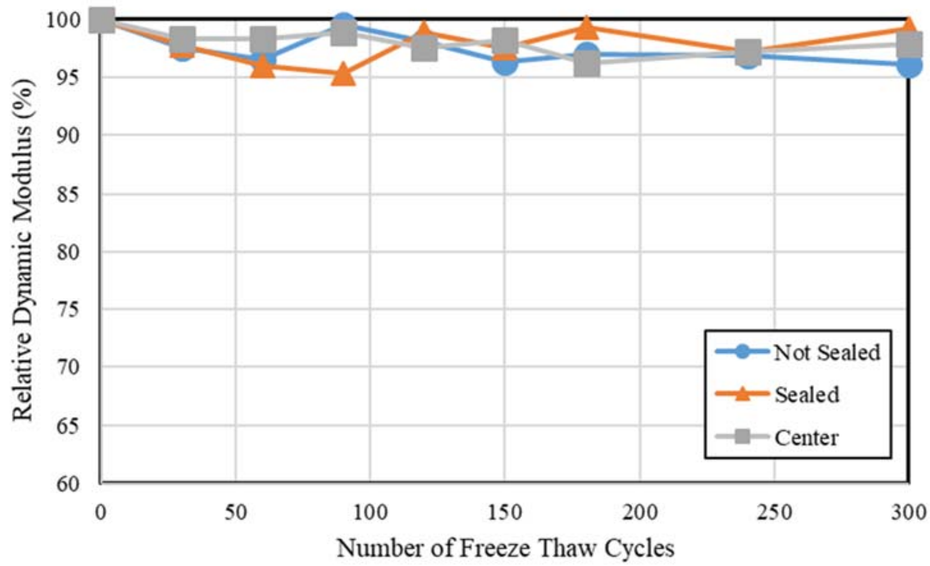

Figure 4.7.1. Freeze-Thaw Results Grouped by Treatment

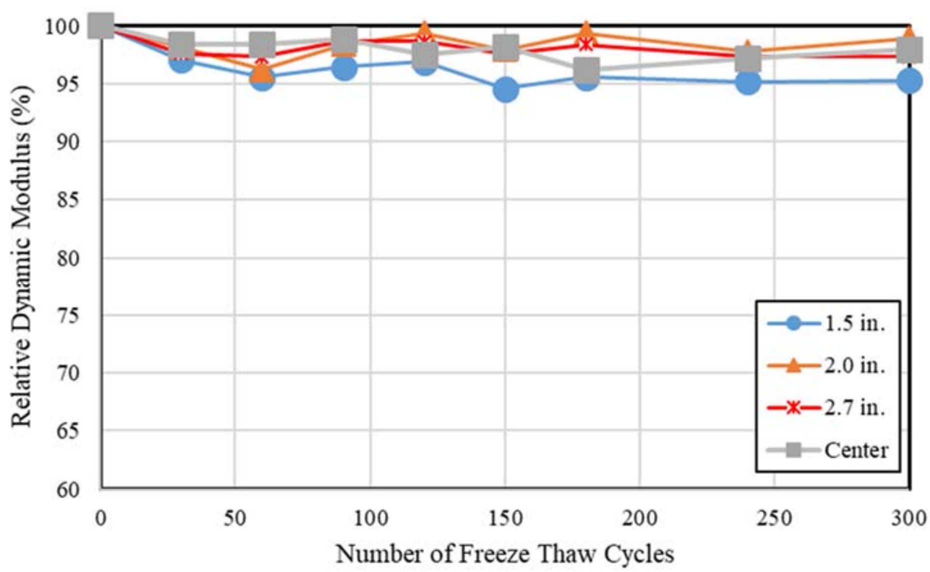

Figure 4.7.2. Freeze-Thaw Results Grouped by Depth of Sawing

After freeze-thaw testing in the deicer solution, a visual rating was performed on the sawn faces using the same criteria as ASTM C672 scaling. Table 4.7.3 provides the core location and rating. Performance using the visual criteria was directly related to the depth of sawing with the deepest saw cuts having the best performance. In all cases, the silane-treated samples had worse performance than the untreated samples. It appeared that the paste containing the silane treatment eroded, leaving several millimeters of exposed aggregate, as shown on the righthand portion of Figure 4.7.3 and 4.7.4. By comparison, the core samples had little to no visual deterioration, with Figure 4.7.5 included as a reference.

Table 4.7.3. Visual rating of the sawn faces

Saw Depth	Condition	Joint Number	Visual Rating
1.5 in.	Not Sealed	2	3
	Not Sealed	8	3
	Sealed	4	4
	Sealed	*8*	*4-5*
T/4 (2.0 in.)	Center	10	1
	Not Sealed	3	1-2
	Not Sealed	7	1-2
	Sealed	1	3
	Sealed	8	4-5
T/3 (2.67 in.)	Center	20	1
	Not Sealed	5	1
	Not Sealed	2	1
	Sealed	*8*	*3*
	Sealed	6	3-4

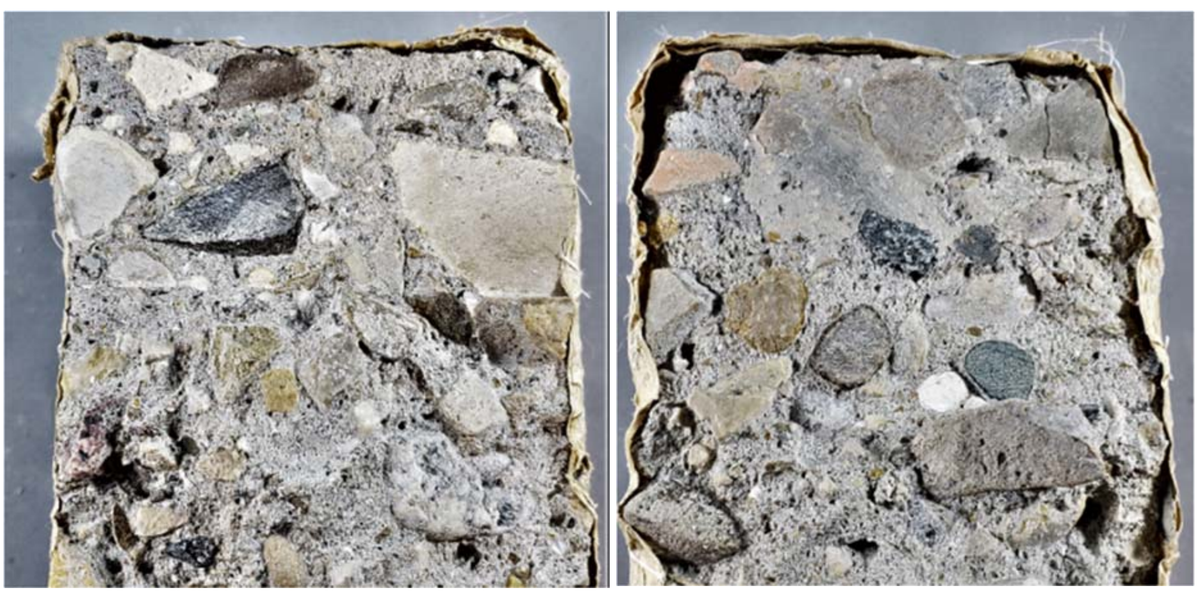

Figure 4.7.3. Samples with 1.5 in. Sawn Face Unsealed (left) and Sealed (right)

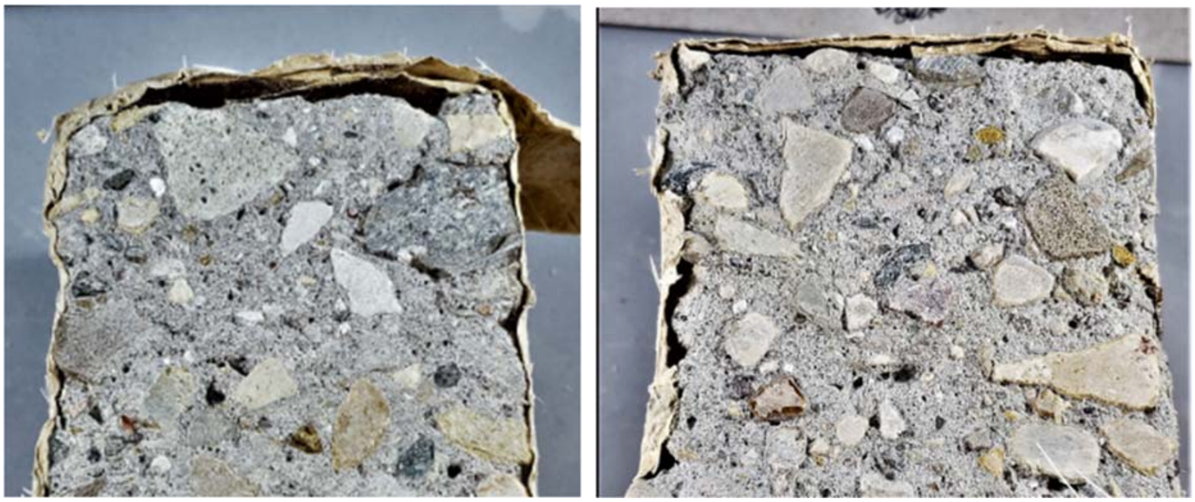

Figure 4.7.4. Samples D/3 Sawn Face Unsealed (left) and Sealed (right)

Figure 4.7.5. Core Sample After Testing

CHAPTER 5
EVALUATION OF IN-SERVICE PAVEMENT TEST SECTIONS

5.1 Introduction

A number of concrete pavement sections have been built in Wisconsin using early entry saw cuts to form the transverse contraction joints. In some instances, early-age joint distress has been observed and more information is needed to fully describe the distress mechanisms. To supplement the findings of the research test section and related laboratory analyses, a listing of candidate projects was provided by Mr. Kevin McMullen of the Wisconsin Concrete Pavement Association, representing various levels of observed early-age joint distress. Project locations selected for field visits and core recovery to better understand joint performance are provided in Table 5.1.1.

Table 5.1.1. Selected In-Service Project Locations

Highway	County	Saw Cut Method	Year of Construction
USH 12 Baraboo to Lake Delton	Sauk	Early Entry	2011
Birch St. Spring St. to Hastings Way	Eau Claire	Early Entry	2010
CTH OO Hastings Way to USH 53	Chippewa	Early Entry	2005
IH 94 USH 53 to STH 37	Eau Claire	Early Entry	2013

5.2 USH 12, Sauk County

This project was constructed in June 2011 and included Baraboo Quartzite as the primary coarse aggregate. Transverse joints were formed using early entry saws. An initial field visit was made in November, 2015 to observe transverse joint conditions. Observations along the mainline pavements indicated the joints were performing well, with sporadic locations of minor joint spalling. There were some locations where the pavement surface appeared rougher in texture and where the transverse joints has appreciable spalling.

A second field visit was made in December, 2015, to extract pavement cores from joints with and without noticeable surface distress and from mid-slab locations near these selected joints. Initial coring efforts were focused on a section of Eastbound USH12 near the project terminus. At this location, the transverse joints exhibited appreciable spalling as well as surface spalling running adjacent to, and parallel to the transverse joints. Figure 5.2.1 provides a photo of this joint condition taken during the November field visit. Based on earlier discussions with the Husqvarna field crews during the test section construction, it appeared that this joint condition was developed due to sawing too early in the sawing window. A pavement core was obtained from this joint as well as from a nearby joint without this noticeable distress and from an adjacent mid-slab location.

A second location along the westbound entrance ramp, just north of STH 33 / Pit Road, was selected for coring due to the observance of appreciable joint spalling as well as parallel cracking that had not yet led to spalling. Figure 5.2.2 provides a photo of this joint condition taken during the November field visit.

Figure 5.2.1. Joint Condition Along EB USH 12, November 2015

Figure 5.2.2. Joint Condition Along WB USH 12 On-Ramp, November 2015

5.3 Birch Street, Eau Claire County

This project was constructed in 2010 with transverse joints formed using early entry saws. An initial field visit was made in May, 2015 to observe transverse joint conditions. Observations along the pavements west of Hastings indicated the majority of joints had minor spalling/fraying along the majority of the joint length. Figure 5.3.1 provides a photo of this joint condition taken during the May field visit.

A second visit was made in August, 2016 to collect cores from selected locations within the intersection area of Birch St and Starr Ave. The right turn lane from SB Starr Ave. to WB Birch St was isolated by traffic control to allow for coring operations to be completed. Figure 5.3.2 provides a photo of this location taken during the August, 2016 field visit, with some of the selected core locations identified with white circular paint marks. Three joint cores were extracted, two of which were at locations with moderate joint spalling (previously sealed) and one from a joint with very minor spalling/fraying (previously sealed). Cores were also obtained from mid-slab locations adjacent to each joint coring location.

Figure 5.3.1. Typical Joint Condition Along Birch Street, May 2015

Figure 5.3.2. Coring Location at Starr Ave & Birch Street, August 2016

5.4 CTH OO, Chippewa County

This project location incorporates two separate construction projects. The intersection area just east of STH 124 was constructed under one contract and is exhibiting extensive transverse and longitudinal joint deterioration. The pavement section immediately to the east was constructed under a separate contract and is showing only minor joint distress. Figures 5.4.1 and 5.4.2 illustrate typical joint conditions as of November, 2015.

Figure 5.4.1. Deteriorated Joint Condition Along CTH OO-P2, Just East of STH 124, November 2015

Figure 5.4.1. Well Performing Joint Conditions Along CTH OO-P1, East of STH 124, November 2015

A second visit was made in August, 2016 to collect cores from selected locations within the left turn lane from westbound CTH OO to southbound STH 124. This lane was closed due to construction activities along STH 124, which provided a protected zone spanning both construction projects.

Three joint cores were extracted from each project section. Cores from the well performing project, herein identified as CTH OO-P1, were obtained from locations with none to minor joint spalling. Mid-slab cores were also extracted from adjacent locations. Cores from the poorer performing project, herein identified as CTH OO-P2, obtained from locations with minor to extensive joint spalling. Mid-slab cores were also extracted from adjacent locations.

5.5 IH 94, Eau Claire County

This project was constructed between 2013 – 2015 and included Limestone as the primary coarse aggregate. Transverse joints were formed using early entry saws. An initial field visit was made in May, 2015 to observe transverse joint conditions. Observations along the mainline pavements indicated the joints were performing well, with sporadic locations of minor joint spalling. Figure 5.5.1 illustrates typical joint conditions as of May, 2015.

A second field visit was made in August, 2016 to extract pavement cores from joints and mid-slab locations. As this project is performing well, these cores were extracted mainly for comparative purposes to the other projects selected for inclusion into this research project.

Figure 5.5.1. Typical Joint Conditions Along WB IH 94, Just West of USH 53, May 2015

5.6 Visual Analysis of Extracted Cores

All of the cores obtained from the selected in-service field projects were transported back to Marquette University for documentation and laboratory analysis. Cores were initially catalogued and photographed in the as-transported condition. Cores obtained at transverse joints were separated along the saw cut and extending crack in preparation for cleaning and testing. For some of the joint cores, the included dowel bar prevented the core from being separated at the joint. In those cases, the core was saw cut just above the exposed dowel bar to allow for separation.

After the joint cores were separated, the saw-cut joint face was carefully cleaned of any surface debris and/or joint sealant/filler material. Where no sealant/filler was present, cleaning was accomplished using soft bristle brushes and gentle agitation in water. When sealant/filler was present, the asphaltic materials were removed by first heating in an oven set to 140 ºF for approximately 1-2 hours and then gently scraping off loosened materials with dental picks. Any remaining asphaltic materials that were adhering to the joint face were removed as much as possible with the aid of a citrus-based spray solvent/cleaner. After final cleaning, the joint faces were photographed and then examined under a microscope and with hand lenses to identify signs of aggregate fracture and/or aggregate socketing, both of which likely would have occurred during the early entry saw cut operations.

The condition assessments of the recovered joint cores were used to develop a comparative joint condition rating. Each of the four observed distress conditions (surface spalling, loss of material from joint face, aggregate fracturing, aggregate socketing) were visually rated on qualitative scale (None, Limited, Moderate, Extensive). The qualitative visual ratings were converted to numerical ratings of 0 – 3 for each observed distress condition and summed to provide a joint condition rating ranging from a potential low of 0 (No Distress) to a potential high of 12 (All distresses at Extensive ratings). Table 5.6.1 provides a summary of the distress measures and joint condition ratings for the recovered joint cores.

Table 5.6.1. Joint Condition Ratings for Recovered Transverse Joint Cores

Joint	Observed Distress Condition				Condition Rating				Joint Condition Rating
	Surface Spalling	Missing Pieces	Fractured Aggregate	Aggregate Socketing	Surface Spalling	Missing Pieces	Fractured Aggregate	Aggregate Socketing	
US12-RA	L	L	N	M	1	1	0	2	4
US12-RB	M	L	N	M	2	1	0	2	5
US12TE-A	L	N	N	M	1	0	0	2	3
US12TE-B	L	L	N	M	1	1	0	2	4
US12-NA	L	N	L	M	1	0	1	2	4
US12-NB	Core Damaged During Transport – Unable to Rate								
94J1A	N	N	N	N	0	0	0	0	0
94J1B	N	N	N	L	0	0	0	1	1
94J2A	M	N	N	L	2	0	0	1	3
94J2B	M	M	N	N	2	2	0	0	4
BIRCHJ1A	E	E	N	E	3	3	0	3	9
BIRCHJ1B	E	E	L	M	3	3	1	2	9
BIRCHJ2A	N	M	N	M	0	2	0	2	4
BIRCHJ2B	E	E	N	M	3	3	0	2	8
BIRCHJ3A	M	N	L	M	2	0	1	2	5
BIRCHJ3B	L	E	M	M	1	3	2	2	8
OOP1J1A	E	M	M	M	3	2	2	2	9
OOP1J1B	M	E	L	L	2	3	1	1	7
OOP1J2A	N	L	N	M	0	1	0	2	3
OOP1J2B	M	M	N	E	2	2	0	3	7
OOP1J3A	M	L	N	M	2	1	0	2	5
OOP1J3B	E	E	N	M	3	3	0	2	8
OOP2J1A	E	M	N	L	3	2	0	1	6
OOP2J1B	L	E	N	M	1	3	0	2	6
OOP2J2A	L	N	N	L	1	0	0	1	2
OOP2J2B	N	L	N	L	0	1	0	1	2
OOP2J3A	E	E	Unable to Rate		3	3	Unable to Rate		
OOP2J3B	E	E	Unable to Rate		3	3	Unable to Rate		

5.7 Absorption Testing of Cores Extracted From In-Service Pavements

Absorption testing was conducted on all extracted cores following procedures specified in ATSM C1535-13 Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes. Because of the nature of the extracted joint core specimens, certain modifications were necessary to produce representative test specimens. Prior to absorption testing, all recovered joint cores were saw cut horizontally, as closely as possible to the bottom of the field formed saw cut, thereby exposing only the saw-cut portion of the joint face. A one inch portion of the saw-cut face was then trimmed off from each end to provide specimen ends with sufficient depth to better simulate the specimen dimensions used during absorption testing at UM-KC. After final trimming, the average width and depth of the exposed saw-cut joint face were determined, as was the maximum thickness of the joint specimen (maximum distance from joint face to outer edge of core specimen). Figures 5.7.1 and 5.7.2 provide representative photos of joint core specimens before and after trimming.

The mid-slab cores obtained from locations adjacent to the joint core locations were also used for absorption testing to provide comparative measures to the joint tests. The mid-slab cores were first saw cut horizontally to match the saw-cut depth of the trimmed adjacent joint specimens. Note that although every attempt was made during field coring to obtain joint cores centered on the joint, some joint cores were offset slightly, resulting in unequal joint halves after coring. The remaining mid-slab core was then saw cut vertically at a position to match the joint location from the adjacent joint core specimen. One inch ends of each core half were then trimmed away, as was done for the joint core specimens. After final trimming, the originally obtained mid-slab core specimen yielded two absorption testing specimens with dimensions closely matching the two trimmed specimens from the core recovered from the adjacent transverse joint.

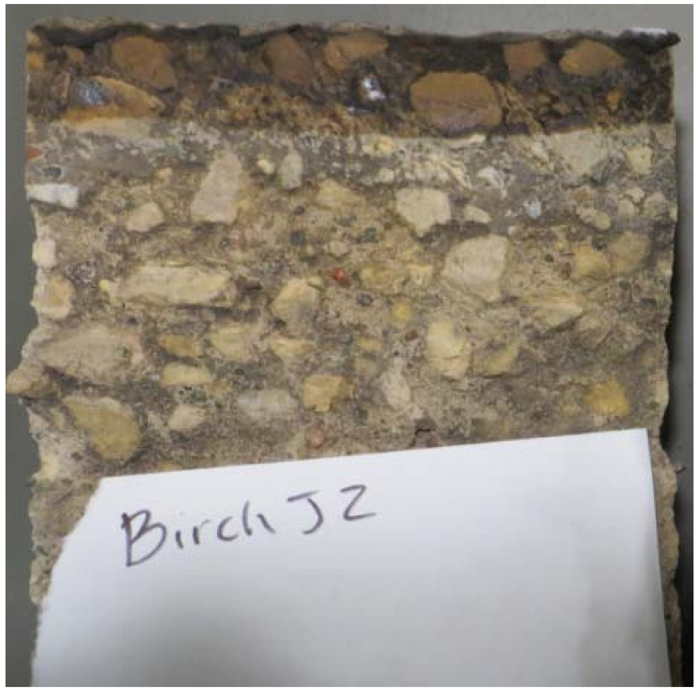

Figure 5.7.1. Typical Transverse Core Specimen After Cleaning (Birch J2)

Figure 5.7.2. Typical Transverse Joint Core Specimens After Trimming (Birch J2A-J2B)

All trimmed cores were saturated for a 24 hour period and then conditioned for three full days at 50ºC and 80% RH within the ESPEC environmental chamber at Marquette University. After conditioning, the specimens were individually sealed in large zip-lock bags and stored at 23ºC for no less than 15 days prior to the start of absorption testing.

Absorption testing was conducted in batches of nine specimens to allow for proper data recording during the first day of testing when multiple, closely spaced readings are taken on each specimen. Absorption testing was conducted for a full 15 days, matching the test period used at UM-KC. All absorption tests at Marquette University were conducted from mid-October through early December, 2016. Data collected from all tests were used to determine the initial and secondary absorption rates following ASTM calculation procedures. Table 5.7.1 provides a summary of the absorption test results. Also shown are the calculated joint distress ratings for each joint core specimen.

Figure 5.7.3 provides a plot of absorption rates versus joint condition ratings. As shown, there is a slight indication that higher levels of initial absorption rates are present for the higher joint condition ratings, but the goodness of fit is very poor.

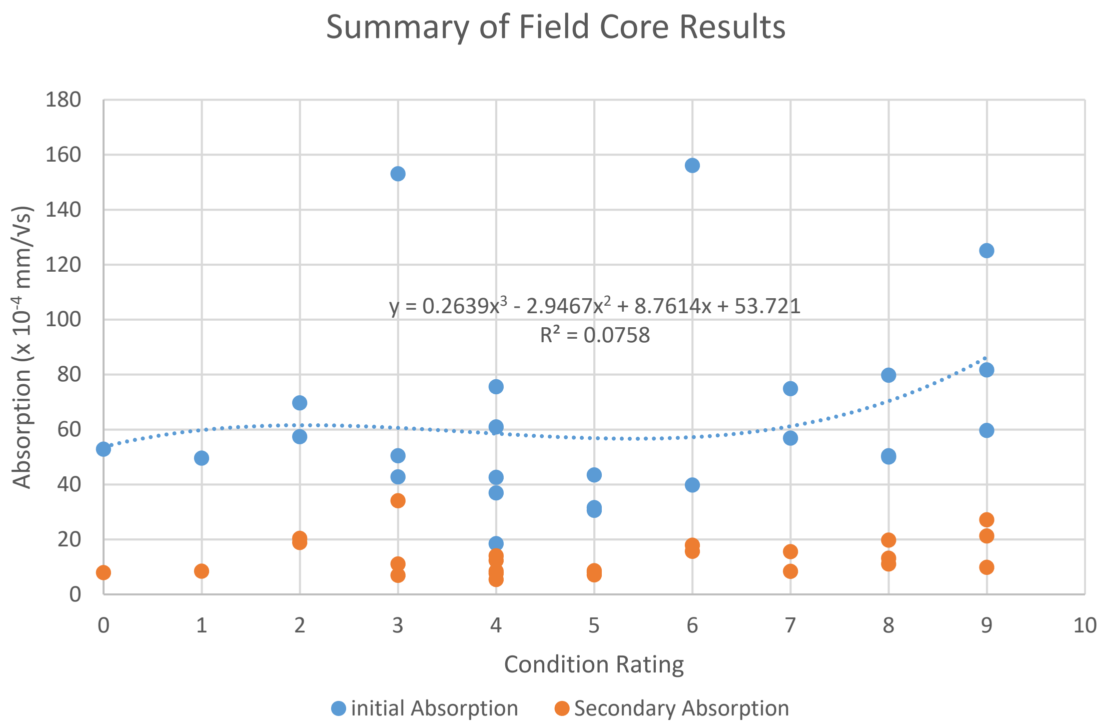

Figure 5.7.3. Absorption Rates versus Visual Joint Condition Ratings

5.8 Air Voids Analysis of Cores Extracted from In-Service Pavements

A microscopic air voids analysis was conducted on one of the post-absorption testing, mid-slab trimmed core specimens from each in-service field project, following procedures specified in ATSM C457-C457M-12 Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete. Due to the poor conditions of the exposed saw cut faces from the joint cores, it was not possible to properly prepare these joint specimens for microscopic analysis. Therefore, the air voids analysis results from the trimmed mid-slab cores specimens, which were obtained near the surface of the constructed concrete pavement to a depth which matches the actual transverse joint saw-cut depth, are proposed for use as surrogates to the air void system in place at the exposed joint faces.

Table 5.7.1. Absorption Test Results for Recovered Cores

Project Location	Slab Position	Sample ID	Condition Rating	Initial x 10^{-4} mm/√s	Secondary x 10^{-4} mm/√s
Birch Street	Center	C1A	n.a.	91.8	21.3
		C1B		109.0	19.1
		C2A		94.2	9.43
		C2B		64.3	14.9
		C3A		61.5	7.52
		C3B		63.9	10.8
	Joint	J1A	9	59.6	27.1
		J1B	9	125.0	21.2
		J2A	4	75.5	12.3
		J2B	8	79.7	19.7
		J3A	5	43.4	8.56
		J3B	8	49.9	13.1
IH 94	Center	C1A	n.a.	70.5	8.21
		C1B		111.0	13.3
		C2A		80.1	19.2
		C2B		65.9	12.5
	Joint	J1A	0	52.8	7.84
		J1B	1	49.5	8.39
		J2A	3	153.0	34.0
		J2B	4	60.9	14.0
USH 12	Center	TE-CA	n.a.	30.7	5.09
		TE-CB		21.2	6.77
	Joint	TE-A	3	42.7	6.85
		TE-B	4	42.5	7.55
		R-A	4	36.9	5.35
		R-B	5	30.5	8.04
		NA	4	18.4	8.41
CTH OO Project 1	Center	C1A	n.a.	62.6	7.91
		C1B		52.8	6.26
		C2A		56.4	10.1
		C2B		49.9	10.6
	Joint	J1A	9	81.6	9.79
		J1B	7	56.8	8.31
		J2A	3	50.4	11.0
		J2B	7	74.8	15.5
		J3A	5	31.5	7.05
		J3B	8	50.4	11.0
CTH OO Project 2	Center	C1A	n.a.	68.9	18.3
		C1B		63.7	15.7
		C2A		36.2	17.6
		C2B		45.8	10.6
	Joint	J1A	6	39.7	15.6
		J1B	6	156.0	17.8
		J2A	2	57.3	18.8
		J2B	2	69.6	20.3

The modified point-count method (ASTM C457 – Procedure B) was utilized to determine the number of stops on the air void, paste and aggregate phases of the exposed mid-slab core face based on a horizontal (E-W) stop spacing of 0.10 inch and a vertical (N-S) spacing of 0.064 in. These measures were then used to compute the percent air voids, paste/air ratio, specific surface and spacing factor for each core specimen. Air voids analysis results are provided in Table 5.8.1, as are ASTM usual ranges for key parameters.

As shown in Table 5.8.1, the measured air void parameters are in general agreement with ASTM usual ranges. Furthermore, the spacing factor is near or below the lower value, which is recommended for concrete exposed to deicing chemicals.

Table 5.8.1. Air Voids Test Results for Recovered Mid-Slab Cores

Test Parameter	Birch St	IH 94	USH 12	CTH OO P1	CTH OO P2	ASTM Usual Range
Air Content, %	7.6	7.0	7.1	10.8	8.0	
Void Frequency	14.6	15.7	16.3	23.9	15.2	
Paste Content, %	25.4	26.2	31.7	28.0	30.5	
Paste-Air Ratio	3.3	3.7	4.4	2.6	3.8	4 - 10
Ave Chord Length	0.0053	0.0044	0.0045	0.0045	0.0053	
Specific Surface, a	770	927	914	884	761	600 - 1100 in^{-1}
Spacing Factor, L	0.0044	0.0041	0.0049	0.0029	0.0050	0.004 - 0.008 in

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

The Wisconsin Department of Transportation (WisDOT) had previously observed joint deterioration which appeared to be directly related to the method and timing of sawing operations. Consequently, the present study was undertaken to evaluate which sawing factors most impacted the near-joint concrete and ultimate durability. One component of the study investigated the saw timing, technique, and equipment (TTE) on performance while a second component investigated depth of sawing and silane sealing (DS).

For the TTE testing, in October 2015, two concrete test sections were constructed, each using either a Southern limestone coarse aggregate or a Northern igneous gravel as the primary coarse aggregate. Numerous transverse joints were sawn in each aggregate mixture using soft-cut (early entry, dry) or conventional (late, wet) with new and old version of blades appropriate for softer limestone and harder igneous gravels. Each concrete mixture had a control saw cut produced using an appropriate new blade for the coarse aggregate and sawn at the optimal timing, with and without dowels. From TTE laboratory study results, the following conclusions can be drawn:

- Sawing early in the timing window using early entry equipment does cause physical damage to the aggregate and concrete. For limestone aggregate, the damage occurred directly underneath the sawing shoe, while for granite aggregate, a crack formed immediately outside the shoe. Absorption results did not indicate greater potential for durability distress. The freeze-thaw durability for the early age limestone samples indicated that damage was detrimental to performance. No difference in freeze-thaw performance was observed for the granite permutations across time.

- Differences in absorption caused by sawing timing, technique, and equipment can be observed. Doweled specimens possessed less absorption than the corresponding undoweled joints. The mixture containing igneous gravels had less absorption than the limestone mixture. Sawing early in the timing window produced the lowest absorption only if sawn using a new blade appropriate for the aggregate. An old/worn blade produces higher absorption and more variability in all cases than the corresponding joint sawn at the same time with a new blade. If the limestone aggregate mixture was sawn late in the timing window, a blade designed for harder aggregates produced less absorption. Silane treatment of the joints provided significant reduction in absorption and was able to minimize absorption from the worst sawing conditions.
- Both concrete mixtures were freeze-thaw durable to 300 cycles with no sawing permutations showing significant freeze-thaw deterioration at 300 cycles. Samples with significantly high or low absorption compared to the mean were tested until 600 cycles. All but one sample set had acceptable performance through 600 cycles indicating that the field-produced concrete was of high quality, considered highly freeze-thaw durable, and not able to distinguish effects from sawing.
- Surface deicer scaling was not influenced by sawing factors. The limestone mixture had worse performance than the granite mixture, with both significantly improving with the application of a topical silane sealer. Chloride penetration was not reduced for the limestone mixture by the application of silane, most likely due to the difficulty identifying a clear demarcation with the limestone aggregate. Chloride penetration was reduced 50% in the granite mixture by the application of silane.

- For the variables included in the TTE evaluation, absorption, freeze-thaw durability, deicer scaling, and chloride penetration did not correlate.

For the DS testing, core samples were obtained from the on-ramp of CTH KC where three different sawing depths (1.5 in., 2.0 in., and 2.7in.) were performed using early entry equipment that corresponded to T/3, T/4, and T/5.3. The shallower cuts were made earlier than the deeper cuts. Silane was applied in the field and both untreated and treated core samples were obtained for laboratory testing in addition to samples from the center of several slabs as a control. The core samples were tested for absorption and freeze-thaw durability using a one-dimensional absorption technique in deicer solution. From DS laboratory study results, the following conclusions can be drawn:

- All joints had activated regardless of sawing depth. The activation crack was more tortuous for the shallower cuts and straightened as the saw depth increased.
- The bulk absorption from the core specimens was low, about half that from the TTE specimens.
- Silane application generally reduced absorption, however the variability was much greater than for the lab-coated specimens in the TTE evaluation, likely due to the already low absorption rate of the concrete.
- Freeze-thaw durability of the DS cores was excellent when evaluated using mass or relative dynamic modulus, however at 300 cycles, there was significant visual deterioration. Freeze-thaw performance was best for the deeper cuts sawn later in the window.

Implementation Recommendations To Be Incorporated Into Specification and Guidance Documents:

- Sawing early in the sawing window should be discouraged. The minimum age to commence sawing should not result in any marring of the surface.
- The limestone mixture was much more sensitive to factors when jointed using the early entry equipment on similar limestone mixtures and should be avoided.
- The granite mixture was not impacted by the practical (concrete hard enough to support the equipment without marketing) range of sawing conditions. Other than practical saw timing, no equipment restrictions are recommended for similar granite mixtures.
- It is not acceptable or appropriate to use one blade for all cuts. Blades should be selected for the coarse aggregate present and used accordingly, especially for limestone aggregate.
- Worn blades cause measurable impact to concrete and a blade log with depth, distance, and time should be maintained by the contractor.
- The use of silane produced an improvement in deicer scaling from the TTE samples but worse performance for the freeze-thaw DS core samples. Additional work is recommended before determining the effectiveness of silane in the field.

Recommendation changes to current WisDOT documents:

Standard Specifications, Section 415.3.2.6 –

(1) The contractor shall provide a schedule for the blade(s) showing cumulative length of sawing and depth of sawing in addition to verification of appropriate blade selection for the desired coarse aggregate contained in the concrete mixture. Blade schedule shall also include information for the alignment shoe. Alignment shoes shall be replaced at the same intervals as the blades.

(2) Early entry sawing equipment is only allowable on mixtures containing predominantly granite coarse aggregate. When employing early entry sawing, only commence sawing when the concrete is sufficiently hard enough to prevent marring the surface timing/brooming and with minimal raveling, chipping, spalling, or otherwise damaging the pavement. Ensure that saws have diamond blades with functioning blade guards and are equipped with guides or other devices to control cut alignment and depth.

Standard Specifications, Section 415.3.7 –

"Based on the current research no additional recommendations would be included for this section."

FDM 14-10-10 –

"Based on the current research no recommendations would be included for joint spacing or design thickness."

CMM Chapter 4, Section 21.2 -

(1) Joint filling is performed on low-speed urban pavements not requiring tining. Joints must be sawed in a single operation to the depth shown in the plans.

CHAPTER 7
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R.A. Smith National

Beyond Surveying and Engineering

WISCONSIN HIGHWAY RESEARCH PROGRAM -WHRP

JOINT SAWING PRACTICES AND EFFECTS ON DURABILITY

ON-SITE PORTLAND CEMENT CONCRETE TESTING

R.A. Smith National is pleased to submit the following information to Marquette University as it relates to the on-site testing of Portland Cement Concrete materials used in association with the Joint Sawing Practices and Effects on Durability Study.

On October 7, 2015, R. A. Smith National provided two HTCP certified technicians to perform Portland Cement Concrete testing and sampling as required under applicable AASHTO and ASTM Testing Standards and in accordance with the Wisconsin Department of Transportation Construction and Materials Manual, Chapter 8 – Materials Testing, Sampling and Acceptance.

Placement of concrete was located at Zignego Redi-Mix Plant located at W226N2940 Duplainville Rd Waukesha, WI 53186. Two revolving truck mixers were used to deliver the material to the testing area. Two difference mix designs were tested as required under the study guidelines using a standard and approved DOT concrete paving mix made with an existing Southern Wisconsin Dolomitic crushed stone coarse aggregate and the other containing an existing Northern igneous gravel. Loads #1 and #2 contained the #2 crushed coarse aggregate and loads #3 and #4 contained the #2 gravel.

R.A. Smith National PCCTECH – I Technicians

Brad Abraham –	Certification #103109 – Exhibit A
John Kastner –	Certification #104535 – Exhibit B

The technicians were responsible for testing and sampling each truck load and adhering to the AASHTO T 141 (R-60) testing standards for fresh concrete sampling as well as for each specific required test. Included in these were:

- Strength Cylinders and Beams – AASHTO T 23
    - 3 cylinders cast – per sample taken
    - 2 beams cast – per sample taken
- Percent Air Content – AASHTO T 152
    - Type B Air Meter
- Slump – AASHTO T 119
- Temperature – AASHTO T 309

Casting and all subsequent testing was performed within the recommended timeframes and did not exceed the overall 15 minute time allotment for fresh concrete sampling. All tests were performed using calibrated equipment and proper procedures. For additional information or step by step procedures followed during the sampling and testing period, please refer to the Portland Cement Concrete Technician Manual.

https://www.uwplatt.edu/files/htcp/pcctec-i-manual.pdf

Southern Wisconsin Dolomitic Crushed Stone – Coarse Aggregate

Mix Data:	Limestone – Load #1		4000psi	Testing: 7:15am	TK#358
	WI A/FA 30% FA 1&2			Temperature	66°
	Load Size =	8.50 CY		Air	7.4%
				Air w/0.3 correction	7.1%
		Actual		Slump	3.125"
	Torp Sand	12100	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Low Chert	8500	lbs		
	#2 Limestone	6940	lbs		
	Cement (St Marys)	3355	lbs		
	Fly Ash	1465	lbs		
	Water	184	gal		
	E260 AE	40	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33351.3	lbs		
	w/cm	0.32			

Mix Data:	Limestone – Load #2		4000psi	Testing: 7:32am	TK#398
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	6.0%
				Air w/0.3 correction	5.7%
		Actual		Slump	1.625"
	Torp Sand	12120	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Low Chert	8480	lbs		
	#2 Limestone	6880	lbs		
	Cement (St Marys)	3380	lbs		
	Fly Ash	1450	lbs		
	Water	184	gal		
	E260 AE	40	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33442.9	lbs		
	w/cm	0.32			

Northern Wisconsin Igneous Gravel

Mix Data:	Gravel - Load #1		4000psi	Testing: 8:43am	TK#358
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	7.5%
				Air w/0.3 correction	7.2%
		Actual		Slump	4.75"
	Torp Sand	11400	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Shilstone	11300	lbs		
	#2 Gravel	4560	lbs		
	Cement (St Marys)	3335	lbs		
	Fly Ash	1475	lbs		
	Water	184	gal		
	E260 AE	41	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33327.8	lbs		
	w/cm	0.33			

Mix Data:	Gravel - Load #2		4000psi	Testing: 8:57am	TK#389
	WI A/FA 30% FA 1&2			Temperature	64°
	Load Size =	8.50 CY		Air	6.6%
				Air w/0.3 correction	6.3%
		Actual		Slump	2.75"
	Torp Sand	11400	lbs	Cylinders: 6"x12" - 3 cast Beams: 6"x6"x21" – 2 cast Methods used for casting cylinders and beams: AASHTO T 23 Cylinders and Beams with Consolidation by Internal Vibration Air meter #5 – Type B AASHTO T 121 Inspection Calibration Report – Exhibit C	
	Shilstone	11420	lbs		
	#2 Gravel	4540	lbs		
	Cement (St Marys)	3385	lbs		
	Fly Ash	1450	lbs		
	Water	184	gal		
	E260 AE	41	fl oz		
	800N WR	144	fl oz		
	Batch Wt.	33427.8	lbs		
	w/cm	0.32			

ANCILLARY CONCRETE DAILY TEST REPORT

PROJECT DESCRIPTION		TESTING DESCRIPTION	
Project ID: *WHRP Joint Sawing Study*	Contract: *1150289*	Date: *10/7/2015*	Reported by: *B. Hayek*
Highway:	County: *Waukesha*	Comments: *Two mix designs used: L1/L2 Limestone (dolomite); G1/G2 Gravel - igneous Cylinders: 6" x 12" (12 cast) Beams: 6" x 6" x 21" (8 cast)*	
Description: *Cast cylinders and beams of differing coarse stone materials*			
Contractor: *Zignego/MU*			

CONCRETE TESTING PERFORMED

Description of Work Represented by Test Results	Sample/Test Location	Mix Grade	Mix Design Type (check one)		Test Type (check one)		Concrete Temperature (degrees F)	Air Content (percent)	Air Content w/Agg Correction 0.3 (percent)	Slump (inches)	Job Control Cylinders Cast
			Stone	Standard Specification	Random QC Test	Start-up process control or other					
Cast cylinder/beams	L1 - #358 Truck	WI A/FA	*#2 Limestone*	*X*		*other*	66	7.4	7.1	3 1/8	C1- C3/B1-B2
Cast cylinder/beams	L2 - #389 - Truck	WI A/FA	*#2 Limestone*	*X*		*other*	64	6	5.7	1 5/8	C4-C6/B3-B4
Cast cylinder/beams	G1 - #358 Truck	WI A/FA	*#2 Gravel*	*X*		*other*	64	7.5	7.2	4 3/4	C7-C9/B5-B6
Cast cylinder/beams	G2 - #389 Truck	WI A/FA	*#2 Gravel*	*X*		*other*	64	6.6	6.3	2 3/4	C10-C12/B7-B8

AGGREGATE TESTING

Aggregate Samples Taken? (check one) Yes: [ ] No: *X*

If Yes, Give sample Identification: ____________________

Marquette University took possession of the cylinder and beam molds for transporting to final cure location. The overall quantity of material used in this study was approximately 34 cubic yards. Testing requirements based on quantity were followed. Given the small quantity of material used, control charts, graphs and moving average data for field testing is not available.

All cast cylinders and beams were cured at Marquette University laboratory. Testing to determine the compressive strength of the cylinders and beams was performed by Marquette University under an eight day and twenty –nine day aging cycle for each of the representative mix designs.

This report is submitted by Benjie Hayek, Project Manager for R. A. Smith National.

Exhibits

A. WisDOT Certified Technician List – Abraham

B. WisDOT Certified Technician List – Kastner

C. AASHTO T 152 – Inspection Calibration Report: Air Meter #5

D. Daily Activity Report

WISDOT Certified Technician List

EXHIBIT A - ABRAHAM

Friday, September 04, 2015

Name:	AggSamp	Aggtec-I	Aggtec-II	ATTS	HMA-IPT	HMA-TPC	HMA-MD	PCCTEC-I	PCCTEC-II	CST	Grading	Profiler	Nucdensity	TMS	Company Name:
105592-Aabye, Alicia		3/6/17 T			2/28/17								3/19/17		Mathy Constr-Northwoods Paving
104530-Abbas, Atheer								2/18/16 R						2/5/16 R	DAAR Engineering Inc
103109-Abraham, Brad		2/4/16 R	2/21/16 T		3/12/16 R	2/7/16		2/25/16 R						1/9/16 R	R.A. Smith National Inc
104687-Abshire, Gerald								2/9/18 R			4/16/16 R			3/1/16	R.A. Smith National Inc
101784-Absolon, Daniel		4/16/17 R			3/1/17 R			5/3/16 R		2/16/16 R			3/22/16 R		Coleman Engineering
105498-Abu Al-Eis, Khader		1/9/17 T			1/31/17		3/28/17	2/5/17		2/18/17	2/14/17		6/26/17		WisDOT - Bureau of Technical Service
102858-Abulughod, Mohammad								3/6/18 R						2/7/18 R	DAAR Engineering Inc
101434-Acker, Duane								3/27/17 R						1/14/17 R	Bloom Companies LLC
103961-Adams, Jay								1/17/16 R						6/7/16	WisDOT- SWR
102963-Adams, Mathew		2/14/17 RT			2/28/17			3/30/18 R						3/25/17 R	Fleming, Andre & Associates
104394-Adamski, Eric		6/11/18 RT						6/25/18 R			4/6/18 R			6/11/18	Spann & Associates LLC
105683-Adelman, Andrew										3/18/18			4/23/17		Vinton Construction Co
103796-Aderungboye, Steve		3/15/16 RT						4/12/16 R		3/12/17				3/12/16	Toki & Associates Inc
105366-Adhikari, Shardul Sharm								3/1/16							Himalayan Consultants LLC
103902-Adil, Muhammad								6/1/17 R	4/1/17 R						K. Singh & Associates Inc
105844-Aho, Kelsey								3/5/18						2/13/18	WisDOT - NER
105804-Al Qayyim, Ali		4/23/18 T											1/8/18	4/23/18	GeoTest Inc
105068-Albert, Dustin													1/13/18 R		Mathy Construction Co-American Asph
104642-Aldape, Juan								5/13/16 R							Zenith Tech Inc
100290-Alekna, Martin								3/24/17 R						2/6/16 R	MSA Professional Services Inc
104171-Allard, Anthony										6/26/17 R					WisDOT - NER
103456-Allen, Gregg								2/3/16 R							Croell Redi Mix
102129-Alt, Steve		3/28/18 R			6/20/18 R			3/9/18 R					2/1/17 R		TEAM Engineering Inc
101789-Ames, Steven		1/11/18 R	2/10/17 R		3/2/18 R	3/14/18 R	2/21/18 R	4/3/16 R	3/18/16 R	3/10/16 R	4/29/17 R	3/14/16 R	7/12/18 R		WisDOT- SWR
103866-Amundson, Jake		6/14/18 R			6/22/18 R	2/19/18 R	3/27/18 R					3/20/16	1/29/18 R	4/27/18 R	Rock Road Co Inc
105450-Amundson, Joshua		6/6/18 R	2/26/18	3/5/18	6/14/18 R	2/5/18		1/30/18 R	3/12/18	6/25/16	2/14/17		4/25/16		Behnke Materials Engineering LLC
103522-Anastas, Edward								3/9/17 R							Cornerstone Pavers LLC
102644-Anderegg, Nathan		2/7/17 RT						1/15/18 R						2/7/17	K. Singh & Associates Inc
105511-Andersen, Kevin								1/16/17						1/10/17	Knight E/A Inc
103780-Anderson, Chris								2/2/16 R							Michels Corp
103943-Anderson, Dale		1/23/18 T										3/19/17	8/17/16 R	1/23/18	Northeast Asphalt
102284-Anderson, Dennis								2/25/16 R							R.A. Smith National Inc
101872-Anderson, Douglas								2/16/18 R					3/31/18 R	4/2/16 R	WisDOT - NWR
105488-Anderson, Harlan								11/20/17							Northeast Wisconsin Tech College
104096-Anderson, Jeffery		1/23/18 R		3/5/18 R	2/27/18 R		3/27/18 R	4/18/17 R	3/31/17 R	3/10/16 R			6/30/17 R	5/2/18 R	WisDOT - Bureau of Technical Service
103630-Anderson, Ky		4/23/18 T						5/2/18 R					4/6/17 R	2/9/18 R	Fleming, Andre & Associates
102255-Anderson, Robert								2/26/18 R						6/21/18 R	DAAR Engineering Inc
105380-Anderson, Sandra										3/13/16					S A Squared LLC
105687-Anderson, Shaun								5/1/17						4/25/17	WisDOT- SWR
101312-Anderson, Todd								1/29/18 R							City of Sun Prairie
103117-Andraschko, Michael		2/5/17 RT									4/29/16 R		2/4/17 R	2/5/17	CQM Inc
100177-Andre, Donald								3/25/17 R						3/24/18 R	Fleming, Andre & Associates
105189-Andreini, Matthew		1/24/18 T	2/26/18	3/5/18				4/17/18 R	3/12/18		2/13/18			1/24/18	WisDOT - Bureau of Technical Service

WISDOT Certified Technician List EXHIBIT B-KASTNER Friday, September 04, 2015

Name:	AggSamp	Aggtec-I	Aggtec-II	ATTS	HMA-IPT	HMA-TPC	HMA-MD	PCCTEC-I	PCCTEC-II	CST	Grading	Profiler	Nucdensity	TMS	Company Name:
103910-Jordan, Zachary								5/16/16 R						3/20/18 R	CGC Inc
102916-Jorgenson, Duane													1/30/17 R		Rock County Public Works
100163-Jorgenson, John		3/22/17 RL		3/4/17 R	2/21/17 RL	3/20/17 R	3/11/17 RL						2/21/16 R		Mathy Construction Co
103178-Joslin, Jonathan		6/12/18 R	2/12/18 R	3/4/16 R	2/24/16 R	2/7/16	3/29/16	3/25/18 RL	4/1/16 R	3/7/18 R	4/11/17 R	3/20/16	6/4/18 RL		WisDOT - SER
105321-Joza, Douglas		2/14/17 RT			3/1/17 R	2/6/17	3/29/16						4/23/17	2/14/17	Wolf Paving Co
100487-Julson, David		1/13/18 R			2/24/18 R			1/7/17 R	3/31/17 R		1/13/18 R				EMCS Inc
101536-Jump, Kevin		3/26/17 RT						2/4/16 R						3/26/17	Donohue & Associates
103852-Juneau, William								4/12/16 R							State Contractors Inc
105952-Jury, Chad															Rock Road Co Inc
105583-Justus, Lauren								2/20/17							Milwaukee County DTPW/Hwy Div
102102-Juza, Paul								3/9/18 R						5/23/18 R	Cooper Engineering Company Inc
105094-Kaetterhenry, Dexter		2/2/18 RT												2/2/18	Gremmer & Associates Inc
105910-Kafczynski, Joseph		4/23/18 T											3/18/18	4/23/18	Becher-Hoppe Associates
105268-Kaiser, Brandon								6/21/18 R					4/1/18	1/18/16	Gremmer & Associates Inc
102818-Kaiser, Scott								6/6/17 R							EMCS Inc
105907-Kakacek, John								4/9/18						3/13/18	Knight E/A Inc
105803-Kalahar, Mitchell		3/5/18			1/30/18										Braun Intertec
105902-Kallas, Michael								3/12/18							HNTB Corp
105378-Kamm, Melissa		3/28/16 T			3/15/16										Payne & Dolan
102234-Kampmeier, Dennis		3/16/18 RT												5/21/18 R	R.G. Huston Co Inc
102183-Kamps, Tracy								4/20/18 R						5/16/18 R	WisDOT - NER
105451-Kann, Michael		6/6/16			6/14/16										River City Paving
104551-Kardelis, Daniel		4/8/16 R						3/19/16 R		5/13/16 R	4/16/16 R		6/3/16 R		Interra, Inc.
103472-Kasmarek, Paul								4/12/16 R					4/23/17 R	2/10/18 R	WisDOT - NCR
105605-Kasper, Ray		3/6/17													Cemstone Concrete Products
105163-Kassab, Victoria								3/22/18 R							WisDOT - NER
105642-Kaster, Samantha		3/20/17 T													Rochester Sand & Gravel
104535-Kastner, John		2/2/16 R			3/15/16			3/5/16 R						2/5/16 R	R.A. Smith National Inc
105960-Katt, Mitch											5/1/18				ECS Midwest LLC
102089-Katzner, David								2/28/16 R						4/3/18 R	MSA Professional Services Inc
105856-Kautzman, David								2/19/18							HNTB Corp
104075-Keckeisen, Jonathan		1/22/17 R			3/12/17 R	2/10/17 R	3/25/17 R	4/11/16 R	4/1/16 R	2/19/16			5/3/18 R		Pitlik & Wick Inc
101269-Keller, Julie Ann		3/7/16 R	2/12/16 R					2/25/16 R							HNTB Corp
105354-Keller,, Jeffrey								2/21/16						1/10/17	CGC Inc
102731-Kelley, Brian		3/7/17 R			1/31/17 R	3/17/17 R									Chippewa County Highway Dept
105054-Kelley, Tasia		1/12/18 R			2/24/18 R	2/5/18							4/4/18 R		Cooper Engineering Company Inc
105398-Kelly, Ashley		3/28/16 T						4/4/16						3/28/16	Mathy Construction-American Matls
100239-Kelly, Martin		12/20/17 R			3/19/17 R			2/2/17 R				3/14/16 R	2/15/16 R		Kapur & Associates
105310-Kelly, Michael		1/25/16 T												1/25/16	Braun Intertec
104423-Kemp, Peter		6/10/16 R		3/4/16 R	3/12/16 R	2/7/16	3/16/16 R	4/22/16 R	3/29/16 R		4/29/16 R	3/17/16 R	7/1/16 R		WisDOT - Bureau of Technical Service
105322-Kemper, Karl		2/14/16 T			3/15/16			3/7/16					4/3/16	2/14/16	Becher-Hoppe Associates
104040-Kempf, Chad								2/22/17 R							Zignego Ready Mix Inc
100785-Kennedy, Carl		3/4/16 R			3/18/16 R	2/1/16 R							7/12/18 R		Mathy Construction Co

EXHIBIT C

R.A. Smith National
Beyond Surveying and Engineering

Inspection Calibration Report (AASHTO T 152)				
Pressure Air Meter				
Inspector:	John Kastner		Date:	**7/29/2015**
Apparatus:	Pressure Air Meter		Test Procedure:	AASHTO T152
Serial Number:	#5		Location:	RASN Lab
Calibration Equipment Used:		Electronic Scale, Graduated Cylinder		
Scale Calibration Date:				
Previous Inspection Date:	**4/16/2015**		Next Date Due:	**10/29/2015**
Action Recommended:	Repair	Replace	None	Other
	Probe 1	Probe 2	Test Time	Thermometer
Thermometer Calibration			30 min	74

Initial Pressure Line Check
(Full of Water) (2 tests)

Initial IPL:	3.0
Test 1:	0
Test 2:	0

	5%	7%	9%
Mass of Bowl, Plate and Grease:	4794.4	4794.4	4794.4
Mass of Bowl, Plate, Grease and Water:	11851	11851	11851
Mass of Water in Bowl:	7056.6	7056.6	7056.6
Mass of Graduated Cylinder:	214.0	214.0	214.0
Mass of Graduated Cylinder and Water:	562.9	712.0	849.8
Mass of Water Removed:	348.9	498.0	635.8
Calculated Percent Air in Bowl:	4.9%	7.1%	9.0%
Measured Percent Air in Bowl:	5.0%	7.1%	8.9%
Difference:	0.1%	0.0%	0.1%
Adjustment in IPL:	None		

The air meter complies with the requirements of the applicable AASHTO or ASTM specification to the extent of the tests made.	YES

IPL:	3.0		
Inspector:			
Date Inspected:			
Air Meter #:	#5		
Volume of Bowl:	7056.6	7056.6	7056.6
Calculated % Air in Bowl:	4.9%	7.1%	9.0%
Measured % Air in Bowl:	5.0%	7.1%	8.9%
Difference % Air in Bowl:	0.1%	0.0%	0.1%
Cal-Can % Air Reading:	5.0%		

EXHIBIT D
Page 1 of 2

October 7, 2015

Truck 1 - #358 7:15 AM

Temp. 66°

Slump 3 1/8"

Air 7.4%

Truck 2 - #389 7:32 AM

Temp. 64°

Slump 1 5/8"

Air 6.0%

0.3 Agg. Correction

EXHIBIT D
Pag 2 of 2

October 7, 2015

Truck 3 8:43

Temp. 64°

Slump 4 3/4"

Air 7.5%

Truck 4 8:57

Temp. 64°

Slump 2 3/4"

Air 6.6%

APPENDIX B
UM-KC LABORATORY STUDY RESULTS

B.1 Individual Absorption Results

The individual absorption results for all samples are provided below. Table 3.1.1 provides a key for the conditions of the individual limestone samples.

Table 3.1.1. Condition designation for limestone samples

Cut	Saw	Timing Window	Blade Type	Blade Condition	Doweled
L01	Soft-Cut	Early	S	N	N
L02	Soft-Cut	Early	S	O	N
L03	Soft-Cut	Early	H	O	N
L04	Soft-Cut	Early	H	N	N
L05	Soft-Cut	Optimal	S	N	Y
L06	Soft-Cut	Optimal	S	N	N
L07	Soft-Cut	Late	S	N	N
L08	Soft-Cut	Late	S	O	N
L09	Soft-Cut	Late	H	O	N
L10	Soft-Cut	Late	H	N	N
L11	Wet	Early	S	N	N
L12	Wet	Early	S	O	N
L13	Wet	Early	H	N	N
L15	Wet	Optimal	S	N	N
L16	Wet	Optimal	S	N	Y
L17	Wet	Late	H	N	N
L18	Wet	Late	H	O	N
L19	Wet	Late	S	N	N

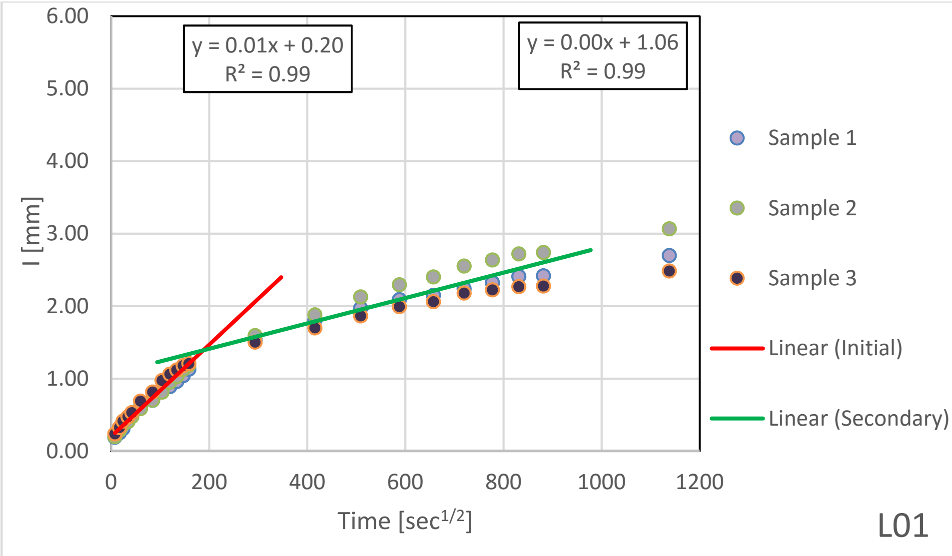


Figure B.1.1 – Absorption Results for L01

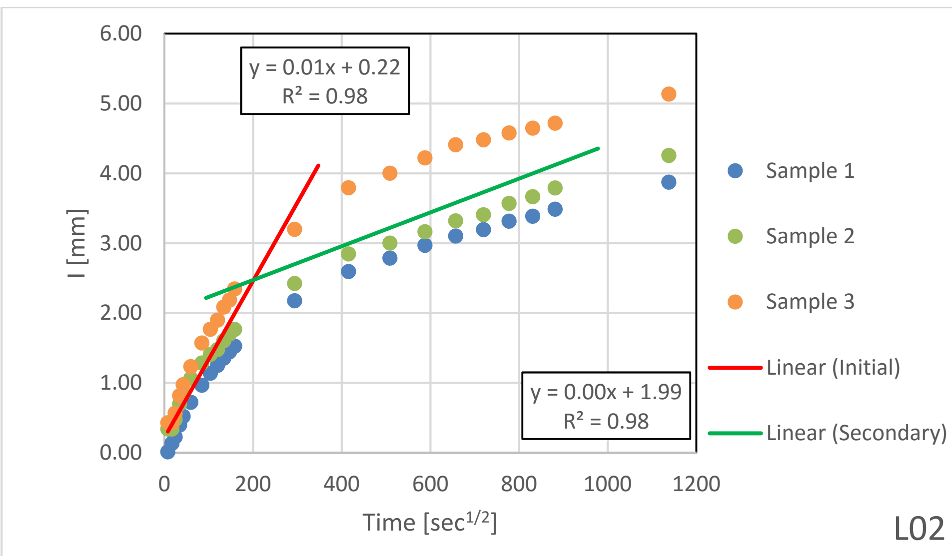


Figure B.1.2 – Absorption Results for L02

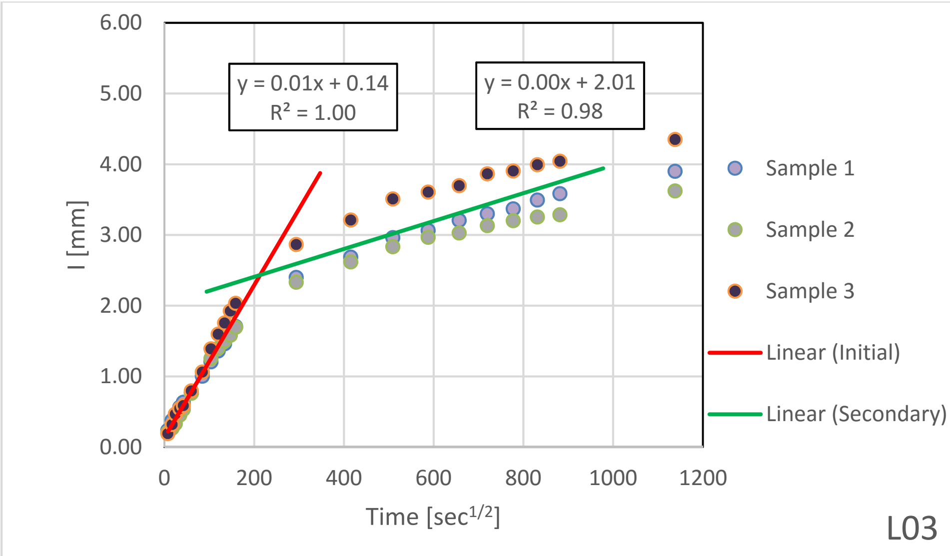


Figure B.1.3 – Absorption Results for L03

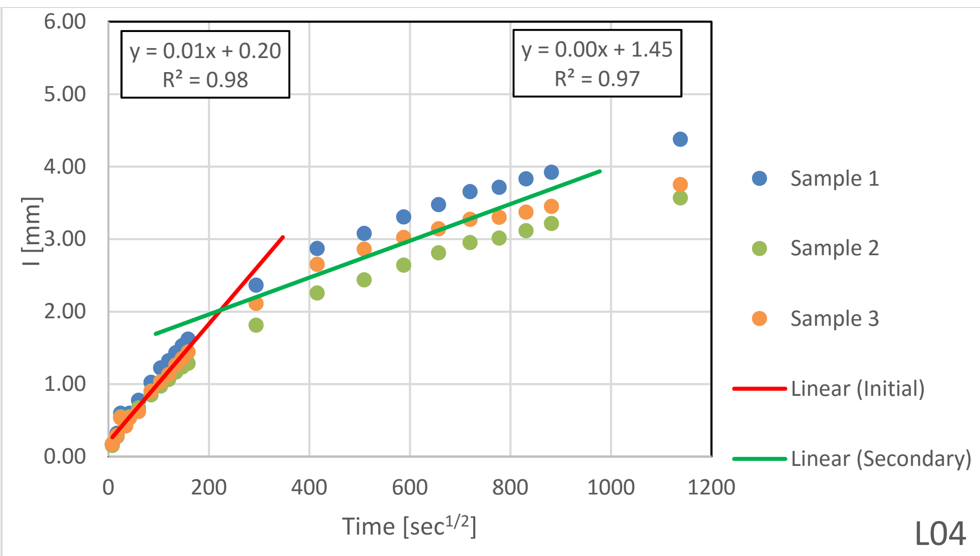


Figure B.1.4 – Absorption Results for L04

(Testing in progress, 2/13/17)
Figure A.1.5 – Absorption Results for L05

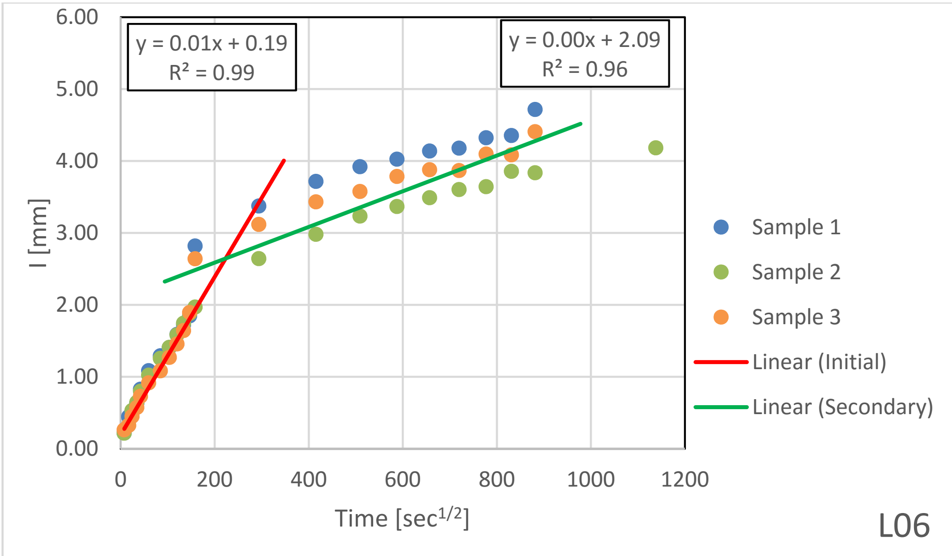


Figure B.1.6 – Absorption Results for L06

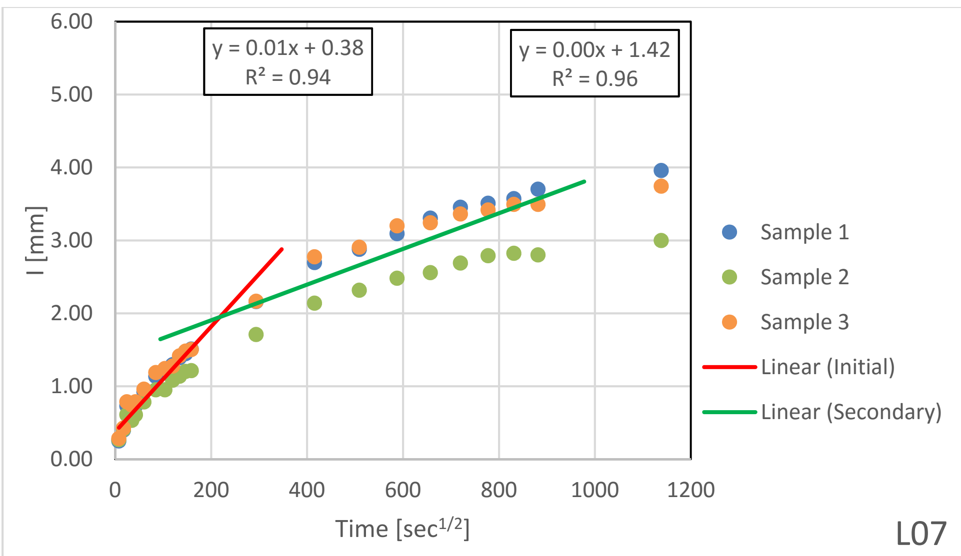


Figure B.1.7 – Absorption Results for L07

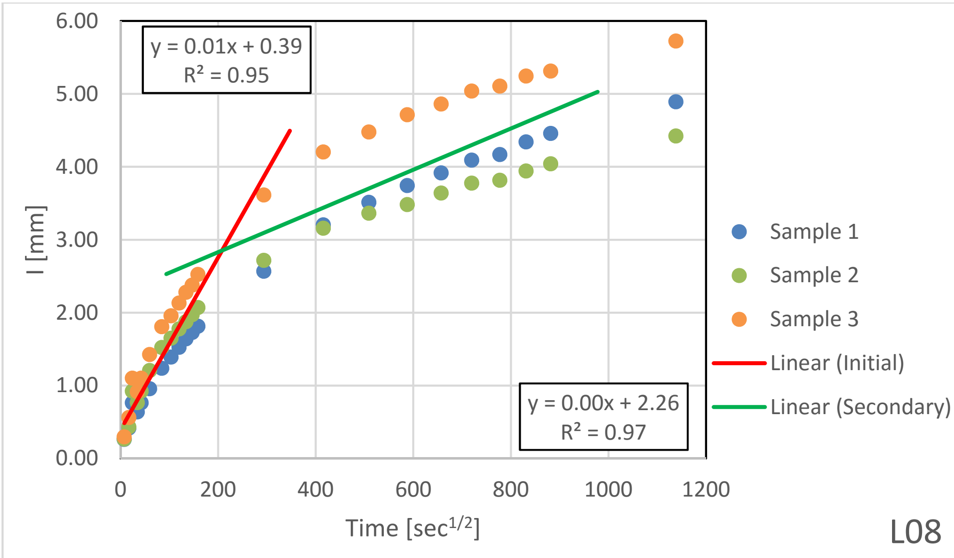


Figure B.1.8 – Absorption Results for L08

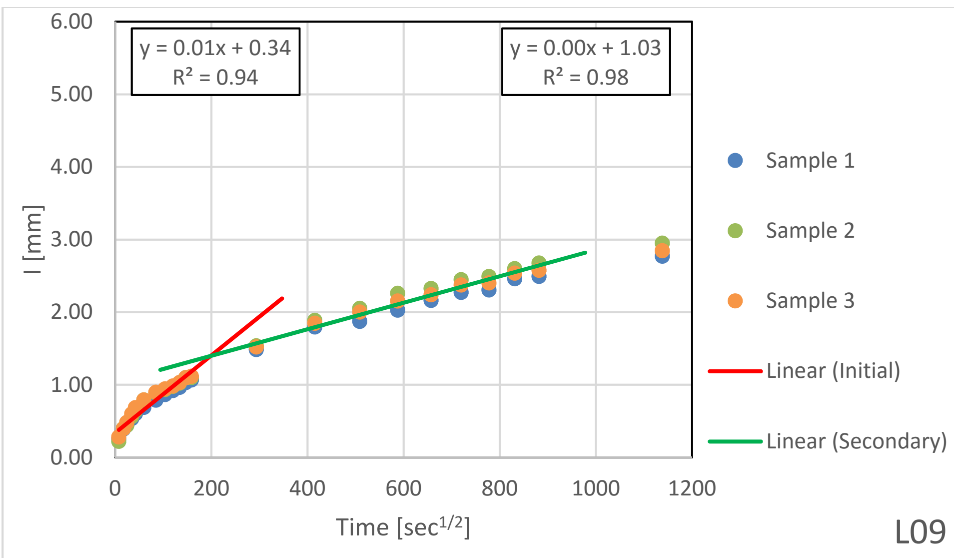


Figure B.1.9 – Absorption Results for L09

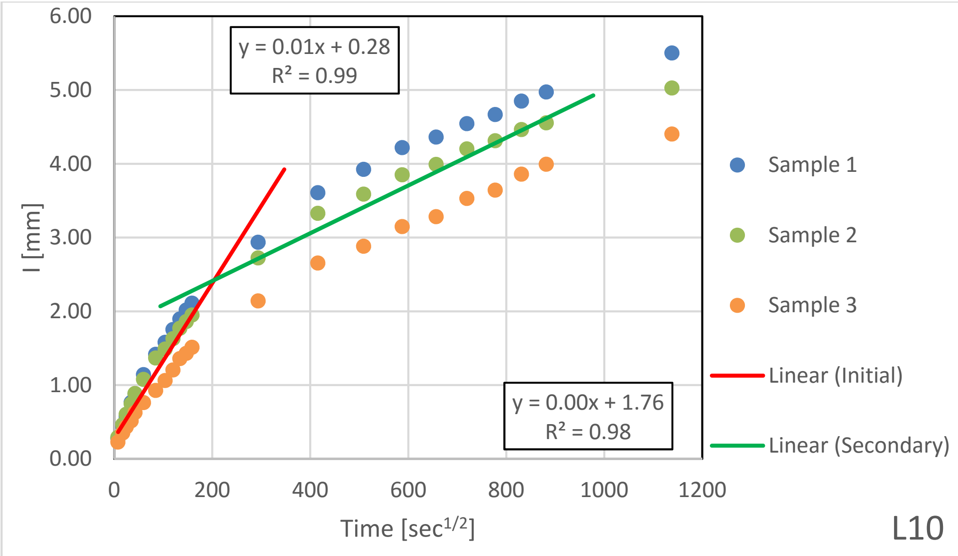


Figure B.1.10 – Absorption Results for L10

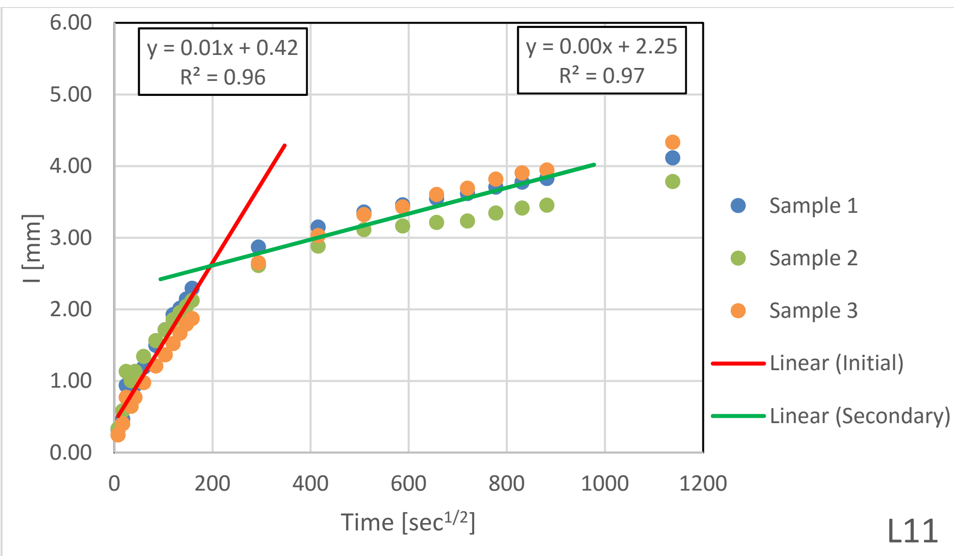


Figure B.1.11 – Absorption Results for L11

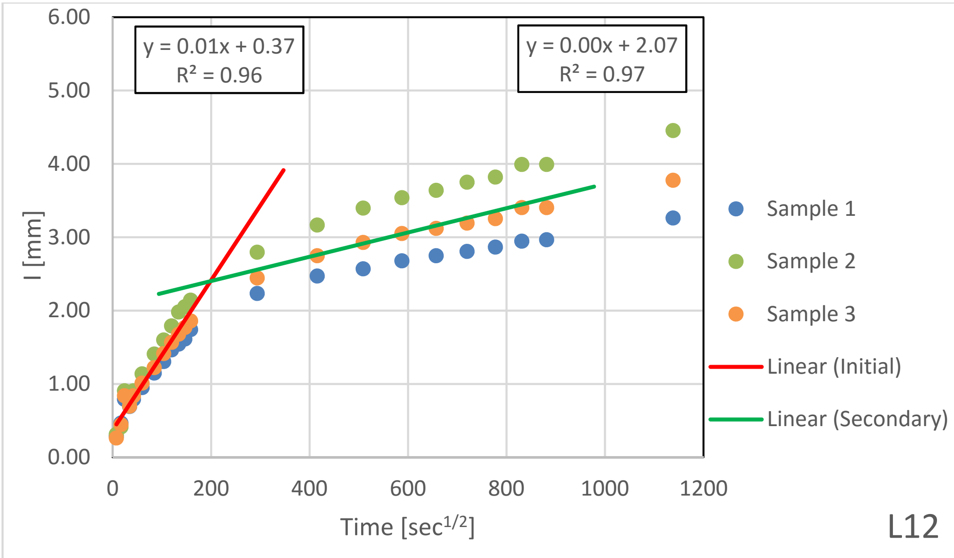


Figure B.1.12 – Absorption Results for L12

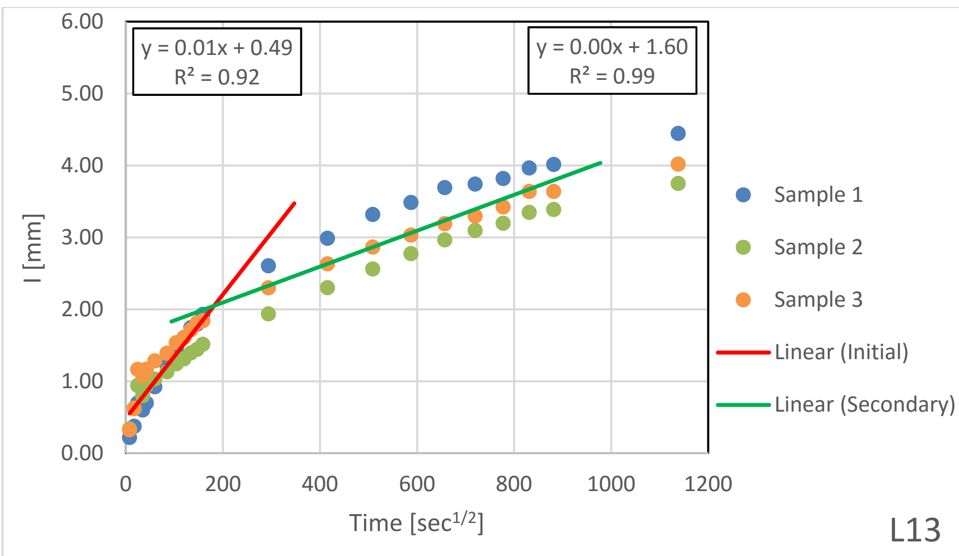


Figure B.1.13 – Absorption Results for L13

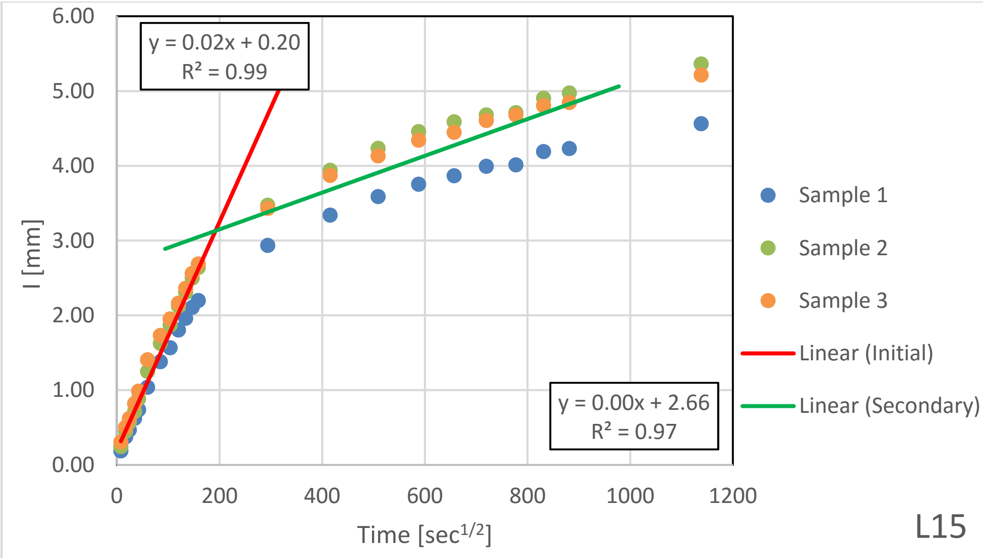


Figure B.1.14 – Absorption Results for L15

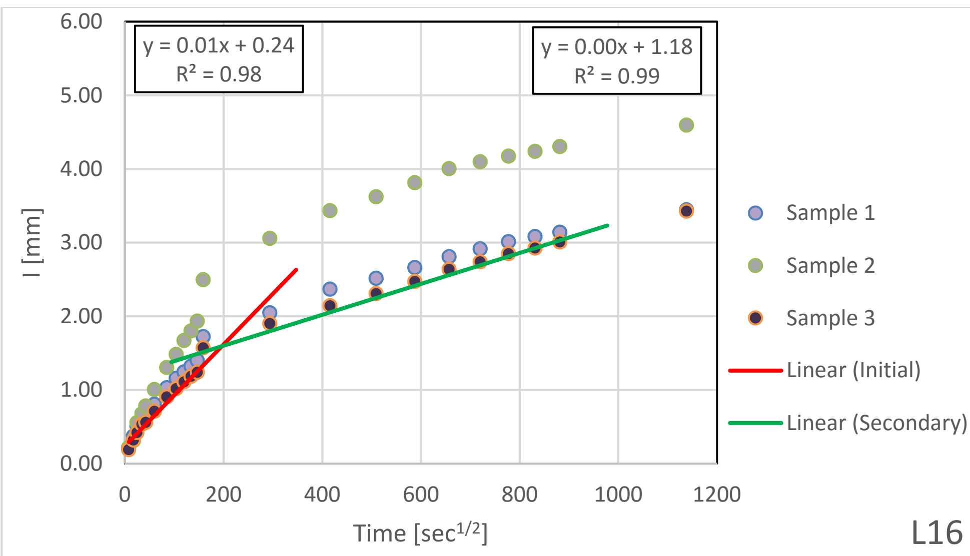


Figure B.1.15 – Absorption Results for L16

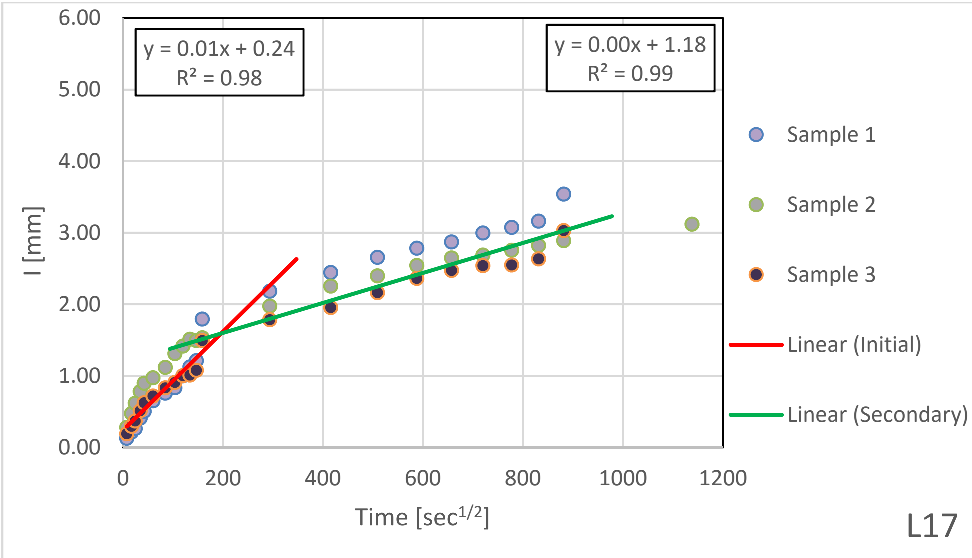


Figure B.1.16 – Absorption Results for L17

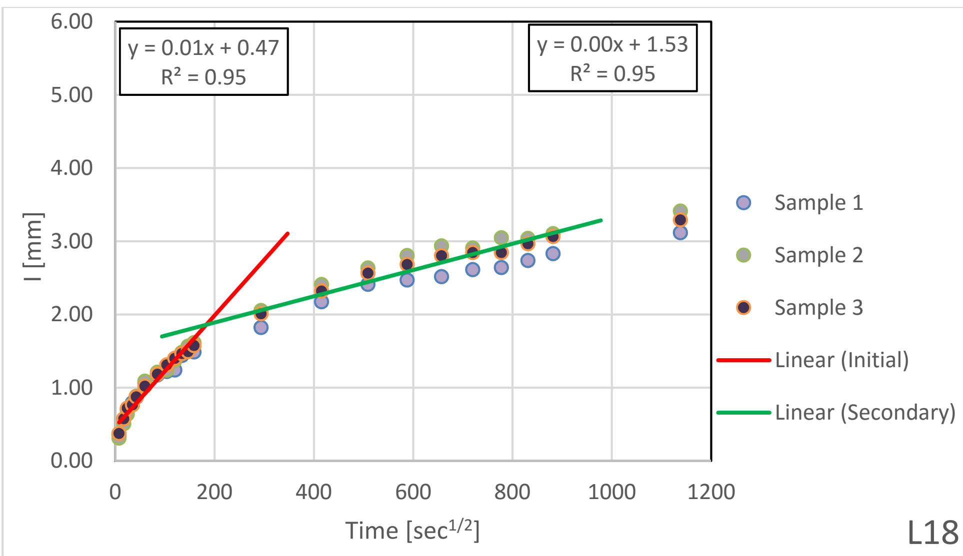


Figure B.1.17 – Absorption Results for L18

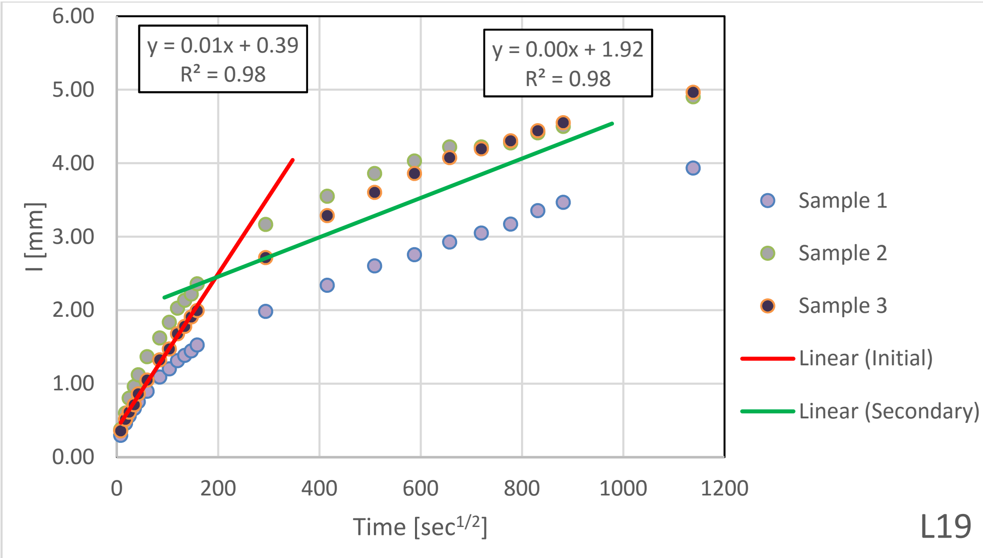


Figure B.1.18 – Absorption Results for L19

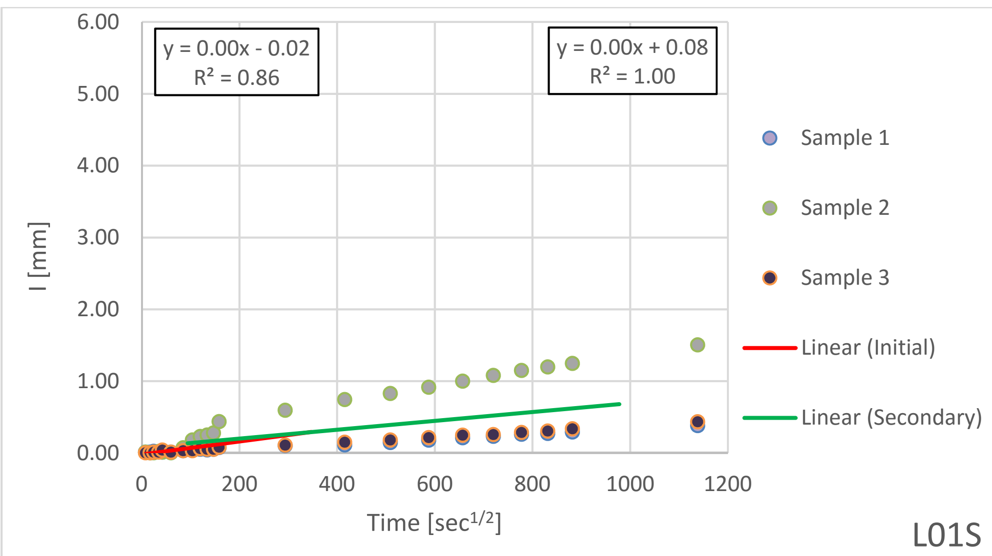


Figure B.1.19 – Absorption Results for L01 Silane-Coated

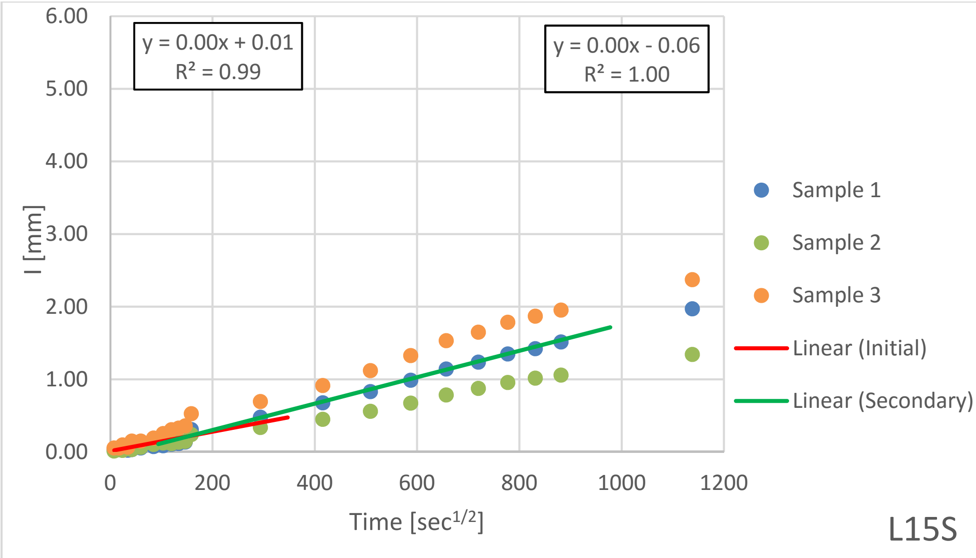


Figure B.1.19 – Absorption Results for L15 Silane-Coated

Table 3.1.2. Condition designation for granite samples

Cut	Saw	Timing	Blade	Condition	Doweled
G01	Soft-Cut	Early	H	N	N
G02	Soft-Cut	Early	H	O	N
G03	Soft-Cut	Early	S	O	N
G04	Soft-Cut	Early	S	N	N
G05	Soft-Cut	Optimal	H	N	Y
G06	Soft-Cut	Optimal	H	N	N
G07	Soft-Cut	Late	H	N	N
G08	Soft-Cut	Late	H	O	N
G09	Soft-Cut	Late	S	O	N
G10	Soft-Cut	Late	S	N	N
G12	Wet	Early	H	N	N
G13	Wet	Early	S	O	N
G14	Wet	Early	S	N	N
G15	Wet	Optimal	H	N	N
G16	Wet	Optimal	H	N	Y
G17	Wet	Late	S	O	N
G18	Wet	Late	S	N	N
G18	Wet	Late	H	N	N

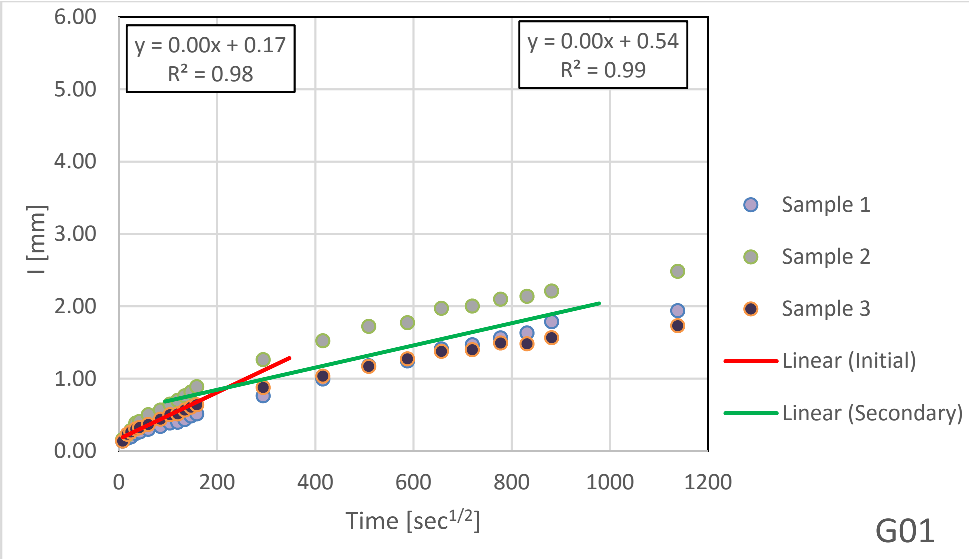


Figure B.1.20 – Absorption Results for G01

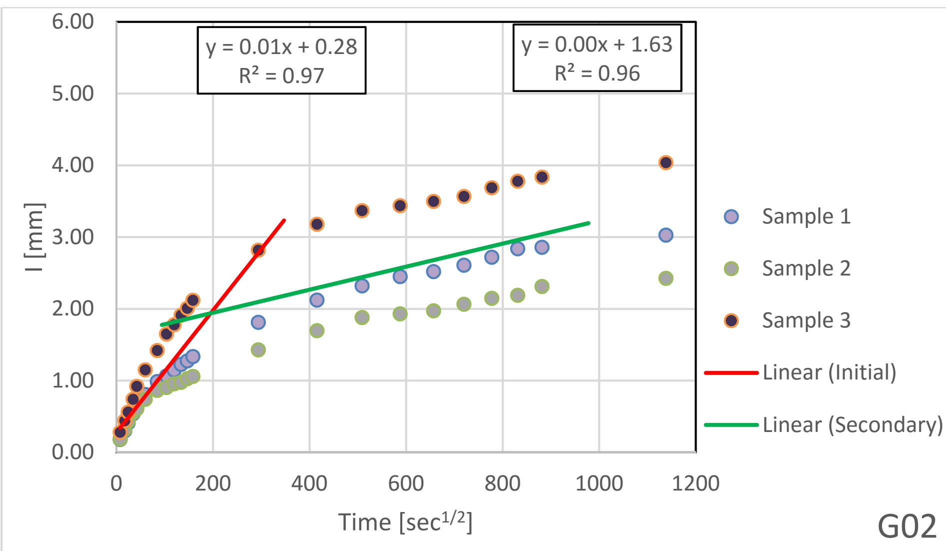


Figure B.1.21 – Absorption Results for G02

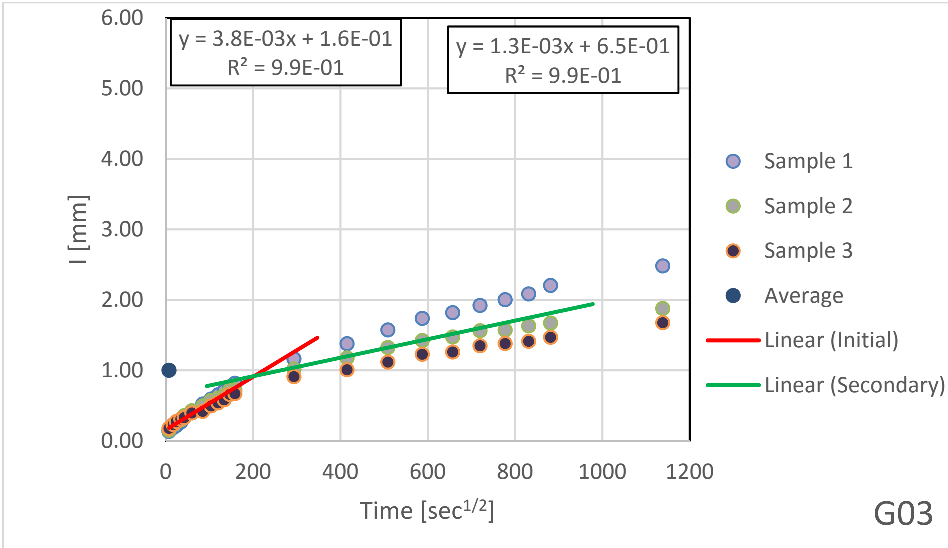


Figure B.1.22 – Absorption Results for G03

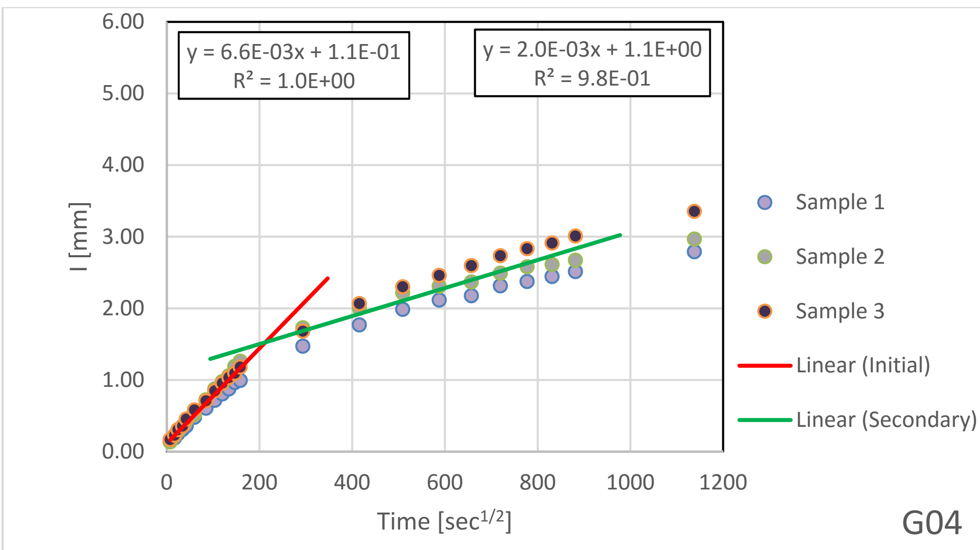


Figure B.1.23 – Absorption Results for G04

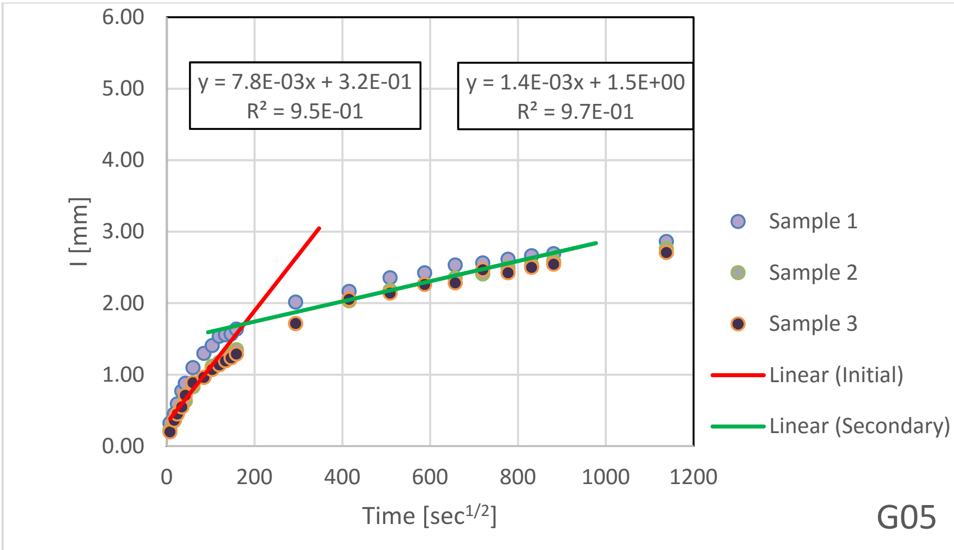


Figure B.1.24 – Absorption Results for G05

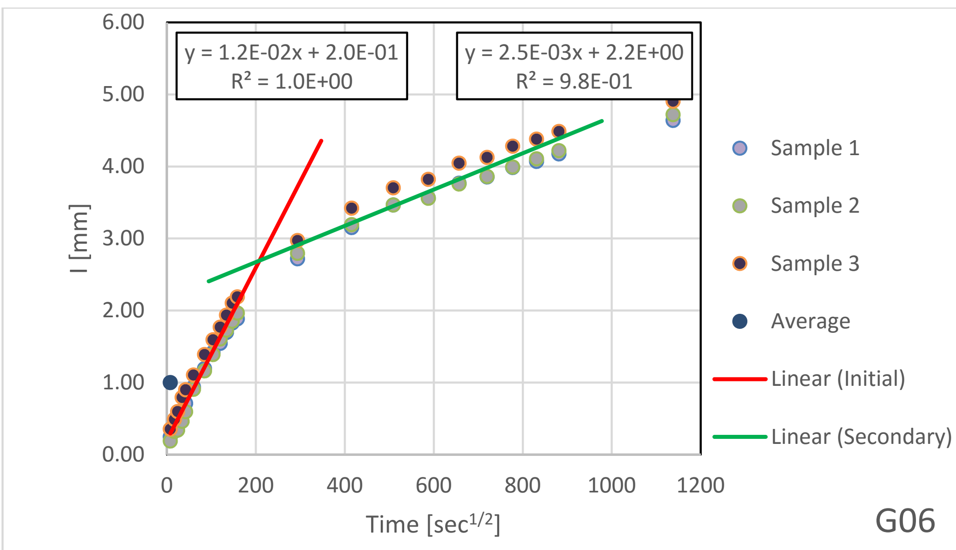


Figure B.1.25 – Absorption Results for G06

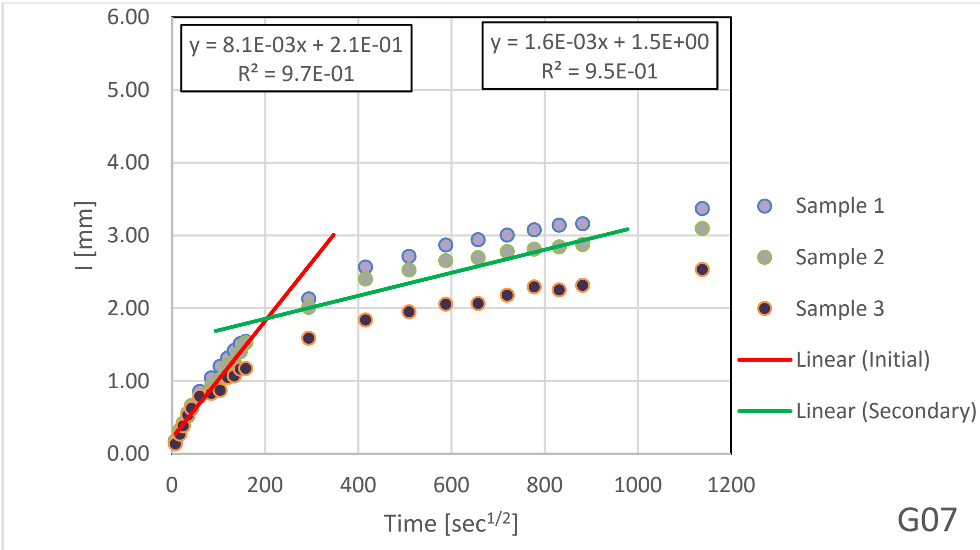


Figure B.1.26 – Absorption Results for G07

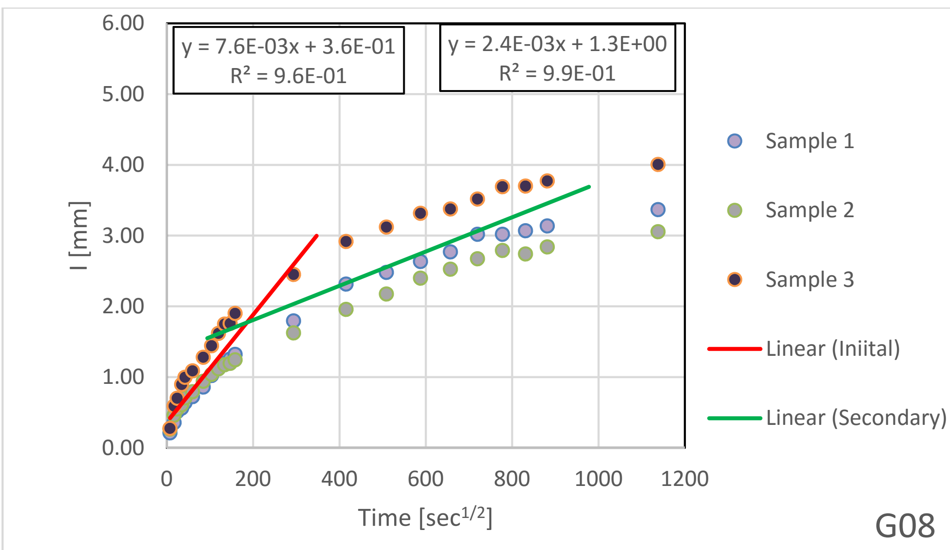


Figure B.1.27 – Absorption Results for G08

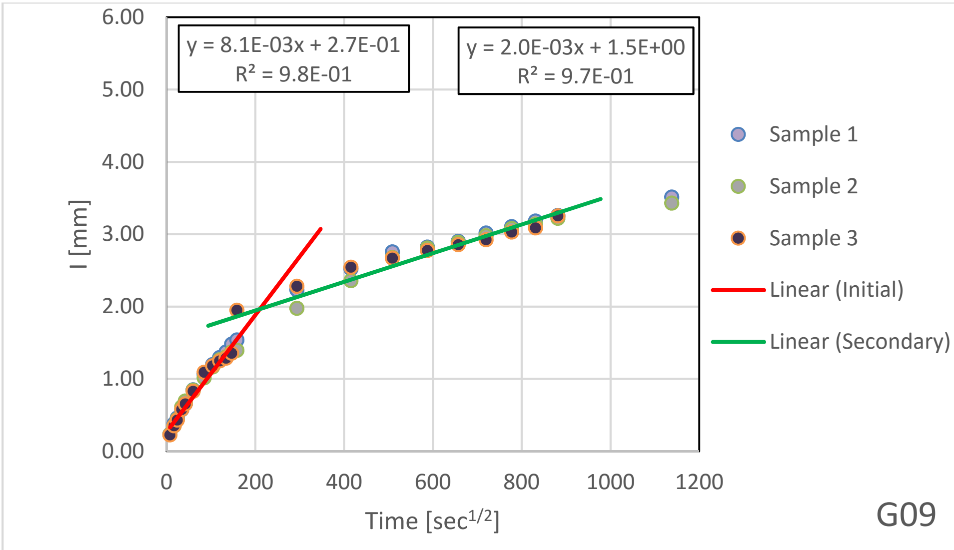


Figure B.1.28 – Absorption Results for G09

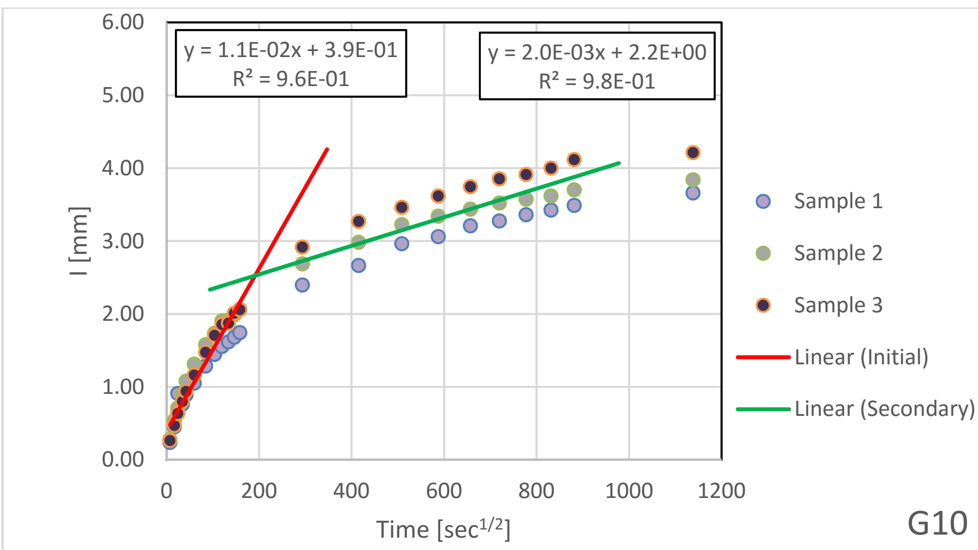


Figure B.1.29 – Absorption Results for G10

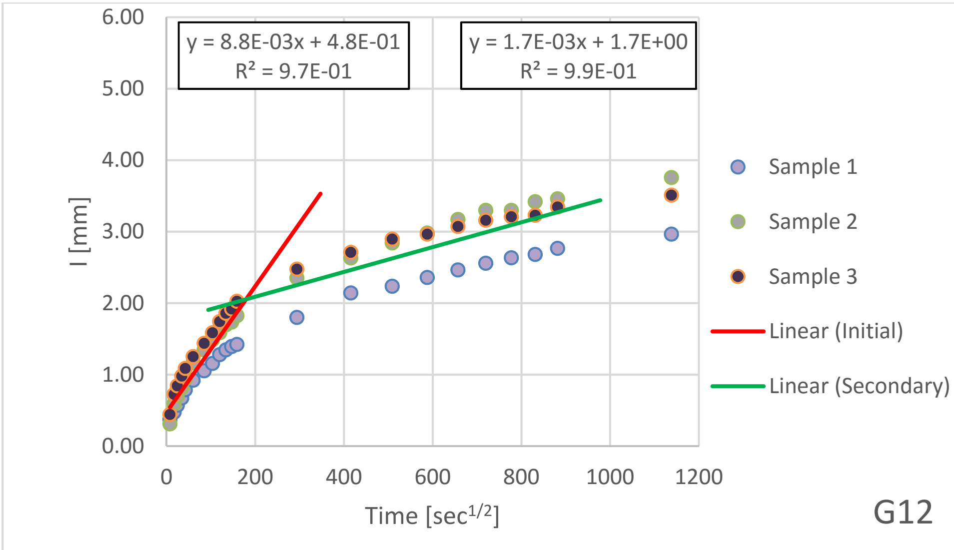


Figure B.1.30 – Absorption Results for G12

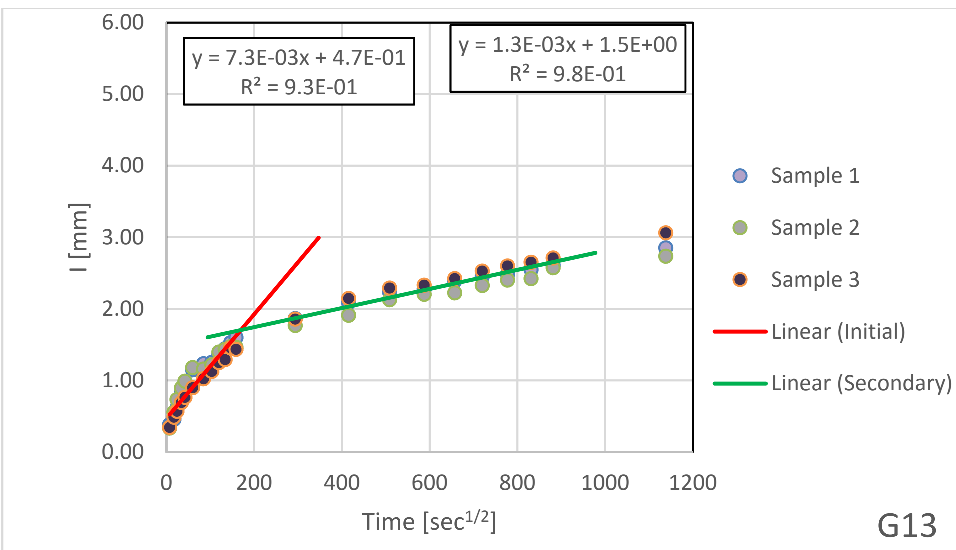


Figure B.1.31 – Absorption Results for G13

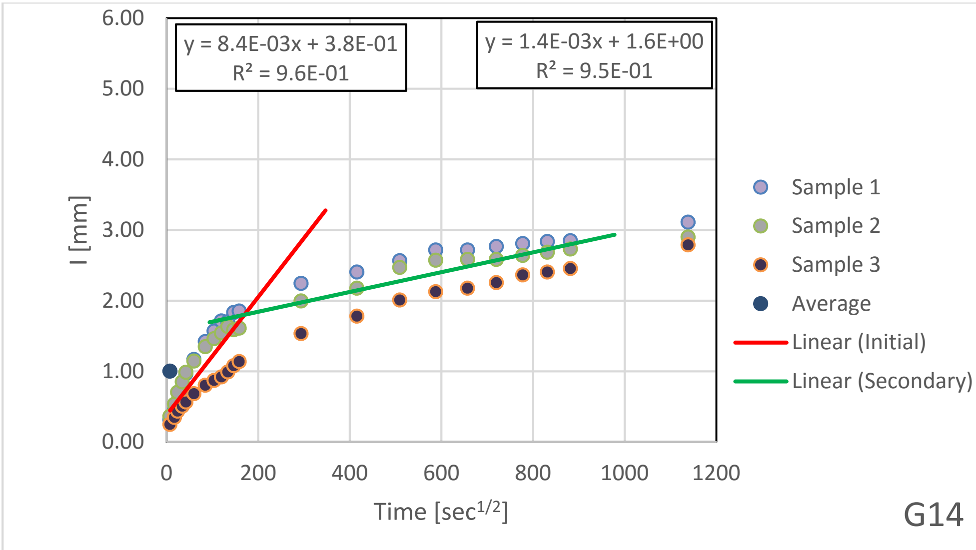


Figure B.1.32 – Absorption Results for G14

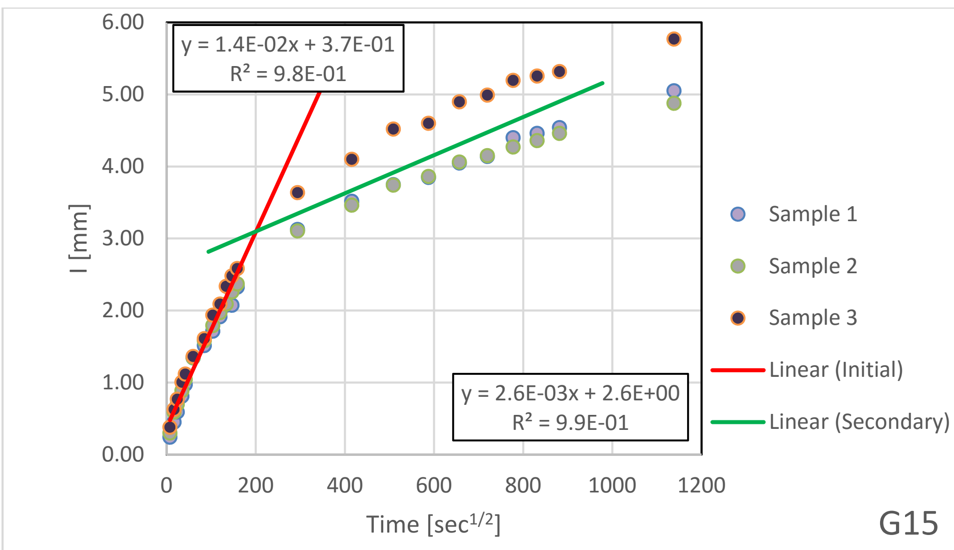


Figure B.1.33 – Absorption Results for G15

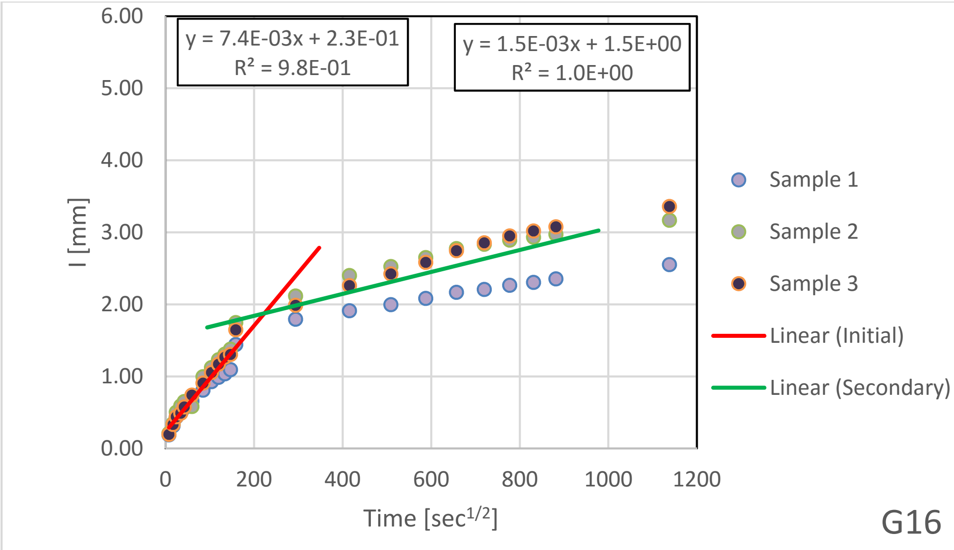


Figure B.1.34 – Absorption Results for G16

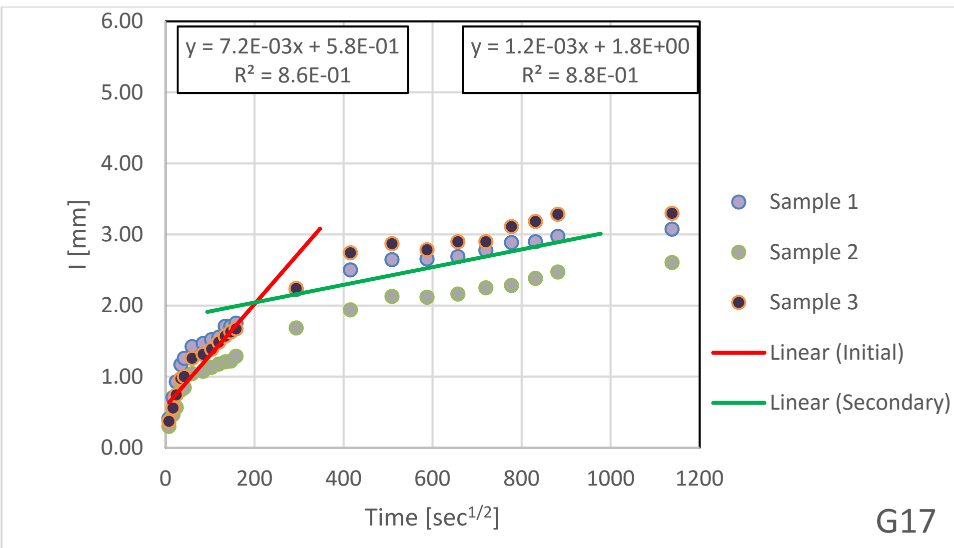


Figure B.1.35 – Absorption Results for G17

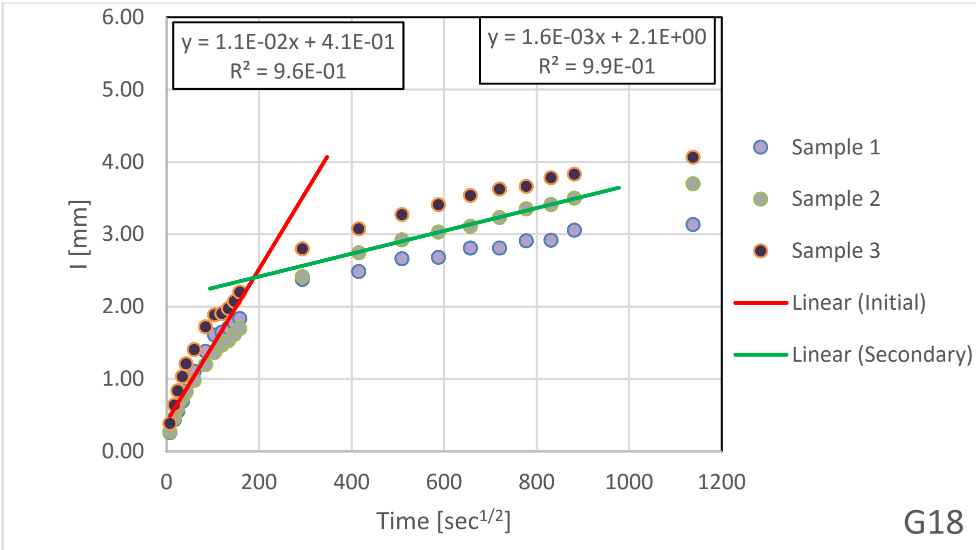


Figure B.1.36 – Absorption Results for G18

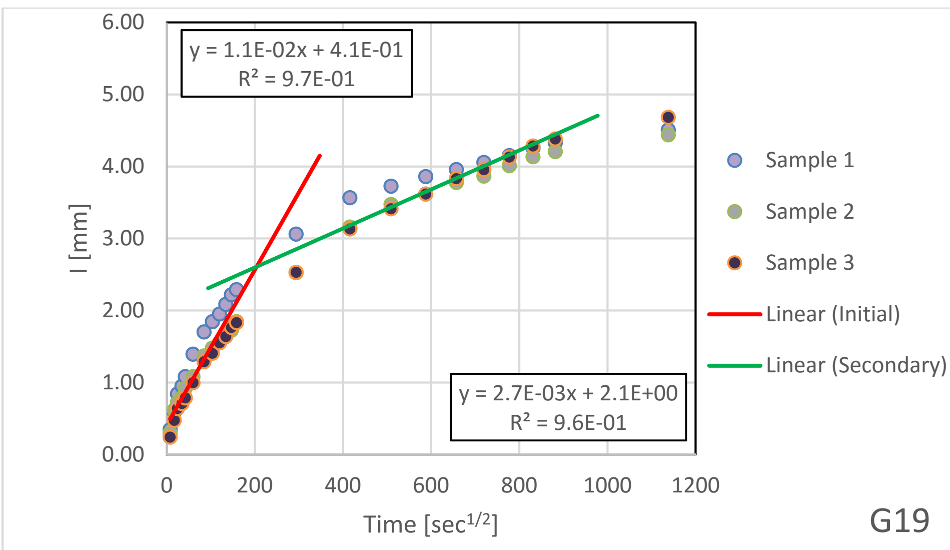


Figure B.1.37 – Absorption Results for G19

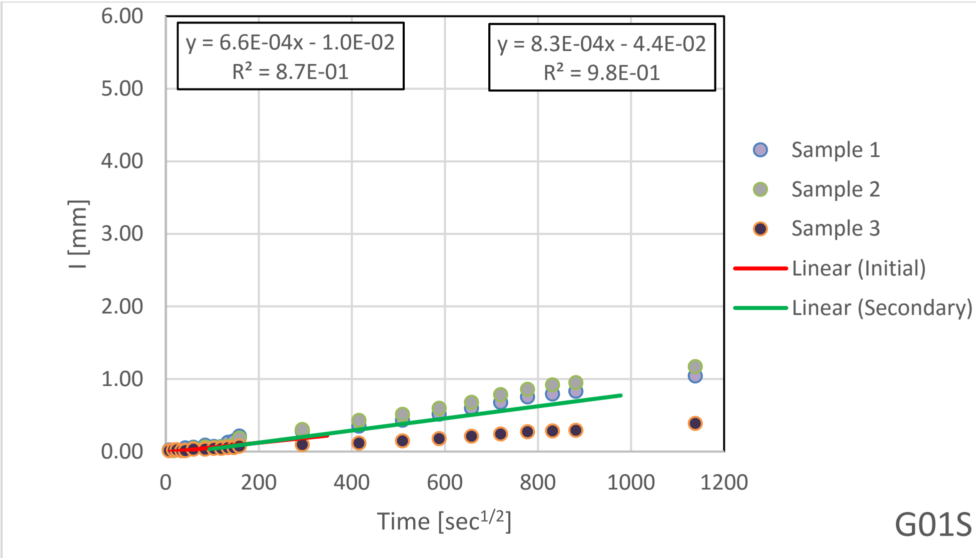


Figure B.1.38 – Absorption Results for G01-Silane Coated

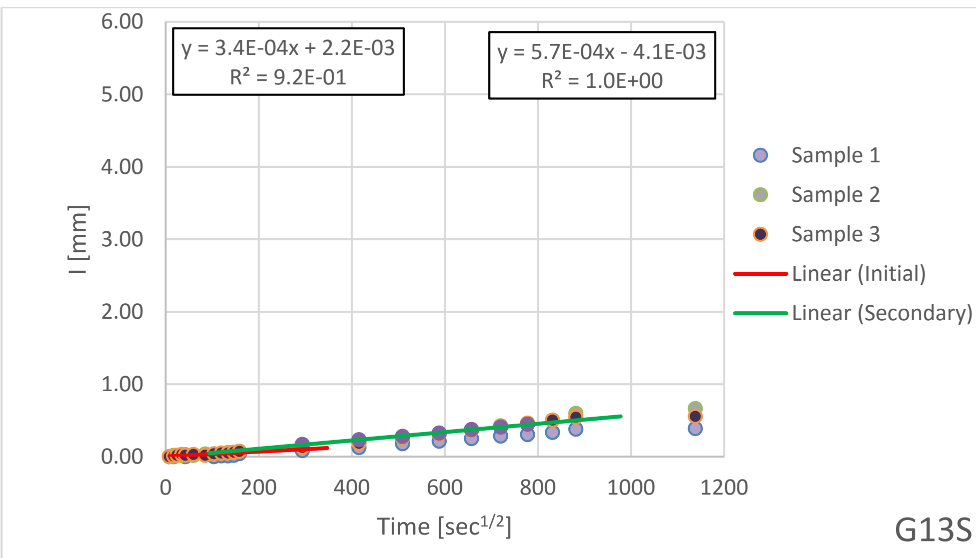


Figure B.1.39 – Absorption Results for G13-Silane Coated

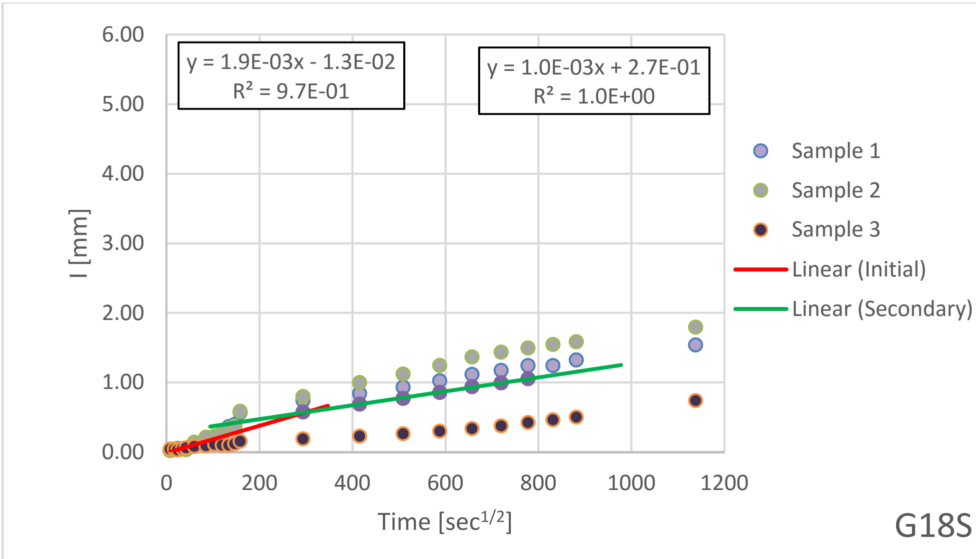


Figure B.1.40 – Absorption Results for G18-Silane Coated

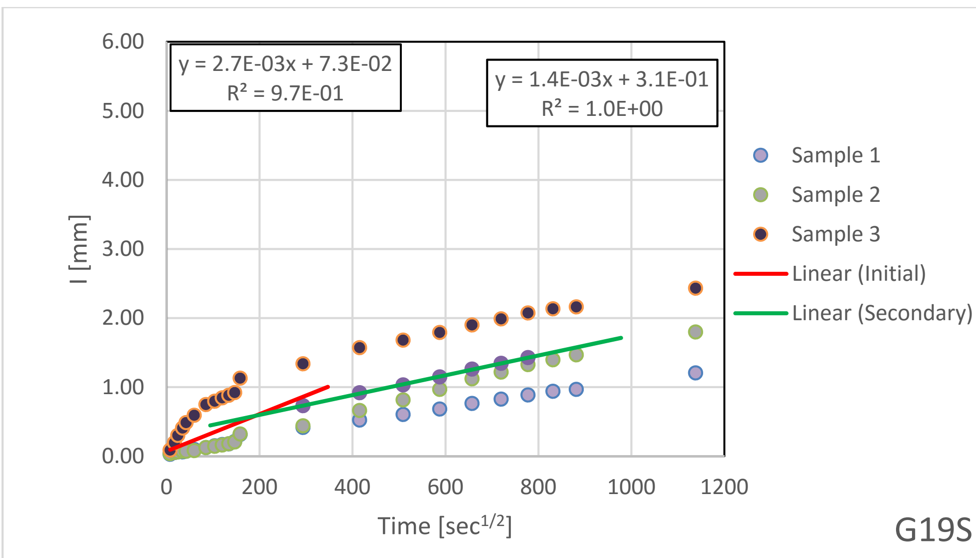


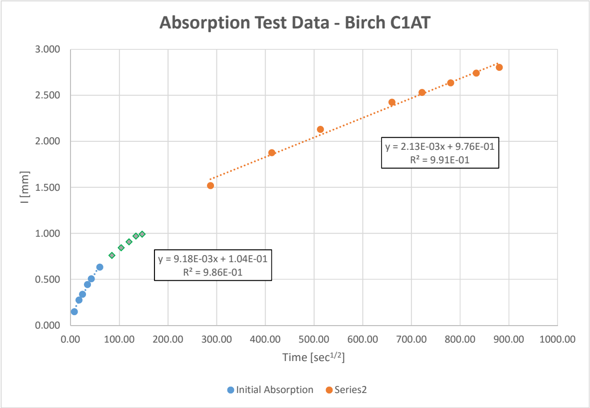
Figure B.1.41 – Absorption Results for G19-Silane Coated

WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-C1AT	
Saw Cut Depth After Trimming, mm	47.0	47.9
Face Width After Trimming, mm	98.9	101.0
Maximum Depth After Trimming, mm		69.4
Mass Before Sealing, g		683.5
Mass after Sealing, g		691.7

Exposed Area, mm^2
4742.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:26:00 AM	691.7				
1	1		60	2 s	60	692.4	60	0.7	7.75	0.14760
1	5		300	10 s	300	693.0	300	1.3	17.32	0.27411
1	10		600	2 min	600	693.3	600	1.6	24.49	0.33737
1	20		1200	2 min	1200	693.8	1200	2.1	34.64	0.44279
1	30		1800	2 min	1800	694.1	1800	2.4	42.43	0.50605
1	60	1	3600	2 min	3600	694.7	3600	3.0	60.00	0.63256
1	120	2	7200	5 min	7200	695.3	7200	3.6	84.85	0.75907
1	180	3	10800	5 min	10800	695.7	10800	4.0	103.92	0.84341
1	240	4	14400	5 min	14400	696.0	14400	4.3	120.00	0.90667
1	300	5	18000	5 min	18000	696.3	18000	4.6	134.16	0.96993
1	360	6	21600	5 min	21600	696.4	21600	4.7	146.97	0.99101
2	1440	24	86400	2 hr	7:21:00 AM	698.9	82500	7.2	287.23	1.51815
3	2880	48	172800	2 hr	7:49:00 AM	700.6	170580	8.9	413.01	1.87660
4	4320	72	259200	2 hr	9:32:00 AM	701.8	263160	10.1	512.99	2.12962
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:26:00 AM	703.2	435600	11.5	660.00	2.42482
7	8640	168	518400	2 hr	9:04:00 AM	703.7	520680	12.0	721.58	2.53024
8	10080	192	604800	2 hr	9:39:00 AM	704.2	609180	12.5	780.50	2.63567
9	11520	216	691200	2 hr	9:16:00 AM	704.7	694200	13.0	833.19	2.74110
10	12960	240	777600	2 hr	7:41:00 AM	705.0	774900	13.3	880.28	2.80435
15	21600	360	1296000	2 hr	9:11:00 AM	703.9	1298700	12.2	1139.61	2.57241



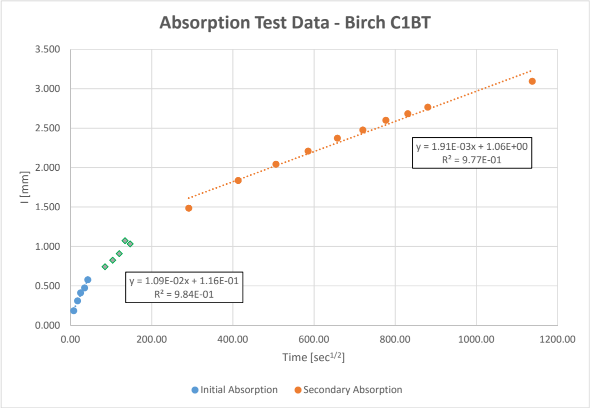
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-C1BAT	
Saw Cut Depth After Trimming, mm	47.9	47.3
Face Width After Trimming, mm	102.1	101.5
Maximum Depth After Trimming, mm		80.0
Mass Before Sealing, g		789.9
Mass after Sealing, g		798.1

Exposed Area, mm^2
4845.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:25:00 AM	798.1				
1	1		60	2 s	60	799.0	60	0.9	7.75	0.18573
1	5		300	10 s	300	799.6	300	1.5	17.32	0.30955
1	10		600	2 min	600	800.1	600	2.0	24.49	0.41274
1	20		1200	2 min	1200	800.4	1200	2.3	34.64	0.47465
1	30		1800	2 min	1800	800.9	1800	2.8	42.43	0.57783
1	60	1	3600	2 min	3600	801.2	3600	3.1	60.00	0.63975
1	120	2	7200	5 min	7200	801.7	7200	3.6	84.85	0.74293
1	180	3	10800	5 min	10800	802.1	10800	4.0	103.92	0.82548
1	240	4	14400	5 min	14400	802.5	14400	4.4	120.00	0.90803
1	300	5	18000	5 min	18000	803.3	18000	5.2	134.16	1.07312
1	360	6	21600	5 min	21600	803.1	21600	5.0	146.97	1.03185
2	1440	24	86400	2 hr	7:57:00 AM	805.3	84720	7.2	291.07	1.48586
3	2880	48	172800	2 hr	7:45:00 AM	807.0	170400	8.9	412.80	1.83669
4	4320	72	259200	2 hr	7:36:00 AM	808.0	256260	9.9	506.22	2.04306
5	5760	120	345600	2 hr	7:37:00 AM	808.8	342720	10.7	585.42	2.20815
6	7200	144	432000	2 hr	8:31:00 AM	809.6	432360	11.5	657.54	2.37325
7	8640	168	518400	2 hr	8:27:00 AM	810.1	518520	12.0	720.08	2.47643
8	10080	192	604800	2 hr	8:08:00 AM	810.7	603780	12.6	777.03	2.60025
9	11520	216	691200	2 hr	8:13:00 AM	811.1	690480	13.0	830.95	2.68280
10	12960	240	777600	2 hr	7:36:00 AM	811.5	774660	13.4	880.15	2.76535
15	21600	360	1296000	2 hr	7:59:00 AM	813.1	1294440	15.0	1137.73	3.09554

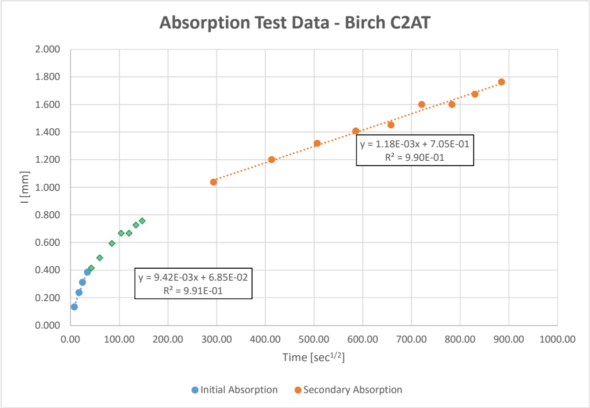


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-C2AT	
Saw Cut Depth After Trimming, mm	68.6	68.1
Face Width After Trimming, mm	98.7	98.7
Maximum Depth After Trimming, mm		63.0
Mass Before Sealing, g		882.8
Mass after Sealing, g		891.0

Exposed Area, mm^2
6746.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:23:00 AM	891.0				
1	1		60	2 s	60	891.9	60	0.9	7.75	0.13341
1	5		300	10 s	300	892.6	300	1.6	17.32	0.23717
1	10		600	2 min	600	893.1	600	2.1	24.49	0.31129
1	20		1200	2 min	1200	893.6	1200	2.6	34.64	0.38541
1	30		1800	2 min	1800	893.8	1800	2.8	42.43	0.41505
1	60	1	3600	2 min	3600	894.3	3600	3.3	60.00	0.48917
1	120	2	7200	5 min	7200	895.0	7200	4.0	84.85	0.59293
1	180	3	10800	5 min	10800	895.5	10800	4.5	103.92	0.66705
1	240	4	14400	5 min	14400	895.5	14400	4.5	120.00	0.66705
1	300	5	18000	5 min	18000	895.9	18000	4.9	134.16	0.72634
1	360	6	21600	5 min	21600	896.1	21600	5.1	146.97	0.75599
2	1440	24	86400	2 hr	8:18:00 AM	898.0	86100	7.0	293.43	1.03763
3	2880	48	172800	2 hr	7:43:00 AM	899.1	170400	8.1	412.80	1.20069
4	4320	72	259200	2 hr	7:39:00 AM	899.9	256560	8.9	506.52	1.31927
5	5760	120	345600	2 hr	7:40:00 AM	900.5	343020	9.5	585.68	1.40821
6	7200	144	432000	2 hr	8:41:00 AM	900.8	433080	9.8	658.09	1.45268
7	8640	168	518400	2 hr	8:51:00 AM	901.8	520080	10.8	721.17	1.60091
8	10080	192	604800	2 hr	10:45:00 AM	901.8	613320	10.8	783.15	1.60091
9	11520	216	691200	2 hr	7:57:00 AM	902.3	689640	11.3	830.45	1.67503
10	12960	240	777600	2 hr	9:58:00 AM	902.9	783300	11.9	885.04	1.76397
15	21600	360	1296000	2 hr	8:08:00 AM	902.9	1295100	11.9	1138.02	1.76397

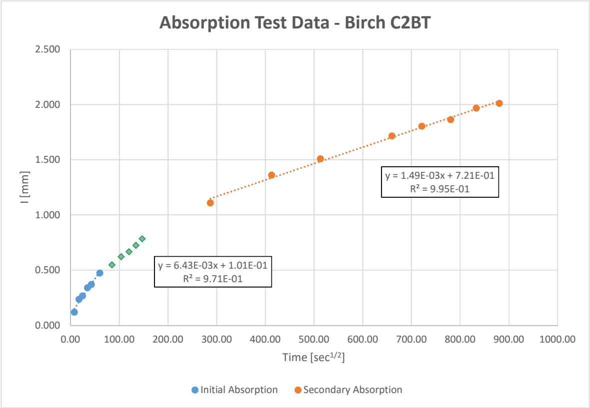


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-C2BT	
Saw Cut Depth After Trimming, mm	67.4	68.8
Face Width After Trimming, mm	99.2	99.4
Maximum Depth After Trimming, mm		86.9
Mass Before Sealing, g		1242.7
Mass after Sealing, g		1252.0

Exposed Area, mm^2
6762.3

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:28:00 AM	1252.0				
1	1		60	2 s	60	1252.8	60	0.8	7.75	0.11830
1	5		300	10 s	300	1253.6	300	1.6	17.32	0.23660
1	10		600	2 min	600	1253.8	600	1.8	24.49	0.26618
1	20		1200	2 min	1200	1254.3	1200	2.3	34.64	0.34012
1	30		1800	2 min	1800	1254.5	1800	2.5	42.43	0.36970
1	60	1	3600	2 min	3600	1255.2	3600	3.2	60.00	0.47321
1	120	2	7200	5 min	7200	1255.7	7200	3.7	84.85	0.54715
1	180	3	10800	5 min	10800	1256.2	10800	4.2	103.92	0.62109
1	240	4	14400	5 min	14400	1256.5	14400	4.5	120.00	0.66545
1	300	5	18000	5 min	18000	1256.9	18000	4.9	134.16	0.72460
1	360	6	21600	5 min	21600	1257.3	21600	5.3	146.97	0.78375
2	1440	24	86400	2 hr	7:21:00 AM	1259.5	82380	7.5	287.02	1.10909
3	2880	48	172800	2 hr	7:50:00 AM	1261.2	170520	9.2	412.94	1.36048
4	4320	72	259200	2 hr	9:33:00 AM	1262.2	263100	10.2	512.93	1.50836
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:27:00 AM	1263.6	435540	11.6	659.95	1.71539
7	8640	168	518400	2 hr	9:04:00 AM	1264.2	520560	12.2	721.50	1.80411
8	10080	192	604800	2 hr	9:39:00 AM	1264.6	609060	12.6	780.42	1.86326
9	11520	216	691200	2 hr	9:16:00 AM	1265.3	694080	13.3	833.11	1.96678
10	12960	240	777600	2 hr	7:41:00 AM	1265.6	774780	13.6	880.22	2.01114
15	21600	360	1296000	2 hr	9:12:00 AM	1267.0	1298640	15.0	1139.58	2.21817

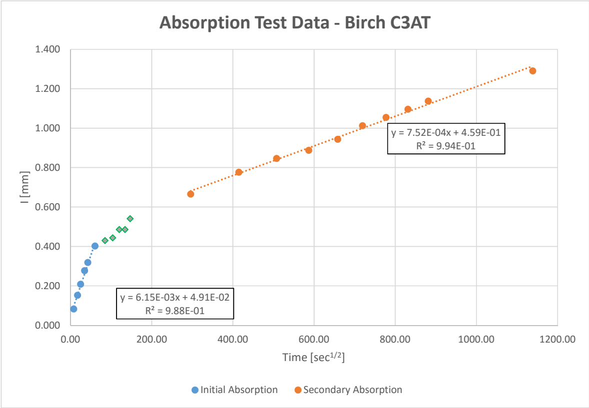


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**Birch-C3AT**	
Saw Cut Depth After Trimming, mm	72.0	72.1
Face Width After Trimming, mm	100.0	100.1
Maximum Depth After Trimming, mm		67.3
Mass Before Sealing, g		1031.7
Mass after Sealing, g		1039.1

Exposed Area, mm^2
7208.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:50:00 AM	1039.4				
1	1		60	2 s	60	1040.0	60	0.6	7.75	0.08323
1	5		300	10 s	300	1040.5	300	1.1	17.32	0.15260
1	10		600	2 min	600	1040.9	600	1.5	24.49	0.20808
1	20		1200	2 min	1200	1041.4	1200	2.0	34.64	0.27745
1	30		1800	2 min	1800	1041.7	1800	2.3	42.43	0.31906
1	60	1	3600	2 min	3600	1042.3	3600	2.9	60.00	0.40230
1	120	2	7200	5 min	7200	1042.5	7200	3.1	84.85	0.43004
1	180	3	10800	5 min	10800	1042.6	10800	3.2	103.92	0.44391
1	240	4	14400	5 min	14400	1042.9	14400	3.5	120.00	0.48553
1	300	5	18000	5 min	18000	1042.9	18000	3.5	134.16	0.48553
1	360	6	21600	5 min	21600	1043.3	21600	3.9	146.97	0.54102
2	1440	24	86400	2 hr	8:10:00 AM	1044.2	87600	4.8	295.97	0.66587
3	2880	48	172800	2 hr	7:36:00 AM	1045.0	171960	5.6	414.68	0.77685
4	4320	72	259200	2 hr	7:24:00 AM	1045.5	257640	6.1	507.58	0.84621
5	5760	120	345600	2 hr	7:31:00 AM	1045.8	344460	6.4	586.91	0.88783
6	7200	144	432000	2 hr	8:12:00 AM	1046.2	433320	6.8	658.27	0.94332
7	8640	168	518400	2 hr	7:33:00 AM	1046.7	517380	7.3	719.29	1.01268
8	10080	192	604800	2 hr	7:41:00 AM	1047.0	604260	7.6	777.34	1.05430
9	11520	216	691200	2 hr	7:52:00 AM	1047.3	691320	7.9	831.46	1.09591
10	12960	240	777600	2 hr	7:40:00 AM	1047.6	777000	8.2	881.48	1.13753
15	21600	360	1296000	2 hr	8:08:00 AM	1048.7	1297080	9.3	1138.89	1.29013

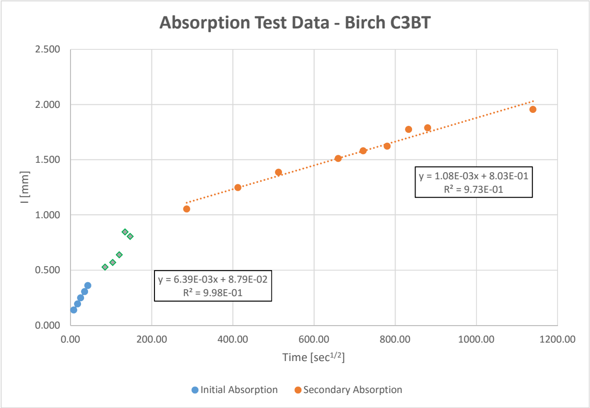


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-C3BT	
Saw Cut Depth After Trimming, mm	71.8	72.2
Face Width After Trimming, mm	99.9	100.4
Maximum Depth After Trimming, mm		81.7
Mass Before Sealing, g		1212.4
Mass after Sealing, g		1221.2

Exposed Area, mm^2
7210.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:40:00 AM	1221.2				
1	1		60	2 s	60	1222.2	60	1.0	7.75	0.13868
1	5		300	10 s	300	1222.6	300	1.4	17.32	0.19415
1	10		600	2 min	600	1223.0	600	1.8	24.49	0.24963
1	20		1200	2 min	1200	1223.4	1200	2.2	34.64	0.30510
1	30		1800	2 min	1800	1223.8	1800	2.6	42.43	0.36057
1	60	1	3600	2 min	3600	1224.3	3600	3.1	60.00	0.42991
1	120	2	7200	5 min	7200	1225.0	7200	3.8	84.85	0.52699
1	180	3	10800	5 min	10800	1225.3	10800	4.1	103.92	0.56859
1	240	4	14400	5 min	14400	1225.8	14400	4.6	120.00	0.63793
1	300	5	18000	5 min	18000	1227.3	18000	6.1	134.16	0.84595
1	360	6	21600	5 min	21600	1227.0	21600	5.8	146.97	0.80435
2	1440	24	86400	2 hr	7:23:00 AM	1228.8	81780	7.6	285.97	1.05397
3	2880	48	172800	2 hr	7:52:00 AM	1230.2	169920	9.0	412.21	1.24813
4	4320	72	259200	2 hr	9:35:00 AM	1231.2	262500	10.0	512.35	1.38681
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:29:00 AM	1232.1	434940	10.9	659.50	1.51162
7	8640	168	518400	2 hr	9:06:00 AM	1232.6	519960	11.4	721.08	1.58096
8	10080	192	604800	2 hr	9:41:00 AM	1232.9	608460	11.7	780.04	1.62257
9	11520	216	691200	2 hr	9:19:00 AM	1234.0	693540	12.8	832.79	1.77512
10	12960	240	777600	2 hr	7:43:00 AM	1234.1	774180	12.9	879.87	1.78898
15	21600	360	1296000	2 hr	9:14:00 AM	1235.3	1298040	14.1	1139.32	1.95540

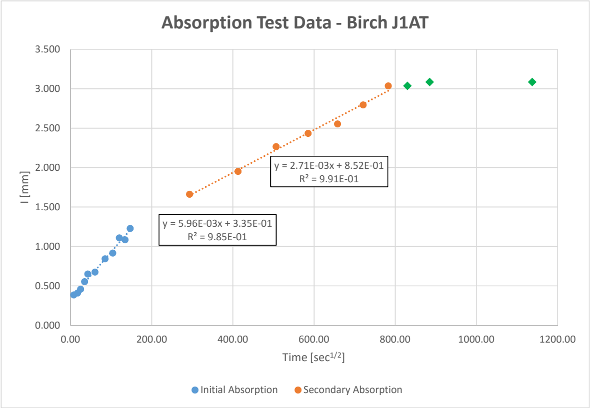


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-J1AT	
Saw Cut Depth After Trimming, mm	43.2	39.3
Face Width After Trimming, mm	101.1	100.1
Maximum Depth After Trimming, mm		66.5
Mass Before Sealing, g		601.4
Mass after Sealing, g		609.3

Exposed Area, mm^2
4149.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:28:00 AM	609.3				
1	1		60	2 s	60	610.9	60	1.6	7.75	0.38557
1	5		300	10 s	300	611.0	300	1.7	17.32	0.40966
1	10		600	2 min	600	611.2	600	1.9	24.49	0.45786
1	20		1200	2 min	1200	611.6	1200	2.3	34.64	0.55425
1	30		1800	2 min	1800	612.0	1800	2.7	42.43	0.65064
1	60	1	3600	2 min	3600	612.1	3600	2.8	60.00	0.67474
1	120	2	7200	5 min	7200	612.8	7200	3.5	84.85	0.84342
1	180	3	10800	5 min	10800	613.1	10800	3.8	103.92	0.91572
1	240	4	14400	5 min	14400	613.9	14400	4.6	120.00	1.10850
1	300	5	18000	5 min	18000	613.8	18000	4.5	134.16	1.08440
1	360	6	21600	5 min	21600	614.4	21600	5.1	146.97	1.22899
2	1440	24	86400	2 hr	8:19:00 AM	616.2	85860	6.9	293.02	1.66275
3	2880	48	172800	2 hr	7:43:00 AM	617.4	170100	8.1	412.43	1.95192
4	4320	72	259200	2 hr	7:40:00 AM	618.7	256320	9.4	506.28	2.26520
5	5760	120	345600	2 hr	7:41:00 AM	619.4	342780	10.1	585.47	2.43388
6	7200	144	432000	2 hr	8:41:00 AM	619.9	432780	10.6	657.86	2.55437
7	8640	168	518400	2 hr	8:51:00 AM	620.9	519780	11.6	720.96	2.79535
8	10080	192	604800	2 hr	10:46:00 AM	621.9	613080	12.6	782.99	3.03633
9	11520	216	691200	2 hr	7:57:00 AM	621.9	689340	12.6	830.27	3.03633
10	12960	240	777600	2 hr	9:58:00 AM	622.1	783000	12.8	884.87	3.08452
15	21600	360	1296000	2 hr	8:00:00 AM	622.1	1294320	12.8	1137.68	3.08452



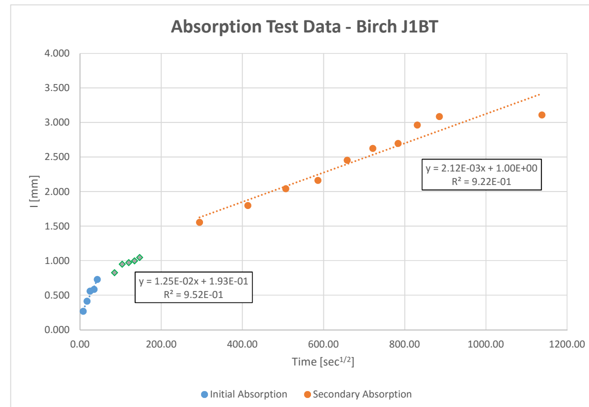
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	**Birch-J1BT**	
Saw Cut Depth After Trimming, mm	41.3	40.1
Face Width After Trimming, mm	101.3	101.0
Maximum Depth After Trimming, mm		80.7
Mass Before Sealing, g		664.1
Mass after Sealing, g		671.4

Exposed Area, mm^2
4116.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:13:00 AM	671.4				
1	1		60	2 s	60	672.5	60	1.1	7.75	0.26720
1	5		300	10 s	300	673.1	300	1.7	17.32	0.41294
1	10		600	2 min	600	673.7	600	2.3	24.49	0.55869
1	20		1200	2 min	1200	673.8	1200	2.4	34.64	0.58298
1	30		1800	2 min	1800	674.4	1800	3.0	42.43	0.72872
1	60	1	3600	2 min	3600	674.5	3600	3.1	60.00	0.75301
1	120	2	7200	5 min	7200	674.8	7200	3.4	84.85	0.82588
1	180	3	10800	5 min	10800	675.3	10800	3.9	103.92	0.94734
1	240	4	14400	5 min	14400	675.4	14400	4.0	120.00	0.97163
1	300	5	18000	5 min	18000	675.5	18000	4.1	134.16	0.99592
1	360	6	21600	5 min	21600	675.7	21600	4.3	146.97	1.04450
2	1440	24	86400	2 hr	8:16:00 AM	677.8	86580	6.4	294.24	1.55460
3	2880	48	172800	2 hr	7:41:00 AM	678.8	170880	7.4	413.38	1.79751
4	4320	72	259200	2 hr	7:37:00 AM	679.8	257040	8.4	506.99	2.04042
5	5760	120	345600	2 hr	7:38:00 AM	680.3	343500	8.9	586.09	2.16187
6	7200	144	432000	2 hr	8:32:00 AM	681.5	433140	10.1	658.13	2.45336
7	8640	168	518400	2 hr	8:49:00 AM	682.2	520560	10.8	721.50	2.62339
8	10080	192	604800	2 hr	10:43:00 AM	682.5	613800	11.1	783.45	2.69627
9	11520	216	691200	2 hr	7:55:00 AM	683.6	690120	12.2	830.73	2.96346
10	12960	240	777600	2 hr	9:57:00 AM	684.1	783840	12.7	885.35	3.08492
15	21600	360	1296000	2 hr	8:00:00 AM	684.2	1295220	12.8	1138.08	3.10921



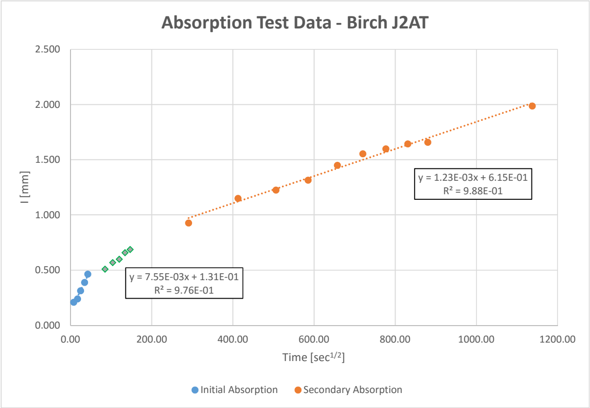
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	**Birch-J2AT**	
Saw Cut Depth After Trimming, mm	67.9	66.9
Face Width After Trimming, mm	99.4	99.3
Maximum Depth After Trimming, mm		61.5
Mass Before Sealing, g		850.2
Mass after Sealing, g		858.6

Exposed Area, mm^2
6696.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:29:00 AM	858.6				
1	1		60	2 s	60	860.0	60	1.4	7.75	0.20907
1	5		300	10 s	300	860.2	300	1.6	17.32	0.23894
1	10		600	2 min	600	860.7	600	2.1	24.49	0.31361
1	20		1200	2 min	1200	861.2	1200	2.6	34.64	0.38828
1	30		1800	2 min	1800	861.7	1800	3.1	42.43	0.46295
1	60	1	3600	2 min	3600	861.8	3600	3.2	60.00	0.47788
1	120	2	7200	5 min	7200	862.0	7200	3.4	84.85	0.50775
1	180	3	10800	5 min	10800	862.4	10800	3.8	103.92	0.56749
1	240	4	14400	5 min	14400	862.6	14400	4.0	120.00	0.59735
1	300	5	18000	5 min	18000	863.0	18000	4.4	134.16	0.65709
1	360	6	21600	5 min	21600	863.2	21600	4.6	146.97	0.68696
2	1440	24	86400	2 hr	7:58:00 AM	864.8	84540	6.2	290.76	0.92590
3	2880	48	172800	2 hr	7:46:00 AM	866.3	170220	7.7	412.58	1.14991
4	4320	72	259200	2 hr	7:37:00 AM	866.8	256080	8.2	506.04	1.22458
5	5760	120	345600	2 hr	7:38:00 AM	867.4	342540	8.8	585.27	1.31418
6	7200	144	432000	2 hr	8:32:00 AM	868.3	432180	9.7	657.40	1.44858
7	8640	168	518400	2 hr	8:28:00 AM	869.0	518340	10.4	719.96	1.55312
8	10080	192	604800	2 hr	8:09:00 AM	869.3	603600	10.7	776.92	1.59792
9	11520	216	691200	2 hr	8:14:00 AM	869.6	690300	11.0	830.84	1.64273
10	12960	240	777600	2 hr	7:37:00 AM	869.7	774480	11.1	880.05	1.65766
15	21600	360	1296000	2 hr	8:00:00 AM	871.9	1294260	13.3	1137.66	1.98620

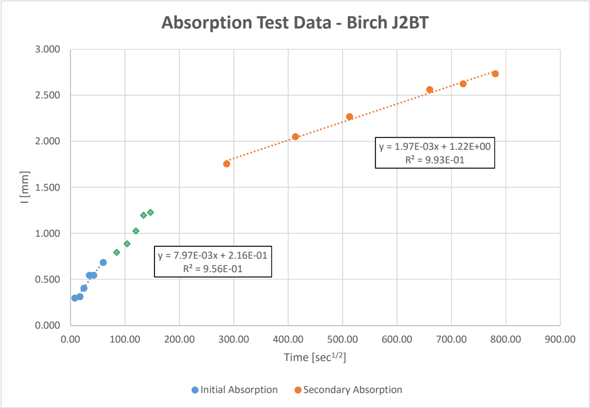


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-J2BT	
Saw Cut Depth After Trimming, mm	63.9	65.7
Face Width After Trimming, mm	99.4	99.3
Maximum Depth After Trimming, mm		85.1
Mass Before Sealing, g		1102.2
Mass after Sealing, g		1111.1

Exposed Area, mm^2
6437.9

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:31:00 AM	1111.1				
1	1		60	2 s	60	1113.0	60	1.9	7.75	0.29513
1	5		300	10 s	300	1113.1	300	2.0	17.32	0.31066
1	10		600	2 min	600	1113.7	600	2.6	24.49	0.40386
1	20		1200	2 min	1200	1114.6	1200	3.5	34.64	0.54366
1	30		1800	2 min	1800	1114.6	1800	3.5	42.43	0.54366
1	60	1	3600	2 min	3600	1115.5	3600	4.4	60.00	0.68345
1	120	2	7200	5 min	7200	1116.2	7200	5.1	84.85	0.79219
1	180	3	10800	5 min	10800	1116.8	10800	5.7	103.92	0.88538
1	240	4	14400	5 min	14400	1117.7	14400	6.6	120.00	1.02518
1	300	5	18000	5 min	18000	1118.8	18000	7.7	134.16	1.19605
1	360	6	21600	5 min	21600	1119.0	21600	7.9	146.97	1.22711
2	1440	24	86400	2 hr	7:22:00 AM	1122.4	82260	11.3	286.81	1.75524
3	2880	48	172800	2 hr	7:56:00 AM	1124.3	170700	13.2	413.16	2.05036
4	4320	72	259200	2 hr	9:33:00 AM	1125.7	262920	14.6	512.76	2.26783
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:27:00 AM	1127.6	435360	16.5	659.82	2.56296
7	8640	168	518400	2 hr	9:05:00 AM	1128.0	520440	16.9	721.42	2.62509
8	10080	192	604800	2 hr	9:40:00 AM	1128.7	608940	17.6	780.35	2.73382
9	11520	216	691200	2 hr	9:17:00 AM	1128.6	693960	17.5	833.04	2.71829
10	12960	240	777600	2 hr	7:41:00 AM	1129.1	774600	18.0	880.11	2.79595
15	21600	360	1296000	2 hr	9:12:00 AM	1130.4	1298460	19.3	1139.50	2.99788

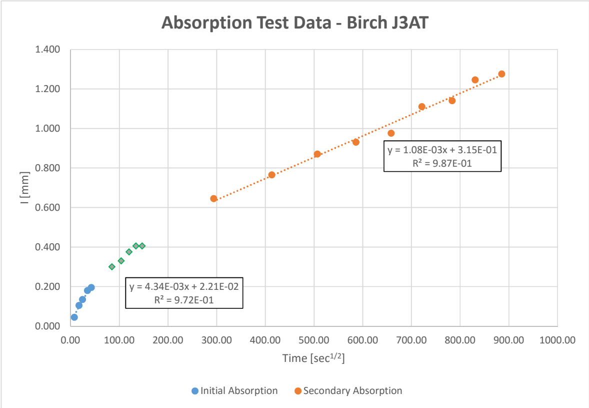


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-J3AT	
Saw Cut Depth After Trimming, mm	66.3	67.8
Face Width After Trimming, mm	98.4	100.3
Maximum Depth After Trimming, mm		68.4
Mass Before Sealing, g		997.8
Mass after Sealing, g		1006.2

Exposed Area, mm^2
6661.4

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:17:00 AM	1006.2				
1	1		60	2 s	60	1006.5	60	0.3	7.75	0.04504
1	5		300	10 s	300	1006.9	300	0.7	17.32	0.10508
1	10		600	2 min	600	1007.1	600	0.9	24.49	0.13511
1	20		1200	2 min	1200	1007.4	1200	1.2	34.64	0.18014
1	30		1800	2 min	1800	1007.5	1800	1.3	42.43	0.19515
1	60	1	3600	2 min	3600	1007.8	3600	1.6	60.00	0.24019
1	120	2	7200	5 min	7200	1008.2	7200	2.0	84.85	0.30024
1	180	3	10800	5 min	10800	1008.4	10800	2.2	103.92	0.33026
1	240	4	14400	5 min	14400	1008.7	14400	2.5	120.00	0.37530
1	300	5	18000	5 min	18000	1008.9	18000	2.7	134.16	0.40532
1	360	6	21600	5 min	21600	1008.9	21600	2.7	146.97	0.40532
2	1440	24	86400	2 hr	8:17:00 AM	1010.5	86400	4.3	293.94	0.64551
3	2880	48	172800	2 hr	7:41:00 AM	1011.3	170640	5.1	413.09	0.76560
4	4320	72	259200	2 hr	7:38:00 AM	1012.0	256860	5.8	506.81	0.87069
5	5760	120	345600	2 hr	7:39:00 AM	1012.4	343320	6.2	585.94	0.93073
6	7200	144	432000	2 hr	8:40:00 AM	1012.7	433380	6.5	658.32	0.97577
7	8640	168	518400	2 hr	8:50:00 AM	1013.6	520380	7.4	721.37	1.11087
8	10080	192	604800	2 hr	10:44:00 AM	1013.8	613620	7.6	783.34	1.14090
9	11520	216	691200	2 hr	7:56:00 AM	1014.5	689940	8.3	830.63	1.24598
10	12960	240	777600	2 hr	9:57:00 AM	1014.7	783600	8.5	885.21	1.27600
15	21600	360	1296000	2 hr	8:00:00 AM	1014.7	1294980	8.5	1137.97	1.27600

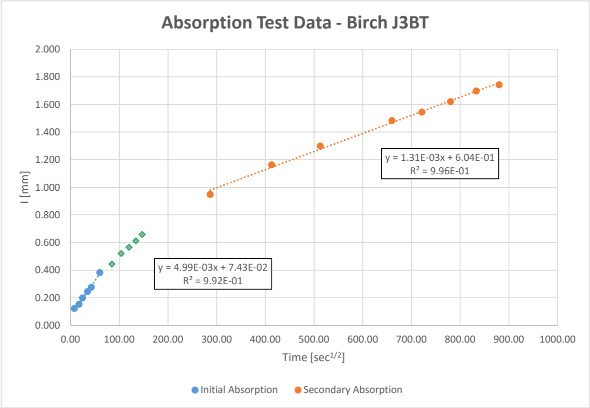


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	Birch-J3BT	
Saw Cut Depth After Trimming, mm	64.7	65.5
Face Width After Trimming, mm	100.3	100.6
Maximum Depth After Trimming, mm		78.3
Mass Before Sealing, g		1121.4
Mass after Sealing, g		1130.3

Exposed Area, mm^2
6539.3

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:32:00 AM	1130.3				
1	1		60	2 s	60	1131.1	60	0.8	7.75	0.12234
1	5		300	10 s	300	1131.3	300	1.0	17.32	0.15292
1	10		600	2 min	600	1131.6	600	1.3	24.49	0.19880
1	20		1200	2 min	1200	1131.9	1200	1.6	34.64	0.24467
1	30		1800	2 min	1800	1132.1	1800	1.8	42.43	0.27526
1	60	1	3600	2 min	3600	1132.8	3600	2.5	60.00	0.38230
1	120	2	7200	5 min	7200	1133.2	7200	2.9	84.85	0.44347
1	180	3	10800	5 min	10800	1133.7	10800	3.4	103.92	0.51993
1	240	4	14400	5 min	14400	1134.0	14400	3.7	120.00	0.56581
1	300	5	18000	5 min	18000	1134.3	18000	4.0	134.16	0.61169
1	360	6	21600	5 min	21600	1134.6	21600	4.3	146.97	0.65756
2	1440	24	86400	2 hr	7:22:00 AM	1136.5	82200	6.2	286.71	0.94811
3	2880	48	172800	2 hr	7:51:00 AM	1137.9	170340	7.6	412.72	1.16220
4	4320	72	259200	2 hr	9:34:00 AM	1138.8	262920	8.5	512.76	1.29983
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:28:00 AM	1140.0	435360	9.7	659.82	1.48334
7	8640	168	518400	2 hr	9:05:00 AM	1140.4	520380	10.1	721.37	1.54451
8	10080	192	604800	2 hr	9:40:00 AM	1140.9	608880	10.6	780.31	1.62097
9	11520	216	691200	2 hr	9:18:00 AM	1141.4	693960	11.1	833.04	1.69743
10	12960	240	777600	2 hr	7:42:00 AM	1141.7	774600	11.4	880.11	1.74331
15	21600	360	1296000	2 hr	9:14:00 AM	1142.0	1298520	11.7	1139.53	1.78918



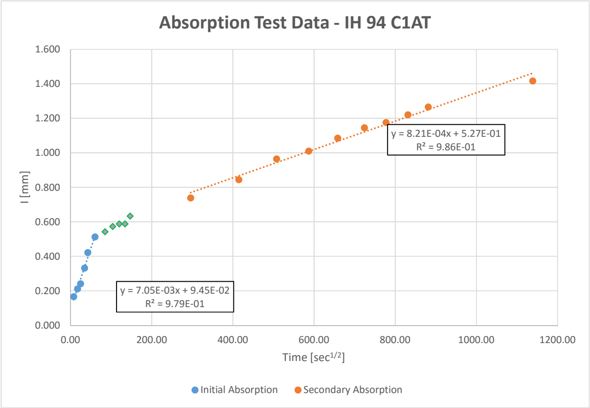
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	IH 94 - C1AT	
Saw Cut Depth After Trimming, mm	68.9	67.3
Face Width After Trimming, mm	97.9	97.0
Maximum Depth After Trimming, mm		63.0
Mass Before Sealing, g		864.6
Mass after Sealing, g		872.0

Exposed Area, mm^2
6636.3

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:54:00 AM	872.4				
1	1		60	2 s	60	873.5	60	1.1	7.75	0.16575
1	5		300	10 s	300	873.8	300	1.4	17.32	0.21096
1	10		600	2 min	600	874.0	600	1.6	24.49	0.24110
1	20		1200	2 min	1200	874.6	1200	2.2	34.64	0.33151
1	30		1800	2 min	1800	875.2	1800	2.8	42.43	0.42192
1	60	1	3600	2 min	3600	875.8	3600	3.4	60.00	0.51233
1	120	2	7200	5 min	7200	876.0	7202	3.6	84.86	0.54247
1	180	3	10800	5 min	10800	876.2	10800	3.8	103.92	0.57260
1	240	4	14400	5 min	14400	876.3	14400	3.9	120.00	0.58767
1	300	5	18000	5 min	18000	876.3	18000	3.9	134.16	0.58767
1	360	6	21600	5 min	21600	876.6	21600	4.2	146.97	0.63288
2	1440	24	86400	2 hr	8:13:00 AM	877.3	87540	4.9	295.87	0.73836
3	2880	48	172800	2 hr	7:38:00 AM	878.0	171840	5.6	414.54	0.84384
4	4320	72	259200	2 hr	7:27:00 AM	878.8	257580	6.4	507.52	0.96439
5	5760	120	345600	2 hr	7:34:00 AM	879.1	344400	6.7	586.86	1.00959
6	7200	144	432000	2 hr	8:16:00 AM	879.6	433320	7.2	658.27	1.08493
7	8640	168	518400	2 hr	9:36:00 AM	880.0	524520	7.6	724.24	1.14521
8	10080	192	604800	2 hr	7:44:00 AM	880.2	604200	7.8	777.30	1.17535
9	11520	216	691200	2 hr	7:54:00 AM	880.5	691200	8.1	831.38	1.22055
10	12960	240	777600	2 hr	7:41:00 AM	880.8	776820	8.4	881.37	1.26576
15	21600	360	1296000	2 hr	8:11:00 AM	881.8	1297020	9.4	1138.87	1.41644



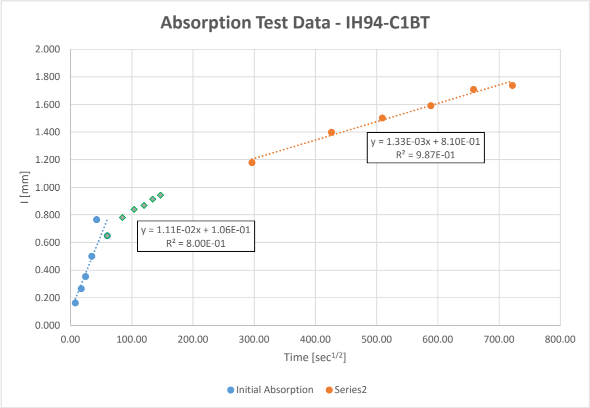
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	**IH 94 - C1BT**	
Saw Cut Depth After Trimming, mm	67.2	68.7
Face Width After Trimming, mm	100.0	99.8
Maximum Depth After Trimming, mm		86.6
Mass Before Sealing, g		1275.6
Mass after Sealing, g		1284.6

Exposed Area, mm^2
6788.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:31:00 AM	1284.6				
1	1		60	2 s	60	1285.7	60	1.1	7.75	0.16205
1	5		300	10 s	300	1286.4	300	1.8	17.32	0.26517
1	10		600	2 min	600	1287.0	600	2.4	24.49	0.35355
1	20		1200	2 min	1200	1288.0	1200	3.4	34.64	0.50087
1	30		1800	2 min	1800	1289.8	1800	5.2	42.43	0.76603
1	60	1	3600	2 min	3600	1289.0	3600	4.4	60.00	0.64818
1	120	2	7200	5 min	7200	1289.9	7202	5.3	84.86	0.78077
1	180	3	10800	5 min	10800	1290.3	10800	5.7	103.92	0.83969
1	240	4	14400	5 min	14400	1290.5	14400	5.9	120.00	0.86915
1	300	5	18000	5 min	18000	1290.8	18000	6.2	134.16	0.91335
1	360	6	21600	5 min	21600	1291.0	21600	6.4	146.97	0.94281
2	1440	24	86400	2 hr	7:54:00 AM	1292.6	87780	8.0	296.28	1.17851
3	2880	48	172800	2 hr	9:56:00 AM	1294.1	181500	9.5	426.03	1.39949
4	4320	72	259200	2 hr	7:32:00 AM	1294.8	259260	10.2	509.18	1.50261
5	5760	120	345600	2 hr	7:40:00 AM	1295.4	346140	10.8	588.34	1.59099
6	7200	144	432000	2 hr	7:49:00 AM	1296.2	433080	11.6	658.09	1.70885
7	8640	168	518400	2 hr	8:09:00 AM	1296.4	520680	11.8	721.58	1.73831
8	10080	192	604800	2 hr	7:14:00 AM	1296.6	603780	12.0	777.03	1.76777
9	11520	216	691200	2 hr	7:27:00 AM	1296.7	690960	12.1	831.24	1.78250
10	12960	240	777600	2 hr	7:47:00 AM	1296.8	778560	12.2	882.36	1.79724
15	21600	360	1296000	2 hr	9:13:00 AM	1297.8	1302120	13.2	1141.10	1.94455

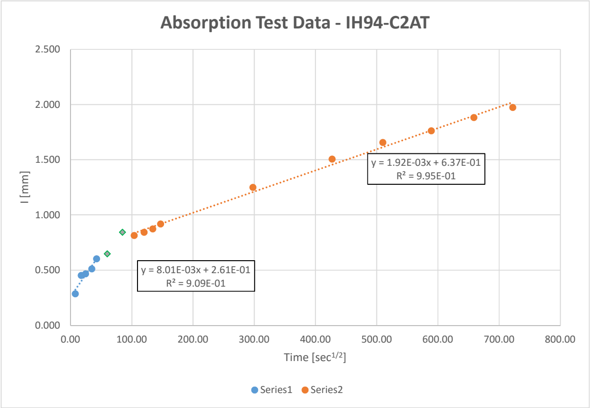


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**IH 94 - C2AT**	
Saw Cut Depth After Trimming, mm	66.0	67.7
Face Width After Trimming, mm	99.2	99.5
Maximum Depth After Trimming, mm		90.5
Mass Before Sealing, g		1192.5
Mass after Sealing, g		1201.5

Exposed Area, mm^2
6641.5

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:12:00 AM	1201.5				
1	1		60	2 s	60	1203.4	60	1.9	7.75	0.28608
1	5		300	10 s	300	1204.5	300	3.0	17.32	0.45170
1	10		600	2 min	600	1204.6	600	3.1	24.49	0.46676
1	20		1200	2 min	1200	1204.9	1200	3.4	34.64	0.51193
1	30		1800	2 min	1800	1205.5	1800	4.0	42.43	0.60227
1	60	1	3600	2 min	3600	1205.8	3600	4.3	60.00	0.64744
1	120	2	7200	5 min	7200	1207.1	7202	5.6	84.86	0.84318
1	180	3	10800	5 min	10800	1206.9	10800	5.4	103.92	0.81306
1	240	4	14400	5 min	14400	1207.1	14400	5.6	120.00	0.84318
1	300	5	18000	5 min	18000	1207.3	18000	5.8	134.16	0.87329
1	360	6	21600	5 min	21600	1207.6	21600	6.1	146.97	0.91846
2	1440	24	86400	2 hr	7:51:00 AM	1209.8	88740	8.3	297.89	1.24971
3	2880	48	172800	2 hr	9:53:00 AM	1211.5	182460	10.0	427.15	1.50567
4	4320	72	259200	2 hr	7:29:00 AM	1212.5	260220	11.0	510.12	1.65624
5	5760	120	345600	2 hr	7:37:00 AM	1213.2	347100	11.7	589.15	1.76164
6	7200	144	432000	2 hr	7:46:00 AM	1214.0	434040	12.5	658.82	1.88209
7	8640	168	518400	2 hr	8:06:00 AM	1214.6	521640	13.1	722.25	1.97243
8	10080	192	604800	2 hr	7:11:00 AM	1214.8	604740	13.3	777.65	2.00255
9	11520	216	691200	2 hr	7:24:00 AM	1215.3	691920	13.8	831.82	2.07783
10	12960	240	777600	2 hr	7:42:00 AM	1215.5	779400	14.0	882.84	2.10794
15	21600	360	1296000	2 hr	9:09:00 AM	1217.3	1303020	15.8	1141.50	2.37896



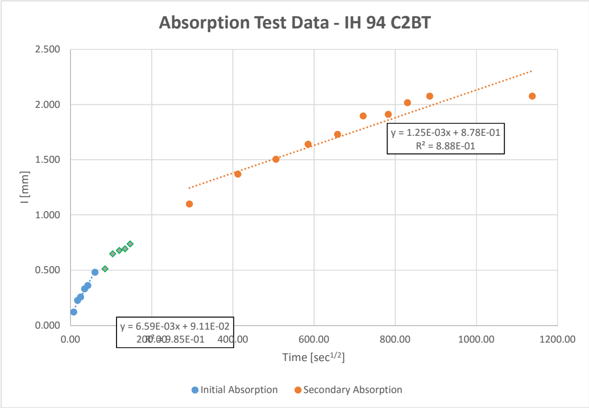
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	IH 94 - C2BT	
Saw Cut Depth After Trimming, mm	65.6	66.8
Face Width After Trimming, mm	100.2	100.6
Maximum Depth After Trimming, mm		59.9
Mass Before Sealing, g		769.8
Mass after Sealing, g		779.0

Exposed Area, mm^2
6646.5

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:32:00 AM	779.0				
1	1		60	2 s	60	779.8	60	0.8	7.75	0.12036
1	5		300	10 s	300	780.5	300	1.5	17.32	0.22568
1	10		600	2 min	600	780.7	600	1.7	24.49	0.25577
1	20		1200	2 min	1200	781.2	1200	2.2	34.64	0.33100
1	30		1800	2 min	1800	781.4	1800	2.4	42.43	0.36109
1	60	1	3600	2 min	3600	782.2	3600	3.2	60.00	0.48146
1	120	2	7200	5 min	7200	782.4	7202	3.4	84.86	0.51155
1	180	3	10800	5 min	10800	783.3	10800	4.3	103.92	0.64696
1	240	4	14400	5 min	14400	783.5	14400	4.5	120.00	0.67705
1	300	5	18000	5 min	18000	783.6	18000	4.6	134.16	0.69210
1	360	6	21600	5 min	21600	783.9	21600	4.9	146.97	0.73723
2	1440	24	86400	2 hr	8:21:00 AM	786.3	85740	7.3	292.81	1.09833
3	2880	48	172800	2 hr	7:44:00 AM	788.1	169920	9.1	412.21	1.36915
4	4320	72	259200	2 hr	7:41:00 AM	789.0	256140	10.0	506.10	1.50456
5	5760	120	345600	2 hr	7:42:00 AM	789.9	342600	10.9	585.32	1.63997
6	7200	144	432000	2 hr	8:42:00 AM	790.5	432600	11.5	657.72	1.73024
7	8640	168	518400	2 hr	8:52:00 AM	791.6	519600	12.6	720.83	1.89574
8	10080	192	604800	2 hr	10:46:00 AM	791.7	612840	12.7	782.84	1.91079
9	11520	216	691200	2 hr	7:58:00 AM	792.4	689160	13.4	830.16	2.01610
10	12960	240	777600	2 hr	9:59:00 AM	792.8	782820	13.8	884.77	2.07629
15	21600	360	1296000	2 hr	8:11:00 AM	792.8	1294740	13.8	1137.87	2.07629

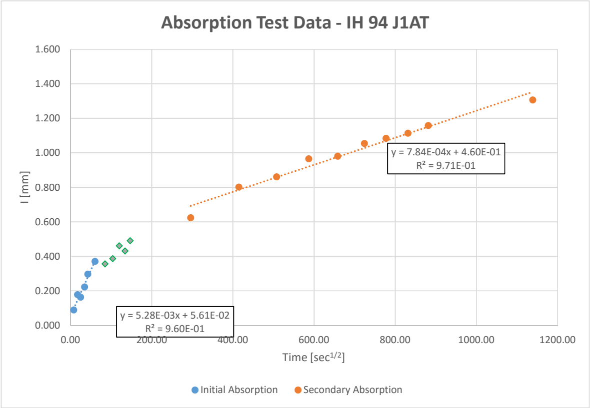


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	IH 94 - J1AT	
Saw Cut Depth After Trimming, mm	68.1	67.9
Face Width After Trimming, mm	100.0	98.1
Maximum Depth After Trimming, mm		62.0
Mass Before Sealing, g		844.5
Mass after Sealing, g		851.9

Exposed Area, mm^2
6735.4

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:55:00 AM	852.7				
1	1		60	2 s	60	853.3	60	0.6	7.75	0.08908
1	5		300	10 s	300	853.9	300	1.2	17.32	0.17816
1	10		600	2 min	600	853.8	600	1.1	24.49	0.16332
1	20		1200	2 min	1200	854.2	1200	1.5	34.64	0.22270
1	30		1800	2 min	1800	854.7	1800	2.0	42.43	0.29694
1	60	1	3600	2 min	3600	855.2	3600	2.5	60.00	0.37117
1	120	2	7200	5 min	7200	855.1	7200	2.4	84.85	0.35633
1	180	3	10800	5 min	10800	855.3	10800	2.6	103.92	0.38602
1	240	4	14400	5 min	14400	855.8	14400	3.1	120.00	0.46025
1	300	5	18000	5 min	18000	855.6	18000	2.9	134.16	0.43056
1	360	6	21600	5 min	21600	856.0	21600	3.3	146.97	0.48995
2	1440	24	86400	2 hr	8:14:00 AM	856.9	87540	4.2	295.87	0.62357
3	2880	48	172800	2 hr	7:39:00 AM	858.1	171840	5.4	414.54	0.80173
4	4320	72	259200	2 hr	7:27:00 AM	858.5	257520	5.8	507.46	0.86112
5	5760	120	345600	2 hr	7:35:00 AM	859.2	344400	6.5	586.86	0.96505
6	7200	144	432000	2 hr	8:17:00 AM	859.3	433320	6.6	658.27	0.97990
7	8640	168	518400	2 hr	9:36:00 AM	859.8	524460	7.1	724.20	1.05413
8	10080	192	604800	2 hr	7:44:00 AM	860.0	604140	7.3	777.26	1.08383
9	11520	216	691200	2 hr	7:55:00 AM	860.2	691200	7.5	831.38	1.11352
10	12960	240	777600	2 hr	7:43:00 AM	860.5	776880	7.8	881.41	1.15806
15	21600	360	1296000	2 hr	8:11:00 AM	861.5	1296960	8.8	1138.84	1.30653

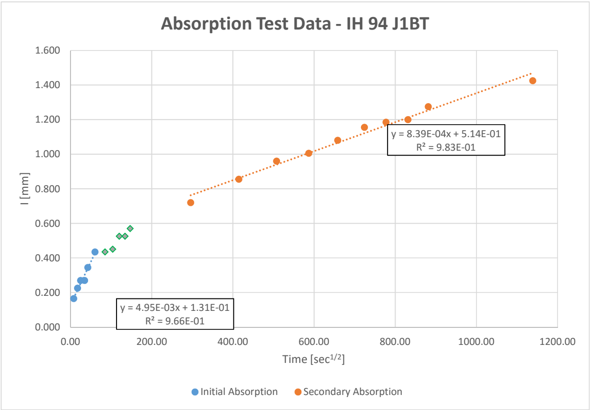


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**IH 94 - J1BT**	
Saw Cut Depth After Trimming, mm	65.6	66.8
Face Width After Trimming, mm	100.8	100.6
Maximum Depth After Trimming, mm		87.3
Mass Before Sealing, g		1269.7
Mass after Sealing, g		1277.1

Exposed Area, mm^2
6666.3

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:53:00 AM	1277.4				
1	1		60	2 s	60	1278.5	60	1.1	7.75	0.16501
1	5		300	10 s	300	1278.9	300	1.5	17.32	0.22501
1	10		600	2 min	600	1279.2	600	1.8	24.49	0.27001
1	20		1200	2 min	1200	1279.2	1200	1.8	34.64	0.27001
1	30		1800	2 min	1800	1279.7	1800	2.3	42.43	0.34502
1	60	1	3600	2 min	3600	1280.3	3600	2.9	60.00	0.43502
1	120	2	7200	5 min	7200	1280.3	7200	2.9	84.85	0.43502
1	180	3	10800	5 min	10800	1280.4	10800	3.0	103.92	0.45002
1	240	4	14400	5 min	14400	1280.9	14400	3.5	120.00	0.52503
1	300	5	18000	5 min	18000	1280.9	18000	3.5	134.16	0.52503
1	360	6	21600	5 min	21600	1281.2	21600	3.8	146.97	0.57003
2	1440	24	86400	2 hr	8:12:00 AM	1282.2	87540	4.8	295.87	0.72004
3	2880	48	172800	2 hr	7:38:00 AM	1283.1	171900	5.7	414.61	0.85504
4	4320	72	259200	2 hr	7:26:00 AM	1283.8	257580	6.4	507.52	0.96005
5	5760	120	345600	2 hr	7:33:00 AM	1284.1	344400	6.7	586.86	1.00505
6	7200	144	432000	2 hr	8:16:00 AM	1284.6	433380	7.2	658.32	1.08005
7	8640	168	518400	2 hr	9:35:00 AM	1285.1	524520	7.7	724.24	1.15506
8	10080	192	604800	2 hr	7:44:00 AM	1285.3	604260	7.9	777.34	1.18506
9	11520	216	691200	2 hr	7:54:00 AM	1285.4	691260	8.0	831.42	1.20006
10	12960	240	777600	2 hr	7:41:00 AM	1285.9	776880	8.5	881.41	1.27506
15	21600	360	1296000	2 hr	8:10:00 AM	1286.9	1297020	9.5	1138.87	1.42507

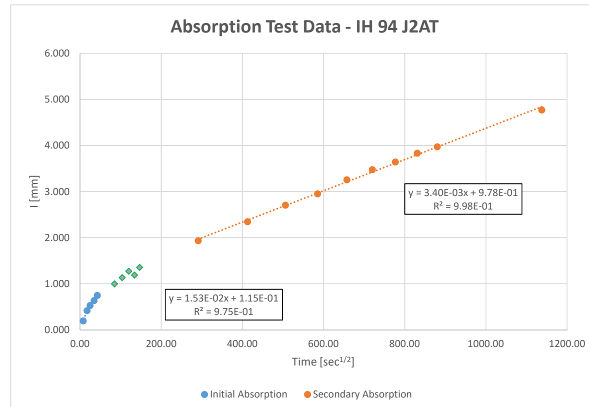


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	IH 94 - J2AT	
Saw Cut Depth After Trimming, mm	67.4	67.4
Face Width After Trimming, mm	8.8	98.8
Maximum Depth After Trimming, mm		90.9
Mass Before Sealing, g		1270.3
Mass after Sealing, g		1279.7

Exposed Area, mm^2
3626.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:27:00 AM	1279.9				
1	1		60	2 s	60	1280.6	60	0.7	7.75	0.19304
1	5		300	10 s	300	1281.4	300	1.5	17.32	0.41367
1	10		600	2 min	600	1281.8	600	1.9	24.49	0.52398
1	20		1200	2 min	1200	1282.2	1200	2.3	34.64	0.63429
1	30		1800	2 min	1800	1282.6	1800	2.7	42.43	0.74460
1	60	1	3600	2 min	3600	1283.0	3600	3.1	60.00	0.85491
1	120	2	7200	5 min	7200	1283.5	7200	3.6	84.85	0.99280
1	180	3	10800	5 min	10800	1284.0	10800	4.1	103.92	1.13069
1	240	4	14400	5 min	14400	1284.5	14400	4.6	120.00	1.26857
1	300	5	18000	5 min	18000	1284.2	18000	4.3	134.16	1.18584
1	360	6	21600	5 min	21600	1284.8	21600	4.9	146.97	1.35131
2	1440	24	86400	2 hr	7:58:00 AM	1286.9	84660	7.0	290.96	1.93044
3	2880	48	172800	2 hr	7:45:00 AM	1288.4	170280	8.5	412.65	2.34410
4	4320	72	259200	2 hr	7:36:00 AM	1289.7	256140	9.8	506.10	2.70261
5	5760	120	345600	2 hr	7:38:00 AM	1290.6	342660	10.7	585.37	2.95081
6	7200	144	432000	2 hr	8:32:00 AM	1291.7	432300	11.8	657.50	3.25417
7	8640	168	518400	2 hr	8:27:00 AM	1292.5	518400	12.6	720.00	3.47479
8	10080	192	604800	2 hr	8:08:00 AM	1293.1	603660	13.2	776.96	3.64025
9	11520	216	691200	2 hr	8:13:00 AM	1293.8	690360	13.9	830.88	3.83330
10	12960	240	777600	2 hr	7:36:00 AM	1294.3	774540	14.4	880.08	3.97119
15	21600	360	1296000	2 hr	8:00:00 AM	1297.2	1294380	17.3	1137.71	4.77094



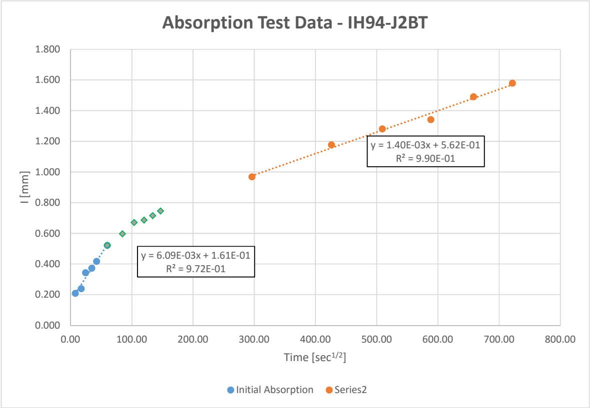
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	IH 94 - J2BT	
Saw Cut Depth After Trimming, mm	67.3	65.2
Face Width After Trimming, mm	101.3	101.3
Maximum Depth After Trimming, mm		58.4
Mass Before Sealing, g		726.5
Mass after Sealing, g		735.2

Exposed Area, mm^2
6711.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:30:00 AM	735.2				
1	1		60	2 s	60	736.6	60	1.4	7.75	0.20861
1	5		300	10 s	300	736.8	300	1.6	17.32	0.23841
1	10		600	2 min	600	737.5	600	2.3	24.49	0.34271
1	20		1200	2 min	1200	737.7	1200	2.5	34.64	0.37252
1	30		1800	2 min	1800	738.0	1800	2.8	42.43	0.41722
1	60	1	3600	2 min	3600	738.7	3600	3.5	60.00	0.52152
1	120	2	7200	5 min	7200	739.2	7202	4.0	84.86	0.59603
1	180	3	10800	5 min	10800	739.7	10800	4.5	103.92	0.67053
1	240	4	14400	5 min	14400	739.8	14400	4.6	120.00	0.68543
1	300	5	18000	5 min	18000	740.0	18000	4.8	134.16	0.71523
1	360	6	21600	5 min	21600	740.2	21600	5.0	146.97	0.74503
2	1440	24	86400	2 hr	7:53:00 AM	741.7	87780	6.5	296.28	0.96854
3	2880	48	172800	2 hr	9:56:00 AM	743.1	181560	7.9	426.10	1.17715
4	4320	72	259200	2 hr	7:32:00 AM	743.8	259320	8.6	509.23	1.28145
5	5760	120	345600	2 hr	7:40:00 AM	744.2	346200	9.0	588.39	1.34106
6	7200	144	432000	2 hr	7:49:00 AM	745.2	433140	10.0	658.13	1.49006
7	8640	168	518400	2 hr	8:09:00 AM	745.8	520740	10.6	721.62	1.57947
8	10080	192	604800	2 hr	7:13:00 AM	745.9	603780	10.7	777.03	1.59437
9	11520	216	691200	2 hr	7:26:00 AM	746.3	690960	11.1	831.24	1.65397
10	12960	240	777600	2 hr	7:46:00 AM	746.5	778560	11.3	882.36	1.68377
15	21600	360	1296000	2 hr	9:13:00 AM	748.9	1302180	13.7	1141.13	2.04139

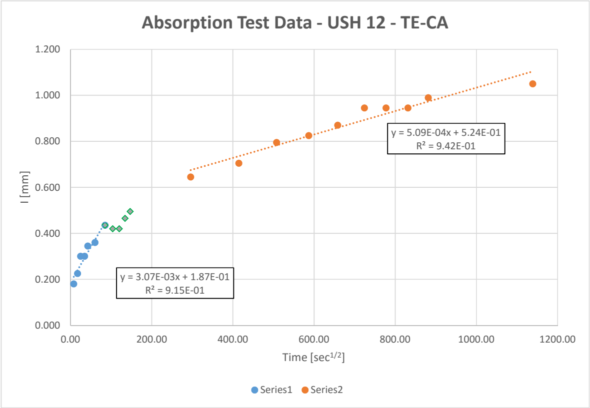


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-TE-CA	
Saw Cut Depth After Trimming, mm	66.7	65.8
Face Width After Trimming, mm	101.0	100.3
Maximum Depth After Trimming, mm		80.1
Mass Before Sealing, g		1081.2
Mass after Sealing, g		1088.1

Exposed Area, mm^2
6668.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:52:00 AM	1088.4				
1	1		60	2 s	60	1089.6	60	1.2	7.75	0.17996
1	5		300	10 s	300	1089.9	300	1.5	17.32	0.22495
1	10		600	2 min	600	1090.4	600	2.0	24.49	0.29994
1	20		1200	2 min	1200	1090.4	1200	2.0	34.64	0.29994
1	30		1800	2 min	1800	1090.7	1800	2.3	42.43	0.34493
1	60	1	3600	2 min	3600	1090.8	3600	2.4	60.00	0.35992
1	120	2	7200	5 min	7200	1091.3	7200	2.9	84.85	0.43491
1	180	3	10800	5 min	10800	1091.2	10802	2.8	103.93	0.41991
1	240	4	14400	5 min	14400	1091.2	14400	2.8	120.00	0.41991
1	300	5	18000	5 min	18000	1091.5	18000	3.1	134.16	0.46490
1	360	6	21600	5 min	21600	1091.7	21600	3.3	146.97	0.49490
2	1440	24	86400	2 hr	8:11:00 AM	1092.7	87540	4.3	295.87	0.64486
3	2880	48	172800	2 hr	7:37:00 AM	1093.1	171900	4.7	414.61	0.70485
4	4320	72	259200	2 hr	7:25:00 AM	1093.7	257580	5.3	507.52	0.79483
5	5760	120	345600	2 hr	7:31:00 AM	1093.9	344340	5.5	586.80	0.82483
6	7200	144	432000	2 hr	8:13:00 AM	1094.2	433260	5.8	658.22	0.86982
7	8640	168	518400	2 hr	9:34:00 AM	1094.7	524520	6.3	724.24	0.94480
8	10080	192	604800	2 hr	7:42:00 AM	1094.7	604200	6.3	777.30	0.94480
9	11520	216	691200	2 hr	7:53:00 AM	1094.7	691260	6.3	831.42	0.94480
10	12960	240	777600	2 hr	7:40:00 AM	1095.0	776880	6.6	881.41	0.98979
15	21600	360	1296000	2 hr	8:09:00 AM	1095.4	1297020	7.0	1138.87	1.04978

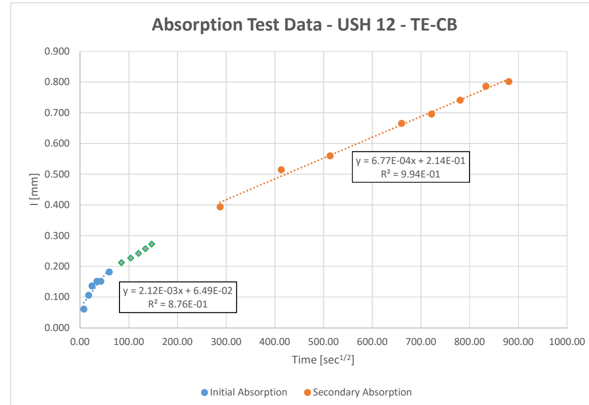


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-TE-CB	
Saw Cut Depth After Trimming, mm	65.9	65.2
Face Width After Trimming, mm	101.0	100.7
Maximum Depth After Trimming, mm		66.6
Mass Before Sealing, g		947.5
Mass after Sealing, g		956.3

Exposed Area, mm^2
6610.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:21:00 AM	956.3				
1	1		60	2 s	60	956.7	60	0.4	7.75	0.06051
1	5		300	10 s	309	957.0	309	0.7	17.58	0.10589
1	10		600	2 min	600	957.2	600	0.9	24.49	0.13614
1	20		1200	2 min	1200	957.3	1200	1.0	34.64	0.15127
1	30		1800	2 min	1800	957.3	1800	1.0	42.43	0.15127
1	60	1	3600	2 min	3600	957.5	3600	1.2	60.00	0.18152
1	120	2	7200	5 min	7200	957.7	7200	1.4	84.85	0.21178
1	180	3	10800	5 min	10800	957.8	10800	1.5	103.92	0.22690
1	240	4	14400	5 min	14400	957.9	14400	1.6	120.00	0.24203
1	300	5	18000	5 min	18000	958.0	18000	1.7	134.16	0.25716
1	360	6	21600	5 min	21600	958.1	21600	1.8	146.97	0.27229
2	1440	24	86400	2 hr	7:19:00 AM	958.9	82680	2.6	287.54	0.39330
3	2880	48	172800	2 hr	7:48:00 AM	959.7	170820	3.4	413.30	0.51432
4	4320	72	259200	2 hr	9:31:00 AM	960.0	263400	3.7	513.23	0.55970
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:25:00 AM	960.7	435840	4.4	660.18	0.66559
7	8640	168	518400	2 hr	9:02:00 AM	960.9	520860	4.6	721.71	0.69584
8	10080	192	604800	2 hr	9:38:00 AM	961.2	609420	4.9	780.65	0.74122
9	11520	216	691200	2 hr	9:15:00 AM	961.5	694440	5.2	833.33	0.78660
10	12960	240	777600	2 hr	7:39:00 AM	961.6	775080	5.3	880.39	0.80173
15	21600	360	1296000	2 hr						

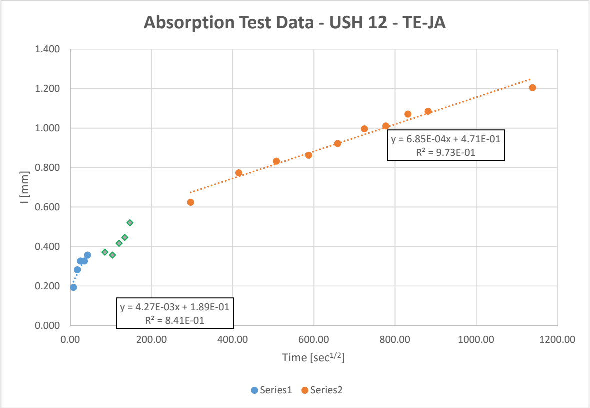


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-TE-JA	
Saw Cut Depth After Trimming, mm	67.5	68.1
Face Width After Trimming, mm	99.3	99.1
Maximum Depth After Trimming, mm		79.9
Mass Before Sealing, g		1124.8
Mass after Sealing, g		1132.0

Exposed Area, mm^2
6725.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:52:00 AM	1132.3				
1	1		60	2 s	60	1133.6	60	1.3	7.75	0.19329
1	5		300	10 s	300	1134.2	300	1.9	17.32	0.28250
1	10		600	2 min	600	1134.5	600	2.2	24.49	0.32710
1	20		1200	2 min	1200	1134.5	1200	2.2	34.64	0.32710
1	30		1800	2 min	1800	1134.7	1800	2.4	42.43	0.35684
1	60	1	3600	2 min	3600	1134.7	3600	2.4	60.00	0.35684
1	120	2	7200	5 min	7200	1134.8	7200	2.5	84.85	0.37171
1	180	3	10800	5 min	10800	1134.7	10800	2.4	103.92	0.35684
1	240	4	14400	5 min	14400	1135.1	14400	2.8	120.00	0.41631
1	300	5	18000	5 min	18000	1135.3	18000	3.0	134.16	0.44605
1	360	6	21600	5 min	21600	1135.8	21600	3.5	146.97	0.52039
2	1440	24	86400	2 hr	8:17:00 AM	1136.5	87900	4.2	296.48	0.62446
3	2880	48	172800	2 hr	7:41:00 AM	1137.5	172140	5.2	414.90	0.77315
4	4320	72	259200	2 hr	7:29:00 AM	1137.9	257820	5.6	507.76	0.83262
5	5760	120	345600	2 hr	7:37:00 AM	1138.1	344700	5.8	587.11	0.86236
6	7200	144	432000	2 hr	8:19:00 AM	1138.5	433620	6.2	658.50	0.92183
7	8640	168	518400	2 hr	9:38:00 AM	1139.0	524760	6.7	724.40	0.99617
8	10080	192	604800	2 hr	7:46:00 AM	1139.1	604440	6.8	777.46	1.01104
9	11520	216	691200	2 hr	7:57:00 AM	1139.5	691500	7.2	831.56	1.07051
10	12960	240	777600	2 hr	7:45:00 AM	1139.6	777180	7.3	881.58	1.08538
15	21600	360	1296000	2 hr	8:12:00 AM	1140.4	1297200	8.1	1138.95	1.20432



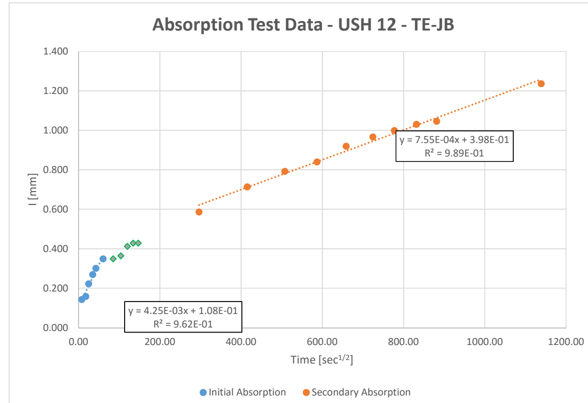
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-TE-JB	
Saw Cut Depth After Trimming, mm	62.6	63.1
Face Width After Trimming, mm	100.5	100.3
Maximum Depth After Trimming, mm		68.5
Mass Before Sealing, g		891.0
Mass after Sealing, g		898.2

Exposed Area, mm^2
6310.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:52:00 AM	898.5				
1	1		60	2 s	60	899.4	60	0.9	7.75	0.14263
1	5		300	10 s	309	899.5	309	1.0	17.58	0.15848
1	10		600	2 min	600	899.9	600	1.4	24.49	0.22187
1	20		1200	2 min	1200	900.2	1200	1.7	34.64	0.26941
1	30		1800	2 min	1800	900.4	1800	1.9	42.43	0.30110
1	60	1	3600	2 min	3600	900.7	3600	2.2	60.00	0.34865
1	120	2	7200	5 min	7200	900.7	7200	2.2	84.85	0.34865
1	180	3	10800	5 min	10800	900.8	10800	2.3	103.92	0.36449
1	240	4	14400	5 min	14400	901.1	14400	2.6	120.00	0.41204
1	300	5	18000	5 min	18000	901.2	18000	2.7	134.16	0.42788
1	360	6	21600	5 min	21600	901.2	21600	2.7	146.97	0.42788
2	1440	24	86400	2 hr	8:17:00 AM	902.2	87900	3.7	296.48	0.58636
3	2880	48	172800	2 hr	7:41:00 AM	903.0	172140	4.5	414.90	0.71314
4	4320	72	259200	2 hr	7:28:00 AM	903.5	257760	5.0	507.70	0.79238
5	5760	120	345600	2 hr	7:36:00 AM	903.8	344640	5.3	587.06	0.83992
6	7200	144	432000	2 hr	8:18:00 AM	904.3	433560	5.8	658.45	0.91916
7	8640	168	518400	2 hr	9:37:00 AM	904.6	524700	6.1	724.36	0.96670
8	10080	192	604800	2 hr	7:45:00 AM	904.8	604380	6.3	777.42	0.99839
9	11520	216	691200	2 hr	7:56:00 AM	905.0	691440	6.5	831.53	1.03009
10	12960	240	777600	2 hr	7:44:00 AM	905.1	777120	6.6	881.54	1.04594
15	21600	360	1296000	2 hr	8:12:00 AM	906.3	1297200	7.8	1138.95	1.23611



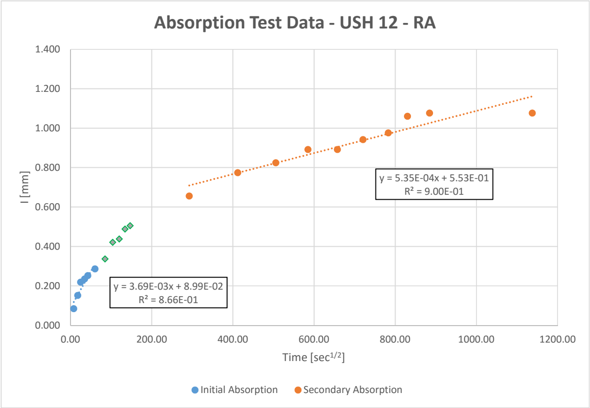
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	**USH12-RA**	
Saw Cut Depth After Trimming, mm	60.5	58.0
Face Width After Trimming, mm	100.4	100.2
Maximum Depth After Trimming, mm		75.1
Mass Before Sealing, g		973.6
Mass after Sealing, g		982.3

Exposed Area, mm^2
5942.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:37:00 AM	982.3				
1	1		60	2 s	60	982.8	60	0.5	7.75	0.08414
1	5		300	10 s	309	983.2	309	0.9	17.58	0.15144
1	10		600	2 min	600	983.6	600	1.3	24.49	0.21875
1	20		1200	2 min	1200	983.7	1200	1.4	34.64	0.23558
1	30		1800	2 min	1800	983.8	1800	1.5	42.43	0.25241
1	60	1	3600	2 min	3600	984.0	3600	1.7	60.00	0.28606
1	120	2	7200	5 min	7200	984.3	7200	2.0	84.85	0.33654
1	180	3	10800	5 min	10800	984.8	10800	2.5	103.92	0.42068
1	240	4	14400	5 min	14400	984.9	14400	2.6	120.00	0.43751
1	300	5	18000	5 min	18000	985.2	18000	2.9	134.16	0.48799
1	360	6	21600	5 min	21600	985.3	21600	3.0	146.97	0.50481
2	1440	24	86400	2 hr	8:22:00 AM	986.2	85500	3.9	292.40	0.65626
3	2880	48	172800	2 hr	7:44:00 AM	986.9	169620	4.6	411.85	0.77405
4	4320	72	259200	2 hr	7:41:00 AM	987.2	255840	4.9	505.81	0.82453
5	5760	120	345600	2 hr	7:42:00 AM	987.6	342300	5.3	585.06	0.89184
6	7200	144	432000	2 hr	8:43:00 AM	987.6	432360	5.3	657.54	0.89184
7	8640	168	518400	2 hr	8:52:00 AM	987.9	519300	5.6	720.62	0.94232
8	10080	192	604800	2 hr	10:47:00 AM	988.1	612600	5.8	782.69	0.97598
9	11520	216	691200	2 hr	7:59:00 AM	988.6	688920	6.3	830.01	1.06011
10	12960	240	777600	2 hr	10:00:00 AM	988.7	782580	6.4	884.64	1.07694
15	21600	360	1296000	2 hr	8:02:00 AM	988.7	1293900	6.4	1137.50	1.07694

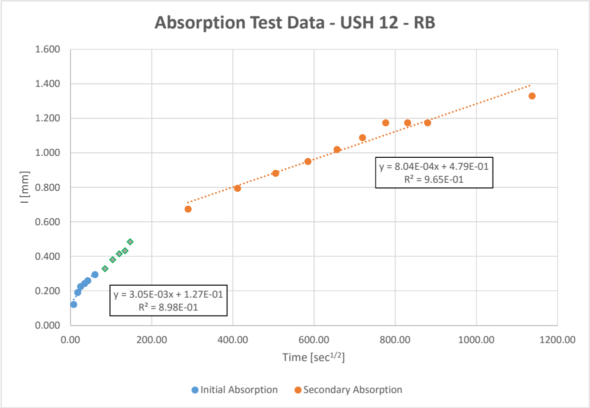


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-RB	
Saw Cut Depth After Trimming, mm	56.6	56.5
Face Width After Trimming, mm	102.2	102.6
Maximum Depth After Trimming, mm		71.9
Mass Before Sealing, g		890.8
Mass after Sealing, g		898.9

Exposed Area, mm^2
5790.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:44:00 AM	898.9				
1	1		60	2 s	60	899.6	60	0.7	7.75	0.12088
1	5		300	10 s	309	900.0	309	1.1	17.58	0.18996
1	10		600	2 min	600	900.2	600	1.3	24.49	0.22450
1	20		1200	2 min	1200	900.3	1200	1.4	34.64	0.24177
1	30		1800	2 min	1800	900.4	1800	1.5	42.43	0.25904
1	60	1	3600	2 min	3600	900.6	3600	1.7	60.00	0.29357
1	120	2	7200	5 min	7200	900.8	7200	1.9	84.85	0.32811
1	180	3	10800	5 min	10800	901.1	10800	2.2	103.92	0.37992
1	240	4	14400	5 min	14400	901.3	14400	2.4	120.00	0.41446
1	300	5	18000	5 min	18000	901.4	18000	2.5	134.16	0.43173
1	360	6	21600	5 min	21600	901.7	21600	2.8	146.97	0.48353
2	1440	24	86400	2 hr	8:00:00 AM	902.8	83760	3.9	289.41	0.67349
3	2880	48	172800	2 hr	7:47:00 AM	903.5	169380	4.6	411.56	0.79437
4	4320	72	259200	2 hr	7:40:00 AM	904.0	255360	5.1	505.33	0.88072
5	5760	120	345600	2 hr	7:42:00 AM	904.4	341880	5.5	584.71	0.94980
6	7200	144	432000	2 hr	8:34:00 AM	904.8	431400	5.9	656.81	1.01887
7	8640	168	518400	2 hr	8:31:00 AM	905.2	517620	6.3	719.46	1.08795
8	10080	192	604800	2 hr	8:12:00 AM	905.7	602880	6.8	776.45	1.17429
9	11520	216	691200	2 hr	8:15:00 AM	905.7	689460	6.8	830.34	1.17429
10	12960	240	777600	2 hr	7:40:00 AM	905.7	773760	6.8	879.64	1.17429
15	21600	360	1296000	2 hr	8:02:00 AM	906.6	1293480	7.7	1137.31	1.32971

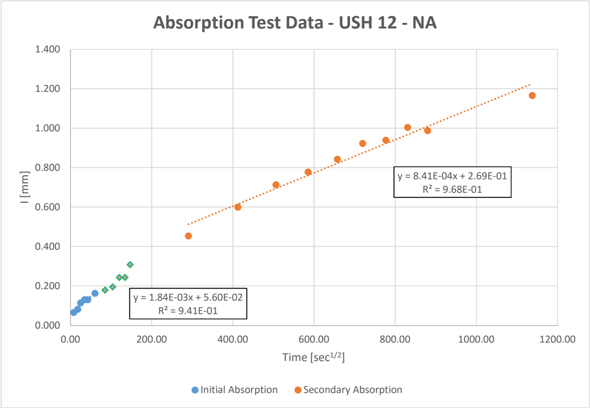


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	USH12-NA	
Saw Cut Depth After Trimming, mm	61.6	60.7
Face Width After Trimming, mm	101.3	100.7
Maximum Depth After Trimming, mm		57.5
Mass Before Sealing, g		752.2
Mass after Sealing, g		760.4

Exposed Area, mm^2
6176.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:32:00 AM	760.4				
1	1		60	2 s	60	760.8	60	0.4	7.75	0.06477
1	5		300	10 s	309	760.9	309	0.5	17.58	0.08096
1	10		600	2 min	600	761.1	600	0.7	24.49	0.11334
1	20		1200	2 min	1200	761.2	1200	0.8	34.64	0.12953
1	30		1800	2 min	1800	761.2	1800	0.8	42.43	0.12953
1	60	1	3600	2 min	3600	761.4	3600	1.0	60.00	0.16191
1	120	2	7200	5 min	7200	761.5	7200	1.1	84.85	0.17810
1	180	3	10800	5 min	10800	761.6	10800	1.2	103.92	0.19430
1	240	4	14400	5 min	14400	761.9	14400	1.5	120.00	0.24287
1	300	5	18000	5 min	18000	761.9	18000	1.5	134.16	0.24287
1	360	6	21600	5 min	21600	762.3	21600	1.9	146.97	0.30764
2	1440	24	86400	2 hr	7:59:00 AM	763.2	84420	2.8	290.55	0.45336
3	2880	48	172800	2 hr	7:46:00 AM	764.1	170040	3.7	412.36	0.59908
4	4320	72	259200	2 hr	7:38:00 AM	764.8	255960	4.4	505.92	0.71242
5	5760	120	345600	2 hr	7:39:00 AM	765.2	342420	4.8	585.17	0.77718
6	7200	144	432000	2 hr	8:33:00 AM	765.6	432060	5.2	657.31	0.84195
7	8640	168	518400	2 hr	8:28:00 AM	766.1	518160	5.7	719.83	0.92291
8	10080	192	604800	2 hr	8:10:00 AM	766.2	603480	5.8	776.84	0.93910
9	11520	216	691200	2 hr	8:13:00 AM	766.6	690060	6.2	830.70	1.00386
10	12960	240	777600	2 hr	7:38:00 AM	766.5	774360	6.1	879.98	0.98767
15	21600	360	1296000	2 hr	8:01:00 AM	767.6	1294140	7.2	1137.60	1.16577

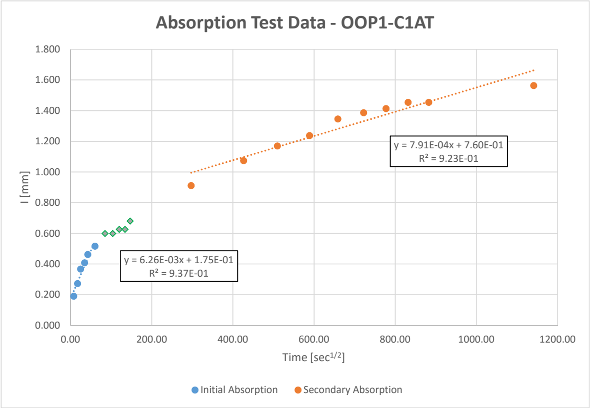


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-C1AT	
Saw Cut Depth After Trimming, mm	75.1	73.9
Face Width After Trimming, mm	99.4	98.1
Maximum Depth After Trimming, mm		85.0
Mass Before Sealing, g		1294.4
Mass after Sealing, g		1303.5

Exposed Area, mm^2
7356.9

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:22:00 AM	1303.5				
1	1		60	2 s	60	1304.9	60	1.4	7.75	0.19030
1	5		300	10 s	300	1305.5	300	2.0	17.32	0.27185
1	10		600	2 min	600	1306.2	600	2.7	24.49	0.36700
1	20		1200	2 min	1200	1306.5	1200	3.0	34.64	0.40778
1	30		1800	2 min	1800	1306.9	1800	3.4	42.43	0.46215
1	60	1	3600	2 min	3600	1307.3	3600	3.8	60.00	0.51652
1	120	2	7200	5 min	7200	1307.9	7200	4.4	84.85	0.59808
1	180	3	10800	5 min	10800	1307.9	10800	4.4	103.92	0.59808
1	240	4	14400	5 min	14400	1308.1	14400	4.6	120.00	0.62527
1	300	5	18000	5 min	18000	1308.1	18000	4.6	134.16	0.62527
1	360	6	21600	5 min	21600	1308.5	21600	5.0	146.97	0.67964
2	1440	24	86400	2 hr	7:53:00 AM	1310.2	88260	6.7	297.09	0.91071
3	2880	48	172800	2 hr	9:55:00 AM	1311.4	181980	7.9	426.59	1.07383
4	4320	72	259200	2 hr	7:31:00 AM	1312.1	259740	8.6	509.65	1.16897
5	5760	120	345600	2 hr	7:39:00 AM	1312.6	346620	9.1	588.74	1.23694
6	7200	144	432000	2 hr	7:48:00 AM	1313.4	433560	9.9	658.45	1.34568
7	8640	168	518400	2 hr	8:08:00 AM	1313.7	521160	10.2	721.91	1.38646
8	10080	192	604800	2 hr	7:13:00 AM	1313.9	604260	10.4	777.34	1.41364
9	11520	216	691200	2 hr	7:26:00 AM	1314.2	691440	10.7	831.53	1.45442
10	12960	240	777600	2 hr	7:45:00 AM	1314.2	778980	10.7	882.60	1.45442
15	21600	360	1296000	2 hr	9:12:00 AM	1315.0	1302600	11.5	1141.32	1.56316

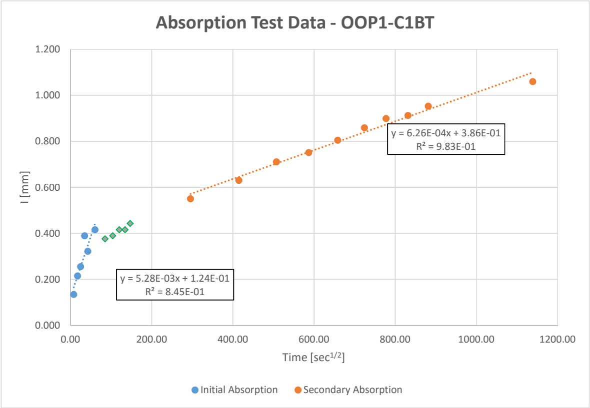


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-C1BT	
Saw Cut Depth After Trimming, mm	74.9	75.3
Face Width After Trimming, mm	99.4	99.1
Maximum Depth After Trimming, mm		64.5
Mass Before Sealing, g		976.7
Mass after Sealing, g		984.1

Exposed Area, mm^2
7453.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:55:00 AM	984.7				
1	1		60	2 s	60	985.7	60	1.0	7.75	0.13416
1	5		300	10 s	300	986.3	300	1.6	17.32	0.21466
1	10		600	2 min	600	986.6	600	1.9	24.49	0.25491
1	20		1200	2 min	1200	987.6	1200	2.9	34.64	0.38907
1	30		1800	2 min	1800	987.1	1800	2.4	42.43	0.32199
1	60	1	3600	2 min	3600	987.8	3600	3.1	60.00	0.41590
1	120	2	7200	5 min	7200	987.5	7200	2.8	84.85	0.37565
1	180	3	10800	5 min	10800	987.6	10800	2.9	103.92	0.38907
1	240	4	14400	5 min	14400	987.8	14400	3.1	120.00	0.41590
1	300	5	18000	5 min	18000	987.8	18000	3.1	134.16	0.41590
1	360	6	21600	5 min	21600	988.0	21600	3.3	146.97	0.44273
2	1440	24	86400	2 hr	8:11:00 AM	988.8	87360	4.1	295.57	0.55006
3	2880	48	172800	2 hr	7:38:00 AM	989.4	171780	4.7	414.46	0.63056
4	4320	72	259200	2 hr	7:25:00 AM	990.0	257400	5.3	507.35	0.71106
5	5760	120	345600	2 hr	7:32:00 AM	990.3	344220	5.6	586.70	0.75131
6	7200	144	432000	2 hr	8:14:00 AM	990.7	433140	6.0	658.13	0.80497
7	8640	168	518400	2 hr	9:34:00 AM	991.1	524340	6.4	724.11	0.85864
8	10080	192	604800	2 hr	7:43:00 AM	991.4	604080	6.7	777.23	0.89889
9	11520	216	691200	2 hr	7:53:00 AM	991.5	691080	6.8	831.31	0.91230
10	12960	240	777600	2 hr	7:41:00 AM	991.8	776760	7.1	881.34	0.95255
15	21600	360	1296000	2 hr	8:10:00 AM	992.6	1296900	7.9	1138.82	1.05988

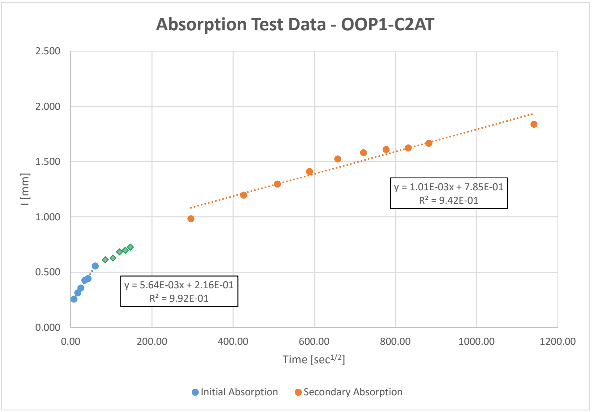


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-C2AT	
Saw Cut Depth After Trimming, mm	70.4	68.8
Face Width After Trimming, mm	100.9	100.8
Maximum Depth After Trimming, mm		87.8
Mass Before Sealing, g		1240.9
Mass after Sealing, g		1249.8

Exposed Area, mm^2
7019.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:33:00 AM	1249.8				
1	1		60	2 s	60	1251.6	60	1.8	7.75	0.25644
1	5		300	10 s	300	1252.0	300	2.2	17.32	0.31343
1	10		600	2 min	600	1252.3	600	2.5	24.49	0.35617
1	20		1200	2 min	1200	1252.8	1200	3.0	34.64	0.42740
1	30		1800	2 min	1800	1252.9	1800	3.1	42.43	0.44165
1	60	1	3600	2 min	3600	1253.7	3600	3.9	60.00	0.55562
1	120	2	7200	5 min	7200	1254.1	7200	4.3	84.85	0.61261
1	180	3	10800	5 min	10800	1254.2	10800	4.4	103.92	0.62686
1	240	4	14400	5 min	14400	1254.6	14400	4.8	120.00	0.68384
1	300	5	18000	5 min	18000	1254.7	18000	4.9	134.16	0.69809
1	360	6	21600	5 min	21600	1254.9	21600	5.1	146.97	0.72658
2	1440	24	86400	2 hr	7:54:00 AM	1256.7	87660	6.9	296.07	0.98302
3	2880	48	172800	2 hr	9:56:00 AM	1258.2	181380	8.4	425.89	1.19672
4	4320	72	259200	2 hr	7:32:00 AM	1258.9	259140	9.1	509.06	1.29645
5	5760	120	345600	2 hr	7:40:00 AM	1259.7	346020	9.9	588.23	1.41043
6	7200	144	432000	2 hr	7:49:00 AM	1260.5	432960	10.7	658.00	1.52440
7	8640	168	518400	2 hr	8:09:00 AM	1260.9	520560	11.1	721.50	1.58139
8	10080	192	604800	2 hr	7:14:00 AM	1261.1	603660	11.3	776.96	1.60988
9	11520	216	691200	2 hr	7:27:00 AM	1261.2	690840	11.4	831.17	1.62413
10	12960	240	777600	2 hr	7:47:00 AM	1261.5	778440	11.7	882.29	1.66687
15	21600	360	1296000	2 hr	9:14:00 AM	1262.7	1302060	12.9	1141.08	1.83783

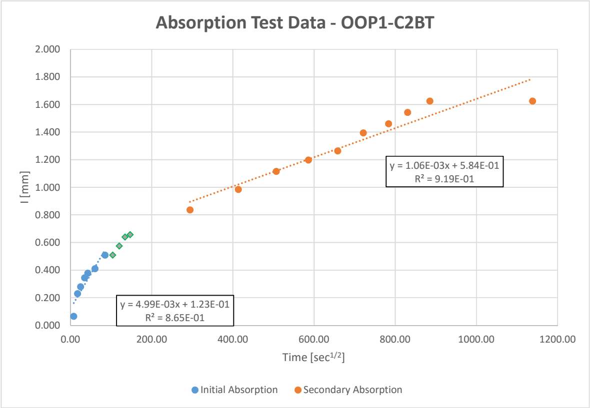


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-C2BT	
Saw Cut Depth After Trimming, mm	59.4	66.2
Face Width After Trimming, mm	96.2	97.9
Maximum Depth After Trimming, mm		62.0
Mass Before Sealing, g		831.0
Mass after Sealing, g		839.5

Exposed Area, mm^2
6094.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:15:00 AM	839.5				
1	1		60	2 s	60	839.9	60	0.4	7.75	0.06563
1	5		300	10 s	300	840.9	300	1.4	17.32	0.22971
1	10		600	2 min	600	841.2	600	1.7	24.49	0.27893
1	20		1200	2 min	1200	841.6	1200	2.1	34.64	0.34456
1	30		1800	2 min	1800	841.8	1800	2.3	42.43	0.37737
1	60	1	3600	2 min	3600	842.0	3600	2.5	60.00	0.41019
1	120	2	7200	5 min	7200	842.6	7200	3.1	84.85	0.50864
1	180	3	10800	5 min	10800	842.6	10800	3.1	103.92	0.50864
1	240	4	14400	5 min	14400	843.0	14400	3.5	120.00	0.57427
1	300	5	18000	5 min	18000	843.4	18000	3.9	134.16	0.63990
1	360	6	21600	5 min	21600	843.5	21600	4.0	146.97	0.65630
2	1440	24	86400	2 hr	8:17:00 AM	844.6	86520	5.1	294.14	0.83679
3	2880	48	172800	2 hr	7:41:00 AM	845.5	170760	6.0	413.23	0.98446
4	4320	72	259200	2 hr	7:38:00 AM	846.3	256980	6.8	506.93	1.11572
5	5760	120	345600	2 hr	7:39:00 AM	846.8	343440	7.3	586.04	1.19775
6	7200	144	432000	2 hr	8:33:00 AM	847.2	433080	7.7	658.09	1.26338
7	8640	168	518400	2 hr	8:50:00 AM	848.0	520500	8.5	721.46	1.39465
8	10080	192	604800	2 hr	10:44:00 AM	848.4	613740	8.9	783.42	1.46028
9	11520	216	691200	2 hr	7:55:00 AM	848.9	690000	9.4	830.66	1.54231
10	12960	240	777600	2 hr	9:57:00 AM	849.4	783720	9.9	885.28	1.62435
15	21600	360	1296000	2 hr	8:10:00 AM	849.4	1295700	9.9	1138.29	1.62435

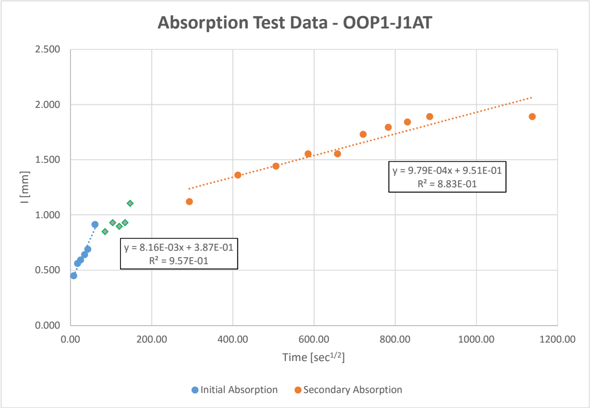


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**OOP1-J1AT**	
Saw Cut Depth After Trimming, mm	70.6	58.4
Face Width After Trimming, mm	95.6	98.0
Maximum Depth After Trimming, mm		85.6
Mass Before Sealing, g		1242.9
Mass after Sealing, g		1252.2

Exposed Area, mm^2
6243.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:30:00 AM	1252.2				
1	1		60	2 s	60	1255.0	60	2.8	7.75	0.44846
1	5		300	10 s	300	1255.7	300	3.5	17.32	0.56057
1	10		600	2 min	600	1255.9	600	3.7	24.49	0.59261
1	20		1200	2 min	1200	1256.2	1200	4.0	34.64	0.64066
1	30		1800	2 min	1800	1256.5	1800	4.3	42.43	0.68871
1	60	1	3600	2 min	3600	1257.9	3600	5.7	60.00	0.91293
1	120	2	7200	5 min	7200	1257.5	7200	5.3	84.85	0.84887
1	180	3	10800	5 min	10800	1258.0	10800	5.8	103.92	0.92895
1	240	4	14400	5 min	14400	1257.8	14400	5.6	120.00	0.89692
1	300	5	18000	5 min	18000	1258.0	18000	5.8	134.16	0.92895
1	360	6	21600	5 min	21600	1259.1	21600	6.9	146.97	1.10513
2	1440	24	86400	2 hr	8:19:00 AM	1259.2	85740	7.0	292.81	1.12115
3	2880	48	172800	2 hr	7:43:00 AM	1260.7	169980	8.5	412.29	1.36139
4	4320	72	259200	2 hr	7:40:00 AM	1261.2	256200	9.0	506.16	1.44148
5	5760	120	345600	2 hr	7:41:00 AM	1261.9	342660	9.7	585.37	1.55359
6	7200	144	432000	2 hr	8:42:00 AM	1261.9	432720	9.7	657.81	1.55359
7	8640	168	518400	2 hr	8:52:00 AM	1263.0	519720	10.8	720.92	1.72977
8	10080	192	604800	2 hr	10:46:00 AM	1263.4	612960	11.2	782.92	1.79384
9	11520	216	691200	2 hr	7:58:00 AM	1263.7	689280	11.5	830.23	1.84189
10	12960	240	777600	2 hr	9:59:00 AM	1264.0	782940	11.8	884.84	1.88994
15	21600	360	1296000	2 hr	8:01:00 AM	1264.0	1294260	11.8	1137.66	1.88994

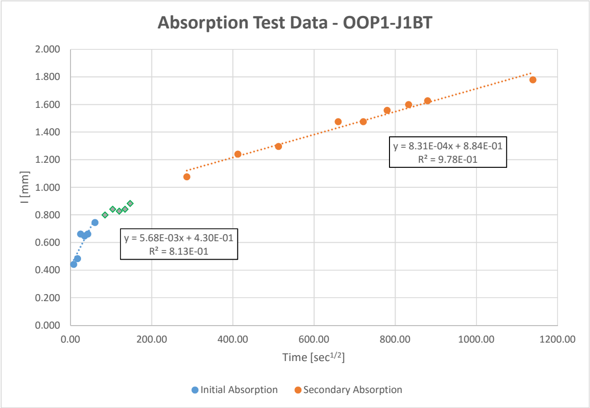


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-J1BT	
Saw Cut Depth After Trimming, mm	71.0	72.2
Face Width After Trimming, mm	99.9	102.7
Maximum Depth After Trimming, mm		59.5
Mass Before Sealing, g		878.6
Mass after Sealing, g		887.8

Exposed Area, mm^2
7253.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:37:00 AM	887.8				
1	1		60	2 s	60	891.0	60	3.2	7.75	0.44119
1	5		300	10 s	300	891.3	300	3.5	17.32	0.48255
1	10		600	2 min	600	892.6	600	4.8	24.49	0.66179
1	20		1200	2 min	1200	892.5	1200	4.7	34.64	0.64800
1	30		1800	2 min	1800	892.6	1800	4.8	42.43	0.66179
1	60	1	3600	2 min	3600	893.2	3600	5.4	60.00	0.74451
1	120	2	7200	5 min	7200	893.6	7200	5.8	84.85	0.79966
1	180	3	10800	5 min	10800	893.9	10800	6.1	103.92	0.84102
1	240	4	14400	5 min	14400	893.8	14400	6.0	120.00	0.82723
1	300	5	18000	5 min	18000	893.9	18000	6.1	134.16	0.84102
1	360	6	21600	5 min	21600	894.2	21600	6.4	146.97	0.88238
2	1440	24	86400	2 hr	7:23:00 AM	895.6	81960	7.8	286.29	1.07541
3	2880	48	172800	2 hr	7:51:00 AM	896.8	170040	9.0	412.36	1.24085
4	4320	72	259200	2 hr	9:34:00 AM	897.2	262620	9.4	512.46	1.29600
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:28:00 AM	898.5	435060	10.7	659.59	1.47524
7	8640	168	518400	2 hr	9:05:00 AM	898.5	520080	10.7	721.17	1.47524
8	10080	192	604800	2 hr	9:41:00 AM	899.1	608640	11.3	780.15	1.55796
9	11520	216	691200	2 hr	9:18:00 AM	899.4	693660	11.6	832.86	1.59932
10	12960	240	777600	2 hr	7:42:00 AM	899.6	774300	11.8	879.94	1.62690
15	21600	360	1296000	2 hr	9:14:00 AM	900.7	1298220	12.9	1139.39	1.77855

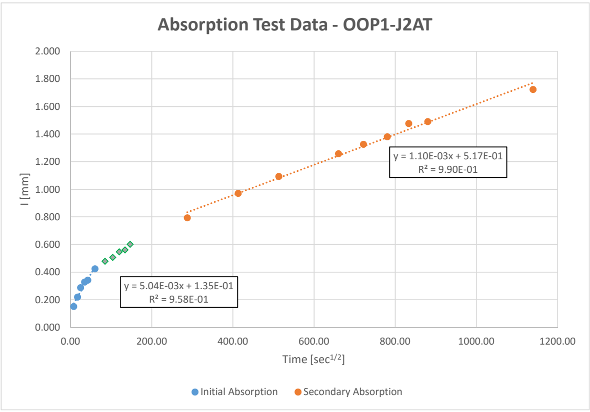


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-J2AT	
Saw Cut Depth After Trimming, mm	69.8	71.8
Face Width After Trimming, mm	104.1	102.5
Maximum Depth After Trimming, mm		85.6
Mass Before Sealing, g		1248.8
Mass after Sealing, g		1258.2

Exposed Area, mm^2
7313.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:23:00 AM	1258.2				
1	1		60	2 s	60	1259.3	60	1.1	7.75	0.15040
1	5		300	10 s	300	1259.8	300	1.6	17.32	0.21877
1	10		600	2 min	600	1260.3	600	2.1	24.49	0.28713
1	20		1200	2 min	1200	1260.6	1200	2.4	34.64	0.32815
1	30		1800	2 min	1800	1260.7	1800	2.5	42.43	0.34183
1	60	1	3600	2 min	3600	1261.3	3600	3.1	60.00	0.42387
1	120	2	7200	5 min	7200	1261.7	7200	3.5	84.85	0.47856
1	180	3	10800	5 min	10800	1261.9	10800	3.7	103.92	0.50590
1	240	4	14400	5 min	14400	1262.2	14400	4.0	120.00	0.54692
1	300	5	18000	5 min	18000	1262.3	18000	4.1	134.16	0.56060
1	360	6	21600	5 min	21600	1262.6	21600	4.4	146.97	0.60162
2	1440	24	86400	2 hr	7:20:00 AM	1264.0	82620	5.8	287.44	0.79304
3	2880	48	172800	2 hr	7:48:00 AM	1265.3	170700	7.1	413.16	0.97079
4	4320	72	259200	2 hr	9:31:00 AM	1266.2	263280	8.0	513.11	1.09385
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:26:00 AM	1267.4	435780	9.2	660.14	1.25792
7	8640	168	518400	2 hr	9:03:00 AM	1267.9	520800	9.7	721.66	1.32629
8	10080	192	604800	2 hr	9:38:00 AM	1268.3	609300	10.1	780.58	1.38098
9	11520	216	691200	2 hr	9:15:00 AM	1269.0	694320	10.8	833.26	1.47669
10	12960	240	777600	2 hr	7:40:00 AM	1269.1	775020	10.9	880.35	1.49037
15	21600	360	1296000	2 hr	9:10:00 AM	1270.8	1298820	12.6	1139.66	1.72281

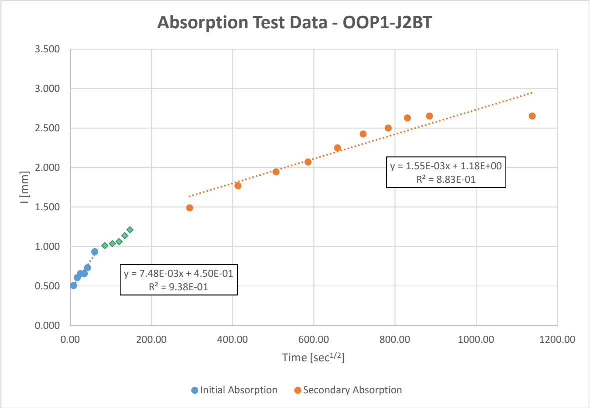


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**OOP1-J2BT**	
Saw Cut Depth After Trimming, mm	69.3	72.3
Face Width After Trimming, mm	10.5	101.3
Maximum Depth After Trimming, mm		60.0
Mass Before Sealing, g		919.4
Mass after Sealing, g		928.0

Exposed Area, mm^2
3957.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:20:00 AM	928.0				
1	1		60	2 s	60	930.0	60	2.0	7.75	0.50534
1	5		300	10 s	300	930.4	300	2.4	17.32	0.60641
1	10		600	2 min	600	930.6	600	2.6	24.49	0.65694
1	20		1200	2 min	1200	930.6	1200	2.6	34.64	0.65694
1	30		1800	2 min	1800	930.9	1800	2.9	42.43	0.73275
1	60	1	3600	2 min	3600	931.7	3600	3.7	60.00	0.93488
1	120	2	7200	5 min	7200	932.0	7200	4.0	84.85	1.01068
1	180	3	10800	5 min	10800	932.1	10800	4.1	103.92	1.03595
1	240	4	14400	5 min	14400	932.2	14400	4.2	120.00	1.06122
1	300	5	18000	5 min	18000	932.5	18000	4.5	134.16	1.13702
1	360	6	21600	5 min	21600	932.8	21600	4.8	146.97	1.21282
2	1440	24	86400	2 hr	8:18:00 AM	933.9	86280	5.9	293.73	1.49076
3	2880	48	172800	2 hr	7:42:00 AM	935.0	170520	7.0	412.94	1.76870
4	4320	72	259200	2 hr	7:39:00 AM	935.7	256740	7.7	506.70	1.94556
5	5760	120	345600	2 hr	7:40:00 AM	936.2	343200	8.2	585.83	2.07190
6	7200	144	432000	2 hr	8:40:00 AM	936.9	433200	8.9	658.18	2.24877
7	8640	168	518400	2 hr	8:51:00 AM	937.6	520260	9.6	721.29	2.42564
8	10080	192	604800	2 hr	10:45:00 AM	937.9	613500	9.9	783.26	2.50144
9	11520	216	691200	2 hr	7:56:00 AM	938.4	689760	10.4	830.52	2.62778
10	12960	240	777600	2 hr	9:53:00 AM	938.5	783180	10.5	884.97	2.65304
15	21600	360	1296000	2 hr	8:01:00 AM	938.5	1294860	10.5	1137.92	2.65304

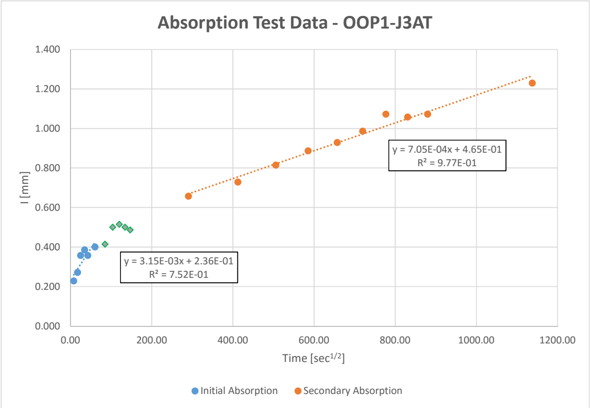


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-J3AT	
Saw Cut Depth After Trimming, mm	69.5	70.1
Face Width After Trimming, mm	100.6	99.8
Maximum Depth After Trimming, mm		46.5
Mass Before Sealing, g		689.5
Mass after Sealing, g		697.9

Exposed Area, mm^2
6994.0

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:34:00 AM	697.9				
1	1		60	2 s	60	699.5	60	1.6	7.75	0.22877
1	5		300	10 s	300	699.8	300	1.9	17.32	0.27166
1	10		600	2 min	600	700.4	600	2.5	24.49	0.35745
1	20		1200	2 min	1200	700.6	1200	2.7	34.64	0.38605
1	30		1800	2 min	1800	700.4	1800	2.5	42.43	0.35745
1	60	1	3600	2 min	3600	700.7	3600	2.8	60.00	0.40035
1	120	2	7200	5 min	7200	700.8	7200	2.9	84.85	0.41464
1	180	3	10800	5 min	10800	701.4	10800	3.5	103.92	0.50043
1	240	4	14400	5 min	14400	701.5	14400	3.6	120.00	0.51473
1	300	5	18000	5 min	18000	701.4	18000	3.5	134.16	0.50043
1	360	6	21600	5 min	21600	701.3	21600	3.4	146.97	0.48613
2	1440	24	86400	2 hr	7:59:00 AM	702.5	84300	4.6	290.34	0.65771
3	2880	48	172800	2 hr	7:46:00 AM	703.0	169920	5.1	412.21	0.72920
4	4320	72	259200	2 hr	7:38:00 AM	703.6	255840	5.7	505.81	0.81499
5	5760	120	345600	2 hr	7:40:00 AM	704.1	342360	6.2	585.12	0.88648
6	7200	144	432000	2 hr	8:33:00 AM	704.4	431940	6.5	657.22	0.92937
7	8640	168	518400	2 hr	8:29:00 AM	704.8	518100	6.9	719.79	0.98657
8	10080	192	604800	2 hr	8:10:00 AM	705.4	603360	7.5	776.76	1.07235
9	11520	216	691200	2 hr	8:14:00 AM	705.3	690000	7.4	830.66	1.05806
10	12960	240	777600	2 hr	7:38:00 AM	705.4	774240	7.5	879.91	1.07235
15	21600	360	1296000	2 hr	8:01:00 AM	706.5	1294020	8.6	1137.55	1.22963

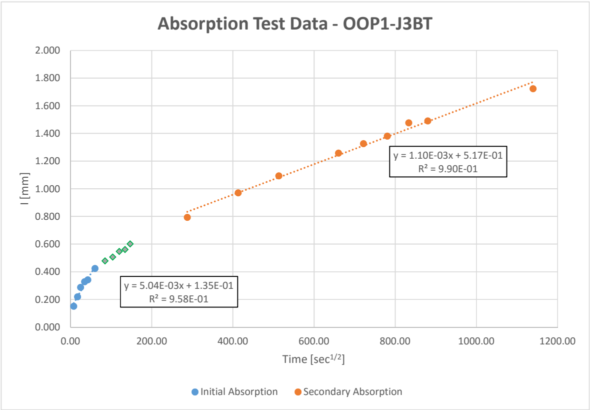


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP1-J3BT	
Saw Cut Depth After Trimming, mm	66.7	64.8
Face Width After Trimming, mm	98.2	100.7
Maximum Depth After Trimming, mm		90.2
Mass Before Sealing, g		1280.0
Mass after Sealing, g		1288.8

Exposed Area, mm^2
6538.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		8:25:00 AM	1288.8				
1	1		60	2 s	60	1290.8	60	2.0	7.75	0.30586
1	5		300	10 s	300	1291.5	300	2.7	17.32	0.41292
1	10		600	2 min	600	1291.8	600	3.0	24.49	0.45880
1	20		1200	2 min	1200	1292.1	1200	3.3	34.64	0.50468
1	30		1800	2 min	1800	1292.3	1800	3.5	42.43	0.53526
1	60	1	3600	2 min	3600	1293.3	3600	4.5	60.00	0.68820
1	120	2	7200	5 min	7200	1292.8	7200	4.0	84.85	0.61173
1	180	3	10800	5 min	10800	1293.6	10800	4.8	103.92	0.73408
1	240	4	14400	5 min	14400	1293.4	14400	4.6	120.00	0.70349
1	300	5	18000	5 min	18000	1293.8	18000	5.0	134.16	0.76466
1	360	6	21600	5 min	21600	1294.3	21600	5.5	146.97	0.84113
2	1440	24	86400	2 hr	7:21:00 AM	1295.0	82560	6.2	287.33	0.94818
3	2880	48	172800	2 hr	7:49:00 AM	1295.9	170640	7.1	413.09	1.08582
4	4320	72	259200	2 hr	9:32:00 AM	1296.6	263220	7.8	513.05	1.19287
5	5760	120	345600	2 hr						
6	7200	144	432000	2 hr	9:26:00 AM	1297.2	435660	8.4	660.05	1.28463
7	8640	168	518400	2 hr	9:03:00 AM	1297.5	520680	8.7	721.58	1.33051
8	10080	192	604800	2 hr	9:39:00 AM	1297.7	609240	8.9	780.54	1.36110
9	11520	216	691200	2 hr	9:15:00 AM	1298.5	694200	9.7	833.19	1.48344
10	12960	240	777600	2 hr	7:40:00 AM	1299.3	774900	10.5	880.28	1.60579
15	21600	360	1296000	2 hr	9:11:00 AM	1299.8	1298760	11.0	1139.63	1.68226

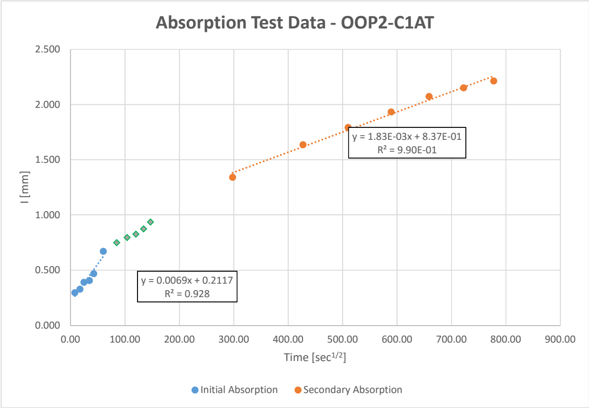


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP2-C1AT	
Saw Cut Depth After Trimming, mm	65.7	65.8
Face Width After Trimming, mm	96.7	98.5
Maximum Depth After Trimming, mm		77.8
Mass Before Sealing, g		1065.8
Mass after Sealing, g		1074.7

Exposed Area, mm^2
6417.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:15:00 AM	1074.7				
1	1		60	2 s	60	1076.6	60	1.9	7.75	0.29608
1	5		300	10 s	300	1076.8	300	2.1	17.32	0.32725
1	10		600	2 min	600	1077.2	600	2.5	24.49	0.38958
1	20		1200	2 min	1200	1077.3	1200	2.6	34.64	0.40516
1	30		1800	2 min	1800	1077.7	1800	3.0	42.43	0.46749
1	60	1	3600	2 min	3600	1079.0	3600	4.3	60.00	0.67007
1	120	2	7200	5 min	7200	1079.5	7200	4.8	84.85	0.74799
1	180	3	10800	5 min	10800	1079.8	10800	5.1	103.92	0.79474
1	240	4	14400	5 min	14400	1080.0	14400	5.3	120.00	0.82591
1	300	5	18000	5 min	18000	1080.3	18000	5.6	134.16	0.87265
1	360	6	21600	5 min	21600	1080.7	21600	6.0	146.97	0.93499
2	1440	24	86400	2 hr	7:51:00 AM	1083.3	88560	8.6	297.59	1.34015
3	2880	48	172800	2 hr	9:54:00 AM	1085.2	182340	10.5	427.01	1.63623
4	4320	72	259200	2 hr	7:30:00 AM	1086.2	260100	11.5	510.00	1.79206
5	5760	120	345600	2 hr	7:37:00 AM	1087.1	346920	12.4	589.00	1.93231
6	7200	144	432000	2 hr	7:47:00 AM	1088.0	433920	13.3	658.73	2.07256
7	8640	168	518400	2 hr	8:06:00 AM	1088.5	521460	13.8	722.12	2.15047
8	10080	192	604800	2 hr	7:11:00 AM	1088.9	604560	14.2	777.53	2.21280
9	11520	216	691200	2 hr	7:24:00 AM	1089.4	691740	14.7	831.71	2.29072
10	12960	240	777600	2 hr	7:43:00 AM	1089.8	779280	15.1	882.77	2.35305
15	21600	360	1296000	2 hr	9:10:00 AM	1091.2	1302900	16.5	1141.45	2.57121

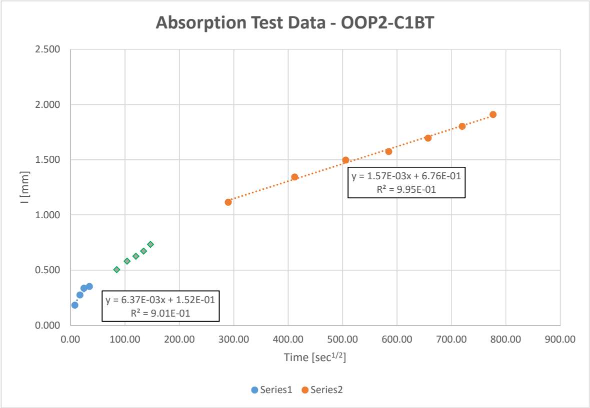


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**OOP2-C1BT**	
Saw Cut Depth After Trimming, mm	65.8	66.0
Face Width After Trimming, mm	99.3	99.4
Maximum Depth After Trimming, mm		72.2
Mass Before Sealing, g		1000.9
Mass after Sealing, g		1009.2

Exposed Area, mm^2
6547.2

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:42:00 AM	1009.2				
1	1		60	2 s	60	1010.4	60	1.2	7.75	0.18329
1	5		300	10 s	300	1011.0	300	1.8	17.32	0.27493
1	10		600	2 min	600	1011.4	600	2.2	24.49	0.33602
1	20		1200	2 min	1200	1011.5	1200	2.3	34.64	0.35130
1	30		1800	2 min	1800	1011.6	1800	2.4	42.43	0.36657
1	60	1	3600	2 min	3600	1012.1	3600	2.9	60.00	0.44294
1	120	2	7200	5 min	7200	1012.5	7200	3.3	84.85	0.50403
1	180	3	10800	5 min	10800	1013.0	10800	3.8	103.92	0.58040
1	240	4	14400	5 min	14400	1013.3	14400	4.1	120.00	0.62623
1	300	5	18000	5 min	18000	1013.6	18000	4.4	134.16	0.67205
1	360	6	21600	5 min	21600	1014.0	21600	4.8	146.97	0.73314
2	1440	24	86400	2 hr	8:00:00 AM	1016.5	83880	7.3	289.62	1.11499
3	2880	48	172800	2 hr	7:47:00 AM	1018.0	169500	8.8	411.70	1.34409
4	4320	72	259200	2 hr	7:40:00 AM	1019.0	255480	9.8	505.45	1.49683
5	5760	120	345600	2 hr	7:41:00 AM	1019.5	341940	10.3	584.76	1.57320
6	7200	144	432000	2 hr	8:34:00 AM	1020.3	431520	11.1	656.90	1.69539
7	8640	168	518400	2 hr	8:30:00 AM	1021.0	517680	11.8	719.50	1.80231
8	10080	192	604800	2 hr	8:11:00 AM	1021.7	602940	12.5	776.49	1.90922
9	11520	216	691200	2 hr	8:15:00 AM	1021.7	689580	12.5	830.41	1.90922
10	12960	240	777600	2 hr	7:39:00 AM	1021.8	773820	12.6	879.67	1.92450
15	21600	360	1296000	2 hr	8:02:00 AM	1022.6	1293600	13.4	1137.37	2.04669

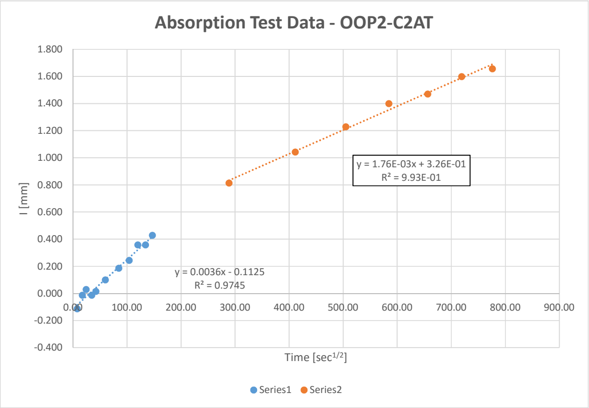


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP2-C2AT	
Saw Cut Depth After Trimming, mm	69.2	70.4
Face Width After Trimming, mm	100.8	99.9
Maximum Depth After Trimming, mm		91.4
Mass Before Sealing, g		1384.4
Mass after Sealing, g		1393.5

Exposed Area, mm^2
7004.4

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:50:00 AM	1393.5				
1	1		60	2 s	60	1392.7	60	-0.8	7.75	-0.11421
1	5		300	10 s	300	1393.4	300	-0.1	17.32	-0.01428
1	10		600	2 min	600	1393.7	600	0.2	24.49	0.02855
1	20		1200	2 min	1200	1393.4	1200	-0.1	34.64	-0.01428
1	30		1800	2 min	1800	1393.6	1800	0.1	42.43	0.01428
1	60	1	3600	2 min	3600	1394.2	3600	0.7	60.00	0.09994
1	120	2	7200	5 min	7200	1394.8	7200	1.3	84.85	0.18560
1	180	3	10800	5 min	10800	1395.2	10800	1.7	103.92	0.24270
1	240	4	14400	5 min	14400	1396.0	14400	2.5	120.00	0.35692
1	300	5	18000	5 min	18000	1396.0	18000	2.5	134.16	0.35692
1	360	6	21600	5 min	21600	1396.5	21600	3.0	146.97	0.42830
2	1440	24	86400	2 hr	8:01:00 AM	1399.2	83460	5.7	288.89	0.81377
3	2880	48	172800	2 hr	7:48:00 AM	1400.8	169080	7.3	411.19	1.04220
4	4320	72	259200	2 hr	7:41:00 AM	1402.1	255060	8.6	505.03	1.22779
5	5760	120	345600	2 hr	7:42:00 AM	1403.3	341520	9.8	584.40	1.39911
6	7200	144	432000	2 hr	8:35:00 AM	1403.8	431100	10.3	656.58	1.47050
7	8640	168	518400	2 hr	8:31:00 AM	1404.7	517260	11.2	719.21	1.59899
8	10080	192	604800	2 hr	8:12:00 AM	1405.1	602520	11.6	776.22	1.65609
9	11520	216	691200	2 hr	8:15:00 AM	1405.2	689100	11.7	830.12	1.67037
10	12960	240	777600	2 hr	7:40:00 AM	1405.5	773400	12.0	879.43	1.71320
15	21600	360	1296000	2 hr	8:03:00 AM	1406.7	1293180	13.2	1137.18	1.88452



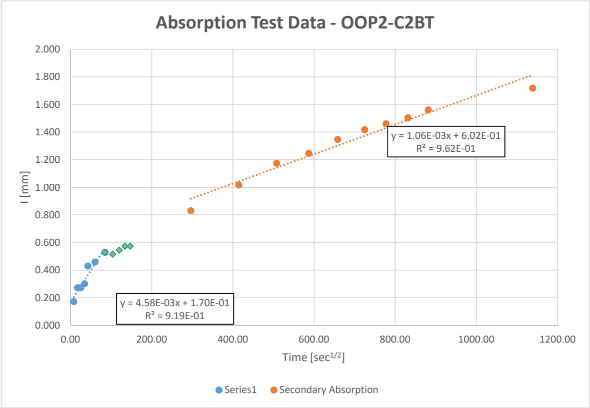
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	**OOP2-C2BT**	
Saw Cut Depth After Trimming, mm	70.1	69.4
Face Width After Trimming, mm	100.4	99.8
Maximum Depth After Trimming, mm		58.3
Mass Before Sealing, g		829.0
Mass after Sealing, g		836.5

Exposed Area, mm^2
6982.0

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:53:00 AM	836.6				
1	1		60	2 s	60	837.8	60	1.2	7.75	0.17187
1	5		300	10 s	300	838.5	300	1.9	17.32	0.27213
1	10		600	2 min	600	838.5	600	1.9	24.49	0.27213
1	20		1200	2 min	1200	838.7	1200	2.1	34.64	0.30077
1	30		1800	2 min	1800	839.6	1800	3.0	42.43	0.42968
1	60	1	3600	2 min	3600	839.8	3600	3.2	60.00	0.45832
1	120	2	7200	5 min	7200	840.3	7200	3.7	84.85	0.52994
1	180	3	10800	5 min	10800	840.2	10800	3.6	103.92	0.51561
1	240	4	14400	5 min	14400	840.4	14400	3.8	120.00	0.54426
1	300	5	18000	5 min	18000	840.6	18000	4.0	134.16	0.57290
1	360	6	21600	5 min	21600	840.6	21600	4.0	146.97	0.57290
2	1440	24	86400	2 hr	8:15:00 AM	842.4	87720	5.8	296.18	0.83071
3	2880	48	172800	2 hr	7:39:00 AM	843.7	171960	7.1	414.68	1.01690
4	4320	72	259200	2 hr	7:28:00 AM	844.8	257700	8.2	507.64	1.17445
5	5760	120	345600	2 hr	7:36:00 AM	845.3	344580	8.7	587.01	1.24607
6	7200	144	432000	2 hr	8:18:00 AM	846.0	433500	9.4	658.41	1.34632
7	8640	168	518400	2 hr	9:37:00 AM	846.5	524640	9.9	724.32	1.41794
8	10080	192	604800	2 hr	7:45:00 AM	846.8	604320	10.2	777.38	1.46090
9	11520	216	691200	2 hr	7:56:00 AM	847.1	691380	10.5	831.49	1.50387
10	12960	240	777600	2 hr	7:43:00 AM	847.5	777000	10.9	881.48	1.56116
15	21600	360	1296000	2 hr	8:12:00 AM	848.6	1297140	12.0	1138.92	1.71871

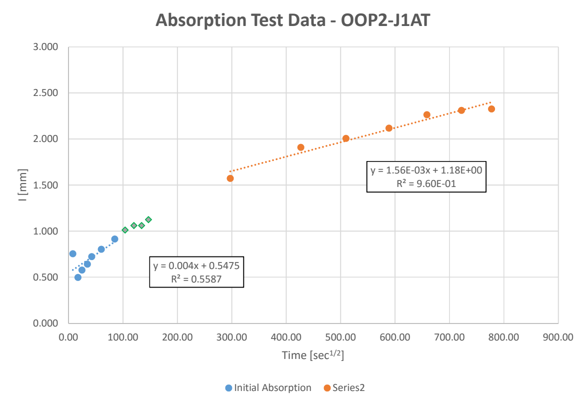


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**OOP2-J1AT**	
Saw Cut Depth After Trimming, mm	61.5	64.2
Face Width After Trimming, mm	98.0	100.3
Maximum Depth After Trimming, mm		80.7
Mass Before Sealing, g		1151.0
Mass after Sealing, g		1160.1

Exposed Area, mm^2
6231.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:21:00 AM	1160.1				
1	1		60	2 s	60	1164.8	60	4.7	7.75	0.75422
1	5		300	10 s	300	1163.2	300	3.1	17.32	0.49747
1	10		600	2 min	600	1163.7	600	3.6	24.49	0.57770
1	20		1200	2 min	1200	1164.1	1200	4.0	34.64	0.64189
1	30		1800	2 min	1800	1164.6	1800	4.5	42.43	0.72213
1	60	1	3600	2 min	3600	1165.1	3600	5.0	60.00	0.80237
1	120	2	7200	5 min	7200	1165.8	7200	5.7	84.85	0.91470
1	180	3	10800	5 min	10800	1166.4	10800	6.3	103.92	1.01098
1	240	4	14400	5 min	14400	1166.7	14400	6.6	120.00	1.05912
1	300	5	18000	5 min	18000	1166.7	18000	6.6	134.16	1.05912
1	360	6	21600	5 min	21600	1167.1	21600	7.0	146.97	1.12331
2	1440	24	86400	2 hr	7:53:00 AM	1169.9	88320	9.8	297.19	1.57264
3	2880	48	172800	2 hr	9:55:00 AM	1172.0	182040	11.9	426.66	1.90963
4	4320	72	259200	2 hr	7:31:00 AM	1172.6	259800	12.5	509.71	2.00591
5	5760	120	345600	2 hr	7:39:00 AM	1173.3	346680	13.2	588.80	2.11824
6	7200	144	432000	2 hr	7:48:00 AM	1174.2	433620	14.1	658.50	2.26267
7	8640	168	518400	2 hr	8:08:00 AM	1174.5	521220	14.4	721.96	2.31081
8	10080	192	604800	2 hr	7:12:00 AM	1174.6	604260	14.5	777.34	2.32686
9	11520	216	691200	2 hr	7:26:00 AM	1175.0	691500	14.9	831.56	2.39105
10	12960	240	777600	2 hr	7:45:00 AM	1175.3	779040	15.2	882.63	2.43919
15	21600	360	1296000	2 hr	9:12:00 AM	1177.0	1302660	16.9	1141.34	2.71199

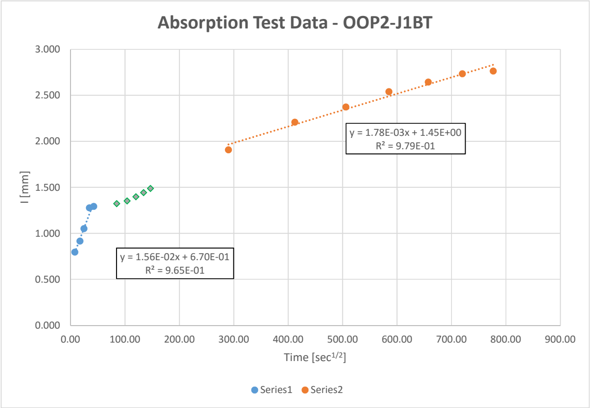


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP2-J1BT	
Saw Cut Depth After Trimming, mm	66.1	67.3
Face Width After Trimming, mm	98.5	101.1
Maximum Depth After Trimming, mm		62.8
Mass Before Sealing, g		924.6
Mass after Sealing, g		933.1

Exposed Area, mm^2
6656.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		8:36:00 AM	933.1				
1	1		60	2 s	60	938.4	60	5.3	7.75	0.79620
1	5		300	10 s	300	939.2	300	6.1	17.32	0.91638
1	10		600	2 min	600	940.1	600	7.0	24.49	1.05158
1	20		1200	2 min	1200	941.6	1200	8.5	34.64	1.27692
1	30		1800	2 min	1800	941.7	1800	8.6	42.43	1.29194
1	60	1	3600	2 min	3600	941.8	3600	8.7	60.00	1.30696
1	120	2	7200	5 min	7200	941.9	7200	8.8	84.85	1.32198
1	180	3	10800	5 min	10800	942.1	10800	9.0	103.92	1.35203
1	240	4	14400	5 min	14400	942.4	14400	9.3	120.00	1.39710
1	300	5	18000	5 min	18000	942.7	18000	9.6	134.16	1.44216
1	360	6	21600	5 min	21600	943.0	21600	9.9	146.97	1.48723
2	1440	24	86400	2 hr	7:59:00 AM	945.8	84180	12.7	290.14	1.90786
3	2880	48	172800	2 hr	7:47:00 AM	947.8	169860	14.7	412.14	2.20831
4	4320	72	259200	2 hr	7:39:00 AM	948.9	255780	15.8	505.75	2.37356
5	5760	120	345600	2 hr	7:41:00 AM	950.0	342300	16.9	585.06	2.53881
6	7200	144	432000	2 hr	8:34:00 AM	950.7	431880	17.6	657.18	2.64397
7	8640	168	518400	2 hr	8:30:00 AM	951.3	518040	18.2	719.75	2.73410
8	10080	192	604800	2 hr	8:11:00 AM	951.5	603300	18.4	776.72	2.76415
9	11520	216	691200	2 hr	8:14:00 AM	951.6	689880	18.5	830.59	2.77917
10	12960	240	777600	2 hr	7:39:00 AM	951.5	774180	18.4	879.87	2.76415
15	21600	360	1296000	2 hr	8:02:00 AM	952.4	1293960	19.3	1137.52	2.89935

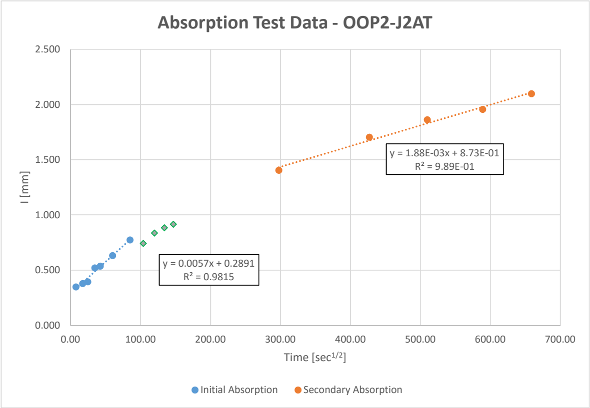


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP2-J2AT	
Saw Cut Depth After Trimming, mm	66.2	67.5
Face Width After Trimming, mm	90.7	99.0
Maximum Depth After Trimming, mm		88.1
Mass Before Sealing, g		1308.6
Mass after Sealing, g		1317.5

Exposed Area, mm^2
6340.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		7:16:00 AM	1317.5				
1	1		60	2 s	60	1319.7	60	2.2	7.75	0.34696
1	5		300	10 s	300	1319.9	300	2.4	17.32	0.37851
1	10		600	2 min	600	1320.0	600	2.5	24.49	0.39428
1	20		1200	2 min	1200	1320.8	1200	3.3	34.64	0.52045
1	30		1800	2 min	1800	1320.9	1800	3.4	42.43	0.53622
1	60	1	3600	2 min	3600	1321.5	3600	4.0	60.00	0.63084
1	120	2	7200	5 min	7200	1322.4	7200	4.9	84.85	0.77278
1	180	3	10800	5 min	10800	1322.2	10800	4.7	103.92	0.74124
1	240	4	14400	5 min	14400	1322.8	14400	5.3	120.00	0.83587
1	300	5	18000	5 min	18000	1323.1	18000	5.6	134.16	0.88318
1	360	6	21600	5 min	21600	1323.3	21600	5.8	146.97	0.91472
2	1440	24	86400	2 hr	7:52:00 AM	1326.4	88560	8.9	297.59	1.40363
3	2880	48	172800	2 hr	9:54:00 AM	1328.3	182280	10.8	426.94	1.70328
4	4320	72	259200	2 hr	7:30:00 AM	1329.3	260040	11.8	509.94	1.86099
5	5760	120	345600	2 hr	7:38:00 AM	1329.9	346920	12.4	589.00	1.95561
6	7200	144	432000	2 hr	7:47:00 AM	1330.8	433860	13.3	658.68	2.09755
7	8640	168	518400	2 hr	8:07:00 AM	1331.1	521460	13.6	722.12	2.14487
8	10080	192	604800	2 hr	7:12:00 AM	1331.2	604560	13.7	777.53	2.16064
9	11520	216	691200	2 hr	7:25:00 AM	1331.7	691740	14.2	831.71	2.23949
10	12960	240	777600	2 hr	7:43:00 AM	1331.9	779220	14.4	882.73	2.27103
15	21600	360	1296000	2 hr	9:10:00 AM	1333.1	1302840	15.6	1141.42	2.46029

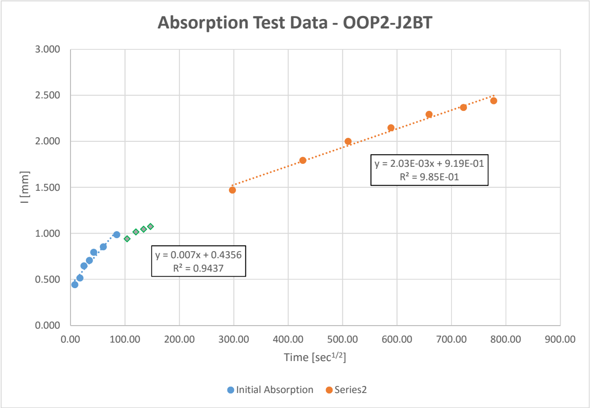


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	OOP2-J2BT	
Saw Cut Depth After Trimming, mm	70.4	67.3
Face Width After Trimming, mm	97.1	100.5
Maximum Depth After Trimming, mm		59.2
Mass Before Sealing, g		852.3
Mass after Sealing, g		860.9

Exposed Area, mm^2
6802.4

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		7:18:00 AM	860.9				
1	1		60	2 s	60	863.9	60	3.0	7.75	0.44102
1	5		300	10 s	300	864.4	300	3.5	17.32	0.51453
1	10		600	2 min	600	865.3	600	4.4	24.49	0.64683
1	20		1200	2 min	1200	865.7	1200	4.8	34.64	0.70564
1	30		1800	2 min	1800	866.3	1800	5.4	42.43	0.79384
1	60	1	3600	2 min	3600	866.7	3600	5.8	60.00	0.85264
1	120	2	7200	5 min	7200	867.6	7200	6.7	84.85	0.98495
1	180	3	10800	5 min	10800	867.3	10800	6.4	103.92	0.94085
1	240	4	14400	5 min	14400	867.8	14400	6.9	120.00	1.01435
1	300	5	18000	5 min	18000	868.0	18000	7.1	134.16	1.04375
1	360	6	21600	5 min	21600	868.2	21600	7.3	146.97	1.07315
2	1440	24	86400	2 hr	7:52:00 AM	870.9	88440	10.0	297.39	1.47007
3	2880	48	172800	2 hr	9:55:00 AM	873.1	182220	12.2	426.87	1.79349
4	4320	72	259200	2 hr	7:30:00 AM	874.5	259920	13.6	509.82	1.99930
5	5760	120	345600	2 hr	7:38:00 AM	875.5	346800	14.6	588.90	2.14631
6	7200	144	432000	2 hr	7:48:00 AM	876.5	433800	15.6	658.63	2.29331
7	8640	168	518400	2 hr	8:07:00 AM	877.0	521340	16.1	722.04	2.36682
8	10080	192	604800	2 hr	7:12:00 AM	877.5	604440	16.6	777.46	2.44032
9	11520	216	691200	2 hr	7:25:00 AM	877.9	691620	17.0	831.64	2.49913
10	12960	240	777600	2 hr	7:44:00 AM	878.3	779160	17.4	882.70	2.55793
15	21600	360	1296000	2 hr	9:11:00 AM	879.1	1302780	18.2	1141.39	2.67553

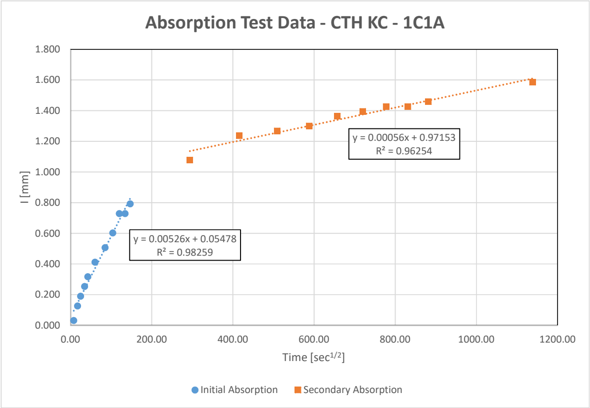


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1C1A	
Saw Cut Depth After Trimming, in	1.283	1.330
Face Width After Trimming, in	3.725	3.761
Maximum Depth After Trimming, in		2.910
Mass Before Sealing, g		517.3
Mass after Sealing, g		522.6

Exposed Area, mm^2
3155.0

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:06:00 AM	522.3				
1	1		60	2 s	60	522.4	60	0.1	7.75	0.03170
1	5		300	10 s	300	522.7	300	0.4	17.32	0.12678
1	10		600	2 min	600	522.9	600	0.6	24.49	0.19018
1	20		1200	2 min	1200	523.1	1200	0.8	34.64	0.25357
1	30		1800	2 min	1800	523.3	1800	1.0	42.43	0.31696
1	60	1	3600	2 min	3600	523.6	3600	1.3	60.00	0.41205
1	120	2	7200	5 min	7200	523.9	7200	1.6	84.85	0.50713
1	180	3	10800	5 min	10800	524.2	10800	1.9	103.92	0.60222
1	240	4	14400	5 min	14400	524.6	14400	2.3	120.00	0.72901
1	300	5	18000	5 min	18000	524.6	18000	2.3	134.16	0.72901
1	360	6	21600	5 min	21600	524.8	21600	2.5	146.97	0.79240
2	1440	24	86400	2 hr	86400	525.7	86400	3.4	293.94	1.07766
3	2880	48	172800	2 hr	172800	526.2	172800	3.9	415.69	1.23614
4	4320	72	259200	2 hr	259200	526.3	259200	4.0	509.12	1.26784
5	5760	120	345600	2 hr	345600	526.4	345600	4.1	587.88	1.29953
6	7200	144	432000	2 hr	432000	526.6	432000	4.3	657.27	1.36292
7	8640	168	518400	2 hr	518400	526.7	518400	4.4	720.00	1.39462
8	10080	192	604800	2 hr	604800	526.8	604800	4.5	777.69	1.42632
9	11520	216	691200	2 hr	691200	526.8	691200	4.5	831.38	1.42632
10	12960	240	777600	2 hr	777600	526.9	777600	4.6	881.82	1.45801
15	21600	360	1296000	2 hr	1296000	527.3	1296000	5.0	1138.42	1.58480

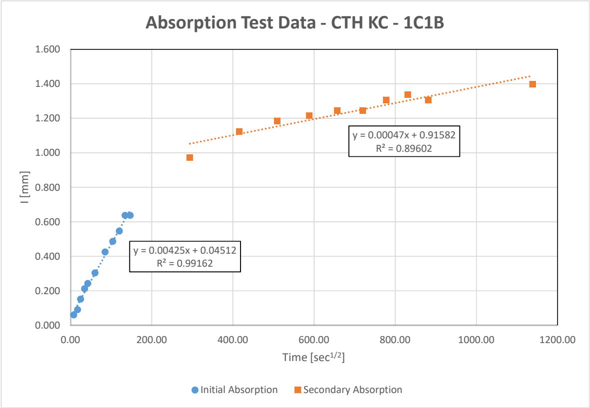


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1C1B	
Saw Cut Depth After Trimming, in	1.330	1.314
Face Width After Trimming, in	3.847	3.872
Maximum Depth After Trimming, in		2.795
Mass Before Sealing, g		494.5
Mass after Sealing, g		500.1

Exposed Area, mm^2
3291.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:01:00 AM	499.9				
1	1		60	2 s	60	500.1	60	0.2	7.75	0.06076
1	5		300	10 s	300	500.2	300	0.3	17.32	0.09114
1	10		600	2 min	600	500.4	600	0.5	24.49	0.15189
1	20		1200	2 min	1200	500.6	1200	0.7	34.64	0.21265
1	30		1800	2 min	1800	500.7	1800	0.8	42.43	0.24303
1	60	1	3600	2 min	3600	500.9	3600	1.0	60.00	0.30379
1	120	2	7200	5 min	7200	501.3	7200	1.4	84.85	0.42530
1	180	3	10800	5 min	10800	501.5	10800	1.6	103.92	0.48606
1	240	4	14400	5 min	14400	501.7	14400	1.8	120.00	0.54682
1	300	5	18000	5 min	18000	502.0	18000	2.1	134.16	0.63795
1	360	6	21600	5 min	21600	502.0	21600	2.1	146.97	0.63795
2	1440	24	86400	2 hr	86400	503.1	86400	3.2	293.94	0.97212
3	2880	48	172800	2 hr	172800	503.6	172800	3.7	415.69	1.12401
4	4320	72	259200	2 hr	259200	503.8	259200	3.9	509.12	1.18477
5	5760	120	345600	2 hr	345600	503.9	345600	4.0	587.88	1.21515
6	7200	144	432000	2 hr	432000	504.0	432000	4.1	657.27	1.24553
7	8640	168	518400	2 hr	518400	504.0	518400	4.1	720.00	1.24553
8	10080	192	604800	2 hr	604800	504.2	604800	4.3	777.69	1.30629
9	11520	216	691200	2 hr	691200	504.3	691200	4.4	831.38	1.33667
10	12960	240	777600	2 hr	777600	504.2	777600	4.3	881.82	1.30629
15	21600	360	1296000	2 hr	1296000	504.5	1296000	4.6	1138.42	1.39742

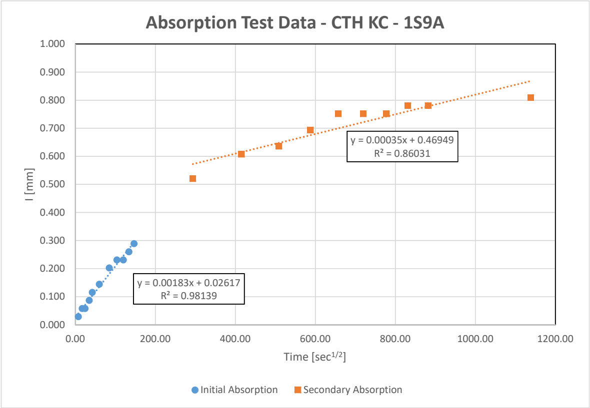


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**CTH KC - 1S9A**	
Saw Cut Depth After Trimming, in	1.371	1.401
Face Width After Trimming, in	3.883	3.856
Maximum Depth After Trimming, in		3.317
Mass Before Sealing, g		617.4
Mass after Sealing, g		623.2

Exposed Area, mm^2
3460.1

Day of Testing	**Time, min**	**Time, hr**	**Time, s**	**Tolerance**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**
1	0		0		9:02:00 AM	622.9				
1	1		60	2 s	60	623.0	60	0.1	7.75	0.02890
1	5		300	10 s	300	623.1	300	0.2	17.32	0.05780
1	10		600	2 min	600	623.1	600	0.2	24.49	0.05780
1	20		1200	2 min	1200	623.2	1200	0.3	34.64	0.08670
1	30		1800	2 min	1800	623.3	1800	0.4	42.43	0.11560
1	60	1	3600	2 min	3600	623.4	3600	0.5	60.00	0.14451
1	120	2	7200	5 min	7200	623.6	7200	0.7	84.85	0.20231
1	180	3	10800	5 min	10800	623.7	10800	0.8	103.92	0.23121
1	240	4	14400	5 min	14400	623.7	14400	0.8	120.00	0.23121
1	300	5	18000	5 min	18000	623.8	18000	0.9	134.16	0.26011
1	360	6	21600	5 min	21600	623.9	21600	1.0	146.97	0.28901
2	1440	24	86400	2 hr	86400	624.7	86400	1.8	293.94	0.52022
3	2880	48	172800	2 hr	172800	625.0	172800	2.1	415.69	0.60692
4	4320	72	259200	2 hr	259200	625.1	259200	2.2	509.12	0.63582
5	5760	120	345600	2 hr	345600	625.3	345600	2.4	587.88	0.69363
6	7200	144	432000	2 hr	432000	625.5	432000	2.6	657.27	0.75143
7	8640	168	518400	2 hr	518400	625.5	518400	2.6	720.00	0.75143
8	10080	192	604800	2 hr	604800	625.5	604800	2.6	777.69	0.75143
9	11520	216	691200	2 hr	691200	625.6	691200	2.7	831.38	0.78033
10	12960	240	777600	2 hr	777600	625.6	777600	2.7	881.82	0.78033
15	21600	360	1296000	2 hr	1296000	625.7	1296000	2.8	1138.42	0.80923

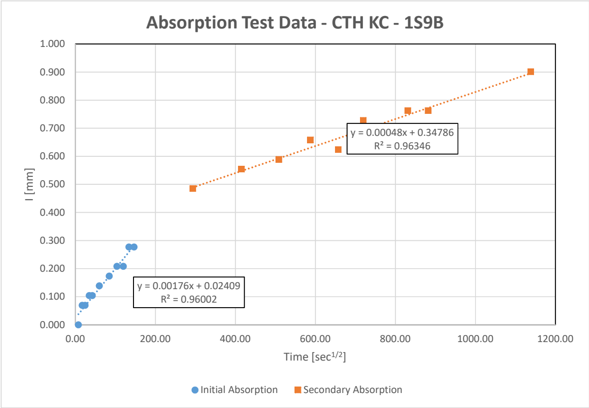


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1S9B	
Saw Cut Depth After Trimming, in	1.285	1.272
Face Width After Trimming, in	3.449	3.548
Maximum Depth After Trimming, in		2.459
Mass Before Sealing, g		388.2
Mass after Sealing, g		394.9

Exposed Area, mm^2
2885.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:03:00 AM	394.7				
1	1		60	2 s	60	394.7	60	0.0	7.75	0.00000
1	5		300	10 s	300	394.9	300	0.2	17.32	0.06931
1	10		600	2 min	600	394.9	600	0.2	24.49	0.06931
1	20		1200	2 min	1200	395.0	1200	0.3	34.64	0.10396
1	30		1800	2 min	1800	395.0	1800	0.3	42.43	0.10396
1	60	1	3600	2 min	3600	395.1	3600	0.4	60.00	0.13861
1	120	2	7200	5 min	7200	395.2	7200	0.5	84.85	0.17327
1	180	3	10800	5 min	10800	395.3	10800	0.6	103.92	0.20792
1	240	4	14400	5 min	14400	395.3	14400	0.6	120.00	0.20792
1	300	5	18000	5 min	18000	395.5	18000	0.8	134.16	0.27723
1	360	6	21600	5 min	21600	395.5	21600	0.8	146.97	0.27723
2	1440	24	86400	2 hr	86400	396.1	86400	1.4	293.94	0.48515
3	2880	48	172800	2 hr	172800	396.3	172800	1.6	415.69	0.55446
4	4320	72	259200	2 hr	259200	396.4	259200	1.7	509.12	0.58911
5	5760	120	345600	2 hr	345600	396.6	345600	1.9	587.88	0.65842
6	7200	144	432000	2 hr	432000	396.5	432000	1.8	657.27	0.62377
7	8640	168	518400	2 hr	518400	396.8	518400	2.1	720.00	0.72773
8	10080	192	604800	2 hr	604800	396.7	604800	2.0	777.69	0.69307
9	11520	216	691200	2 hr	691200	396.9	691200	2.2	831.38	0.76238
10	12960	240	777600	2 hr	777600	396.9	777600	2.2	881.82	0.76238
15	21600	360	1296000	2 hr	1296000	397.3	1296000	2.6	1138.42	0.90100

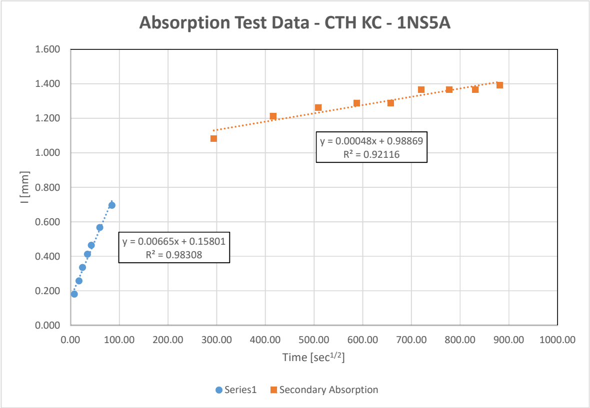


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1NS5A	
Saw Cut Depth After Trimming, in	1.505	1.521
Face Width After Trimming, in	3.958	3.991
Maximum Depth After Trimming, in		3.277
Mass Before Sealing, g		698.5
Mass after Sealing, g		704.4

Exposed Area, mm^2
3879.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:04:00 AM	704.1				
1	1		60	2 s	60	704.8	60	0.7	7.75	0.18043
1	5		300	10 s	300	705.1	300	1.0	17.32	0.25776
1	10		600	2 min	600	705.4	600	1.3	24.49	0.33508
1	20		1200	2 min	1200	705.7	1200	1.6	34.64	0.41241
1	30		1800	2 min	1800	705.9	1800	1.8	42.43	0.46396
1	60	1	3600	2 min	3600	706.3	3600	2.2	60.00	0.56707
1	120	2	7200	5 min	7200	706.8	7200	2.7	84.85	0.69594
1	180	3	10800	5 min	10800	707.0	10800	2.9	103.92	0.74750
1	240	4	14400	5 min	14400	707.1	14400	3.0	120.00	0.77327
1	300	5	18000	5 min	18000	707.4	18000	3.3	134.16	0.85060
1	360	6	21600	5 min	21600	707.3	21600	3.2	146.97	0.82482
2	1440	24	86400	2 hr	86400	708.3	86400	4.2	293.94	1.08258
3	2880	48	172800	2 hr	172800	708.8	172800	4.7	415.69	1.21146
4	4320	72	259200	2 hr	259200	709.0	259200	4.9	509.12	1.26301
5	5760	120	345600	2 hr	345600	709.1	345600	5.0	587.88	1.28879
6	7200	144	432000	2 hr	432000	709.1	432000	5.0	657.27	1.28879
7	8640	168	518400	2 hr	518400	709.4	518400	5.3	720.00	1.36611
8	10080	192	604800	2 hr	604800	709.4	604800	5.3	777.69	1.36611
9	11520	216	691200	2 hr	691200	709.4	691200	5.3	831.38	1.36611
10	12960	240	777600	2 hr	777600	709.5	777600	5.4	881.82	1.39189
15	21600	360	1296000	2 hr	1296000	708.7	1296000	4.6	1138.42	1.18568

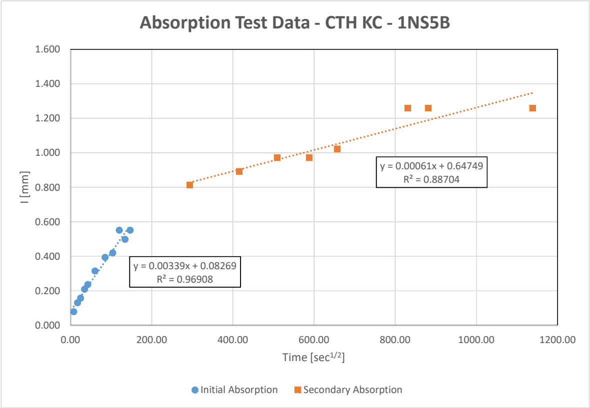


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1NS5B	
Saw Cut Depth After Trimming, in	1.534	1.539
Face Width After Trimming, in	3.826	3.864
Maximum Depth After Trimming, in		2.429
Mass Before Sealing, g		495.3
Mass after Sealing, g		501.5

Exposed Area, mm^2
3811.5

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:05:00 AM	501.3				
1	1		60	2 s	60	501.6	60	0.3	7.75	0.07871
1	5		300	10 s	300	501.8	300	0.5	17.32	0.13118
1	10		600	2 min	600	501.9	600	0.6	24.49	0.15742
1	20		1200	2 min	1200	502.1	1200	0.8	34.64	0.20989
1	30		1800	2 min	1800	502.2	1800	0.9	42.43	0.23613
1	60	1	3600	2 min	3600	502.5	3600	1.2	60.00	0.31484
1	120	2	7200	5 min	7200	502.8	7200	1.5	84.85	0.39355
1	180	3	10800	5 min	10800	502.9	10800	1.6	103.92	0.41978
1	240	4	14400	5 min	14400	503.4	14400	2.1	120.00	0.55096
1	300	5	18000	5 min	18000	503.2	18000	1.9	134.16	0.49849
1	360	6	21600	5 min	21600	503.4	21600	2.1	146.97	0.55096
2	1440	24	86400	2 hr	86400	504.4	86400	3.1	293.94	0.81333
3	2880	48	172800	2 hr	172800	504.7	172800	3.4	415.69	0.89204
4	4320	72	259200	2 hr	259200	505.0	259200	3.7	509.12	0.97075
5	5760	120	345600	2 hr	345600	505.0	345600	3.7	587.88	0.97075
6	7200	144	432000	2 hr	432000	505.2	432000	3.9	657.27	1.02322
7	8640	168	518400	2 hr	518400		518400		720.00	
8	10080	192	604800	2 hr	604800		604800		777.69	
9	11520	216	691200	2 hr	691200	506.1	691200	4.8	831.38	1.25935
10	12960	240	777600	2 hr	777600	506.1	777600	4.8	881.82	1.25935
15	21600	360	1296000	2 hr	1296000	506.1	1296000	4.8	1138.42	1.25935

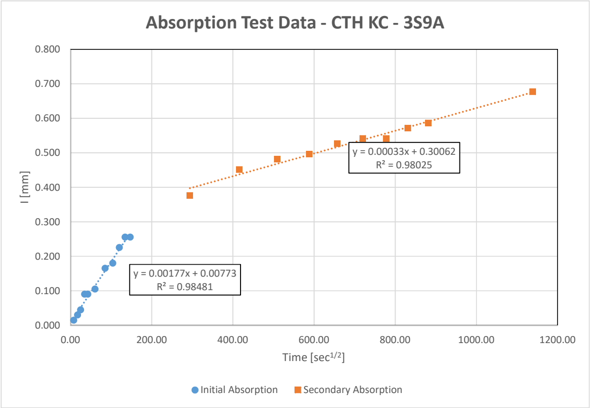


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 3S9A	
Saw Cut Depth After Trimming, in	2.711	2.665
Face Width After Trimming, in	3.819	3.849
Maximum Depth After Trimming, in		2.527
Mass Before Sealing, g		912.4
Mass after Sealing, g		919.4

Exposed Area, mm^2
6648.9

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:06:00 AM	919.1				
1	1		60	2 s	60	919.2	60	0.1	7.75	0.01504
1	5		300	10 s	300	919.3	300	0.2	17.32	0.03008
1	10		600	2 min	600	919.4	600	0.3	24.49	0.04512
1	20		1200	2 min	1200	919.7	1200	0.6	34.64	0.09024
1	30		1800	2 min	1800	919.7	1800	0.6	42.43	0.09024
1	60	1	3600	2 min	3600	919.8	3600	0.7	60.00	0.10528
1	120	2	7200	5 min	7200	920.2	7200	1.1	84.85	0.16544
1	180	3	10800	5 min	10800	920.3	10800	1.2	103.92	0.18048
1	240	4	14400	5 min	14400	920.6	14400	1.5	120.00	0.22560
1	300	5	18000	5 min	18000	920.8	18000	1.7	134.16	0.25568
1	360	6	21600	5 min	21600	920.8	21600	1.7	146.97	0.25568
2	1440	24	86400	2 hr	86400	921.6	86400	2.5	293.94	0.37600
3	2880	48	172800	2 hr	172800	922.1	172800	3.0	415.69	0.45120
4	4320	72	259200	2 hr	259200	922.3	259200	3.2	509.12	0.48128
5	5760	120	345600	2 hr	345600	922.4	345600	3.3	587.88	0.49632
6	7200	144	432000	2 hr	432000	922.6	432000	3.5	657.27	0.52640
7	8640	168	518400	2 hr	518400	922.7	518400	3.6	720.00	0.54144
8	10080	192	604800	2 hr	604800	922.7	604800	3.6	777.69	0.54144
9	11520	216	691200	2 hr	691200	922.9	691200	3.8	831.38	0.57152
10	12960	240	777600	2 hr	777600	923.0	777600	3.9	881.82	0.58656
15	21600	360	1296000	2 hr	1296000	923.6	1296000	4.5	1138.42	0.67681

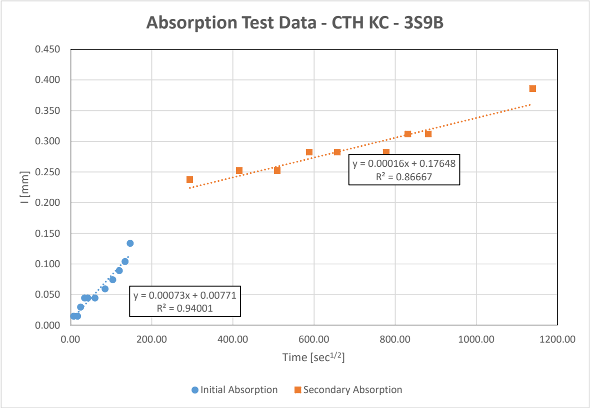


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 3S9B	
Saw Cut Depth After Trimming, in	2.710	2.729
Face Width After Trimming, in	3.851	3.825
Maximum Depth After Trimming, in		3.222
Mass Before Sealing, g		1129.9
Mass after Sealing, g		1137.7

Exposed Area, mm^2
6733.8

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:07:00 AM	1137.1				
1	1		60	2 s	60	1137.2	60	0.1	7.75	0.01485
1	5		300	10 s	300	1137.2	300	0.1	17.32	0.01485
1	10		600	2 min	600	1137.3	600	0.2	24.49	0.02970
1	20		1200	2 min	1200	1137.4	1200	0.3	34.64	0.04455
1	30		1800	2 min	1800	1137.4	1800	0.3	42.43	0.04455
1	60	1	3600	2 min	3600	1137.4	3600	0.3	60.00	0.04455
1	120	2	7200	5 min	7200	1137.5	7200	0.4	84.85	0.05940
1	180	3	10800	5 min	10800	1137.6	10800	0.5	103.92	0.07425
1	240	4	14400	5 min	14400	1137.7	14400	0.6	120.00	0.08910
1	300	5	18000	5 min	18000	1137.8	18000	0.7	134.16	0.10395
1	360	6	21600	5 min	21600	1138.0	21600	0.9	146.97	0.13365
2	1440	24	86400	2 hr	86400	1138.7	86400	1.6	293.94	0.23761
3	2880	48	172800	2 hr	172800	1138.8	172800	1.7	415.69	0.25246
4	4320	72	259200	2 hr	259200	1138.8	259200	1.7	509.12	0.25246
5	5760	120	345600	2 hr	345600	1139.0	345600	1.9	587.88	0.28216
6	7200	144	432000	2 hr	432000	1139.0	432000	1.9	657.27	0.28216
7	8640	168	518400	2 hr	518400	1138.9	518400	1.8	720.00	0.26731
8	10080	192	604800	2 hr	604800	1139.0	604800	1.9	777.69	0.28216
9	11520	216	691200	2 hr	691200	1139.2	691200	2.1	831.38	0.31186
10	12960	240	777600	2 hr	777600	1139.2	777600	2.1	881.82	0.31186
15	21600	360	1296000	2 hr	1296000	1139.7	1296000	2.6	1138.42	0.38611

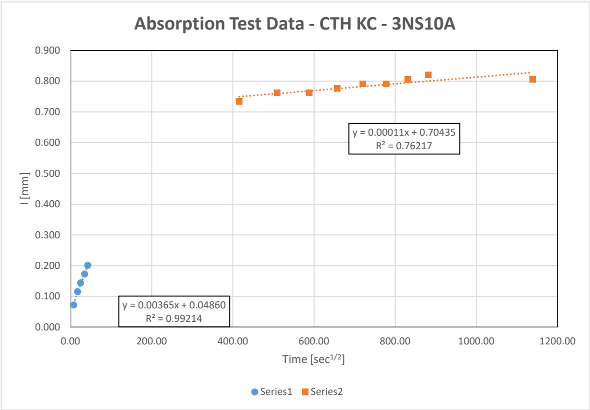


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 3NS10A	
Saw Cut Depth After Trimming, in	2.690	2.679
Face Width After Trimming, in	4.036	3.991
Maximum Depth After Trimming, in		2.779
Mass Before Sealing, g		1047.7
Mass after Sealing, g		1055.3

Exposed Area, mm^2
6951.1

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:15:00 AM	1054.9				
1	1		60	2 s	60	1055.4	60	0.5	7.75	0.07193
1	5		300	10 s	300	1055.7	300	0.8	17.32	0.11509
1	10		600	2 min	600	1055.9	600	1.0	24.49	0.14386
1	20		1200	2 min	1200	1056.1	1200	1.2	34.64	0.17263
1	30		1800	2 min	1800	1056.3	1800	1.4	42.43	0.20141
1	60	1	3600	2 min	3600	1056.6	3600	1.7	60.00	0.24457
1	120	2	7200	5 min	7200	1057.1	7200	2.2	84.85	0.31650
1	180	3	10800	5 min	10800	1057.3	10800	2.4	103.92	0.34527
1	240	4	14400	5 min	14400	1057.6	14400	2.7	120.00	0.38843
1	300	5	18000	5 min	18000	1057.8	18000	2.9	134.16	0.41720
1	360	6	21600	5 min	21600	1057.9	21600	3.0	146.97	0.43159
2	1440	24	86400	2 hr	86400	1059.3	86400	4.4	293.94	0.63299
3	2880	48	172800	2 hr	172800	1060.0	172800	5.1	415.69	0.73370
4	4320	72	259200	2 hr	259200	1060.2	259200	5.3	509.12	0.76247
5	5760	120	345600	2 hr	345600	1060.2	345600	5.3	587.88	0.76247
6	7200	144	432000	2 hr	432000	1060.3	432000	5.4	657.27	0.77685
7	8640	168	518400	2 hr	518400	1060.4	518400	5.5	720.00	0.79124
8	10080	192	604800	2 hr	604800	1060.4	604800	5.5	777.69	0.79124
9	11520	216	691200	2 hr	691200	1060.5	691200	5.6	831.38	0.80563
10	12960	240	777600	2 hr	777600	1060.6	777600	5.7	881.82	0.82001
15	21600	360	1296000	2 hr	1296000	1060.5	1296000	5.6	1138.42	0.80563

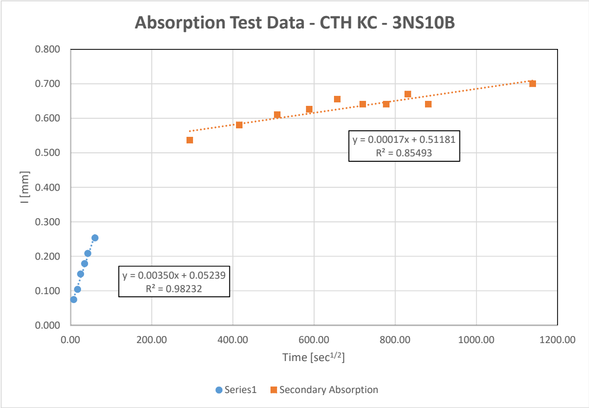


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 3NS10B	
Saw Cut Depth After Trimming, in	2.728	2.718
Face Width After Trimming, in	3.813	3.830
Maximum Depth After Trimming, in		2.988
Mass Before Sealing, g		1042.0
Mass after Sealing, g		1049.7

Exposed Area, mm^2
6713.5

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:10:00 AM	1049.1				
1	1		60	2 s	60	1049.6	60	0.5	7.75	0.07448
1	5		300	10 s	300	1049.8	300	0.7	17.32	0.10427
1	10		600	2 min	600	1050.1	600	1.0	24.49	0.14895
1	20		1200	2 min	1200	1050.3	1200	1.2	34.64	0.17874
1	30		1800	2 min	1800	1050.5	1800	1.4	42.43	0.20854
1	60	1	3600	2 min	3600	1050.8	3600	1.7	60.00	0.25322
1	120	2	7200	5 min	7200	1051.1	7200	2.0	84.85	0.29791
1	180	3	10800	5 min	10800	1051.4	10800	2.3	103.92	0.34259
1	240	4	14400	5 min	14400	1051.6	14400	2.5	120.00	0.37238
1	300	5	18000	5 min	18000	1051.8	18000	2.7	134.16	0.40217
1	360	6	21600	5 min	21600	1051.8	21600	2.7	146.97	0.40217
2	1440	24	86400	2 hr	86400	1052.7	86400	3.6	293.94	0.53623
3	2880	48	172800	2 hr	172800	1053.0	172800	3.9	415.69	0.58092
4	4320	72	259200	2 hr	259200	1053.2	259200	4.1	509.12	0.61071
5	5760	120	345600	2 hr	345600	1053.3	345600	4.2	587.88	0.62561
6	7200	144	432000	2 hr	432000	1053.5	432000	4.4	657.27	0.65540
7	8640	168	518400	2 hr	518400	1053.4	518400	4.3	720.00	0.64050
8	10080	192	604800	2 hr	604800	1053.4	604800	4.3	777.69	0.64050
9	11520	216	691200	2 hr	691200	1053.6	691200	4.5	831.38	0.67029
10	12960	240	777600	2 hr	777600	1053.4	777600	4.3	881.82	0.64050
15	21600	360	1296000	2 hr	1296000	1053.8	1296000	4.7	1138.42	0.70008

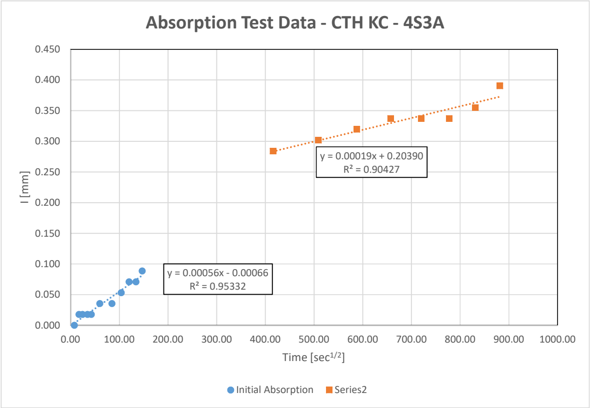


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4S3A	
Saw Cut Depth After Trimming, in	2.130	2.118
Face Width After Trimming, in	4.104	4.121
Maximum Depth After Trimming, in		2.674
Mass Before Sealing, g		803.1
Mass after Sealing, g		810.3

Exposed Area, mm^2
5635.4

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:17:00 AM	810.0				
1	1		60	2 s	60	810.0	60	0.0	7.75	0.00000
1	5		300	10 s	300	810.1	300	0.1	17.32	0.01774
1	10		600	2 min	600	810.1	600	0.1	24.49	0.01774
1	20		1200	2 min	1200	810.1	1200	0.1	34.64	0.01774
1	30		1800	2 min	1800	810.1	1800	0.1	42.43	0.01774
1	60	1	3600	2 min	3600	810.2	3600	0.2	60.00	0.03549
1	120	2	7200	5 min	7200	810.2	7200	0.2	84.85	0.03549
1	180	3	10800	5 min	10800	810.3	10800	0.3	103.92	0.05323
1	240	4	14400	5 min	14400	810.4	14400	0.4	120.00	0.07098
1	300	5	18000	5 min	18000	810.4	18000	0.4	134.16	0.07098
1	360	6	21600	5 min	21600	810.5	21600	0.5	146.97	0.08872
2	1440	24	86400	2 hr	86400	811.1	86400	1.1	293.94	0.19519
3	2880	48	172800	2 hr	172800	811.6	172800	1.6	415.69	0.28392
4	4320	72	259200	2 hr	259200	811.7	259200	1.7	509.12	0.30166
5	5760	120	345600	2 hr	345600	811.8	345600	1.8	587.88	0.31941
6	7200	144	432000	2 hr	432000	811.9	432000	1.9	657.27	0.33715
7	8640	168	518400	2 hr	518400	811.9	518400	1.9	720.00	0.33715
8	10080	192	604800	2 hr	604800	811.9	604800	1.9	777.69	0.33715
9	11520	216	691200	2 hr	691200	812.0	691200	2.0	831.38	0.35490
10	12960	240	777600	2 hr	777600	812.2	777600	2.2	881.82	0.39039
15	21600	360	1296000	2 hr	1296000	811.4	1296000	1.4	1138.42	0.24843

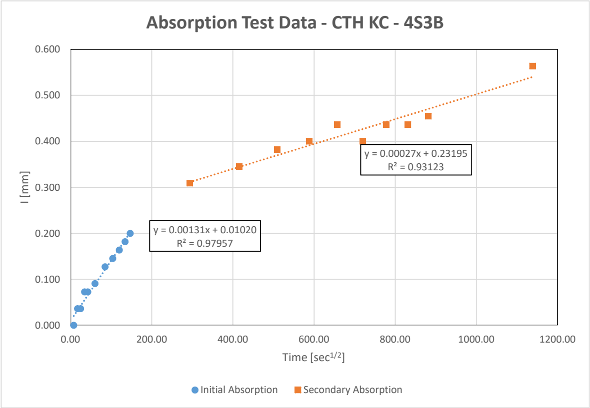


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4S3B	
Saw Cut Depth After Trimming, in	2.170	2.156
Face Width After Trimming, in	3.921	3.964
Maximum Depth After Trimming, in		3.059
Mass Before Sealing, g		883.9
Mass after Sealing, g		890.7

Exposed Area, mm^2
5501.7

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:11:00 AM	890.3				
1	1		60	2 s	60	890.3	60	0.0	7.75	0.00000
1	5		300	10 s	300	890.5	300	0.2	17.32	0.03635
1	10		600	2 min	600	890.5	600	0.2	24.49	0.03635
1	20		1200	2 min	1200	890.7	1200	0.4	34.64	0.07271
1	30		1800	2 min	1800	890.7	1800	0.4	42.43	0.07271
1	60	1	3600	2 min	3600	890.8	3600	0.5	60.00	0.09088
1	120	2	7200	5 min	7200	891.0	7200	0.7	84.85	0.12723
1	180	3	10800	5 min	10800	891.1	10800	0.8	103.92	0.14541
1	240	4	14400	5 min	14400	891.2	14400	0.9	120.00	0.16359
1	300	5	18000	5 min	18000	891.3	18000	1.0	134.16	0.18176
1	360	6	21600	5 min	21600	891.4	21600	1.1	146.97	0.19994
2	1440	24	86400	2 hr	86400	892.0	86400	1.7	293.94	0.30900
3	2880	48	172800	2 hr	172800	892.2	172800	1.9	415.69	0.34535
4	4320	72	259200	2 hr	259200	892.4	259200	2.1	509.12	0.38170
5	5760	120	345600	2 hr	345600	892.5	345600	2.2	587.88	0.39988
6	7200	144	432000	2 hr	432000	892.7	432000	2.4	657.27	0.43623
7	8640	168	518400	2 hr	518400	892.5	518400	2.2	720.00	0.39988
8	10080	192	604800	2 hr	604800	892.7	604800	2.4	777.69	0.43623
9	11520	216	691200	2 hr	691200	892.7	691200	2.4	831.38	0.43623
10	12960	240	777600	2 hr	777600	892.8	777600	2.5	881.82	0.45441
15	21600	360	1296000	2 hr	1296000	893.4	1296000	3.1	1138.42	0.56346

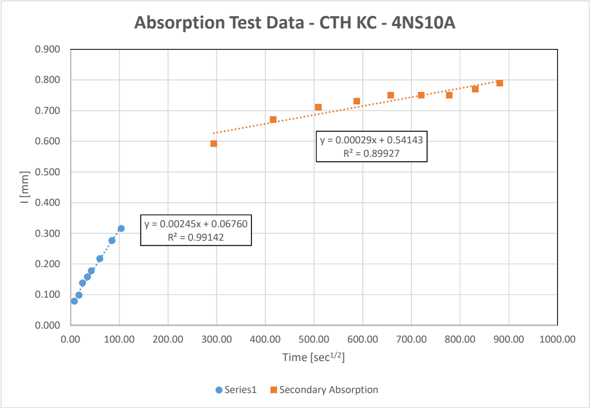


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4NS10A	
Saw Cut Depth After Trimming, in	1.925	1.922
Face Width After Trimming, in	4.112	4.052
Maximum Depth After Trimming, in		2.497
Mass Before Sealing, g		639.0
Mass after Sealing, g		646.1

Exposed Area, mm^2
5065.6

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		9:23:00 AM	645.8				
1	1		60	2 s	60	646.2	60	0.4	7.75	0.07896
1	5		300	10 s	300	646.3	300	0.5	17.32	0.09870
1	10		600	2 min	600	646.5	600	0.7	24.49	0.13819
1	20		1200	2 min	1200	646.6	1200	0.8	34.64	0.15793
1	30		1800	2 min	1800	646.7	1800	0.9	42.43	0.17767
1	60	1	3600	2 min	3600	646.9	3600	1.1	60.00	0.21715
1	120	2	7200	5 min	7200	647.2	7200	1.4	84.85	0.27637
1	180	3	10800	5 min	10800	647.4	10800	1.6	103.92	0.31585
1	240	4	14400	5 min	14400	647.5	14400	1.7	120.00	0.33560
1	300	5	18000	5 min	18000	647.6	18000	1.8	134.16	0.35534
1	360	6	21600	5 min	21600	647.7	21600	1.9	146.97	0.37508
2	1440	24	86400	2 hr	86400	648.8	86400	3.0	293.94	0.59223
3	2880	48	172800	2 hr	172800	649.2	172800	3.4	415.69	0.67119
4	4320	72	259200	2 hr	259200	649.4	259200	3.6	509.12	0.71067
5	5760	120	345600	2 hr	345600	649.5	345600	3.7	587.88	0.73041
6	7200	144	432000	2 hr	432000	649.6	432000	3.8	657.27	0.75015
7	8640	168	518400	2 hr	518400	649.6	518400	3.8	720.00	0.75015
8	10080	192	604800	2 hr	604800	649.6	604800	3.8	777.69	0.75015
9	11520	216	691200	2 hr	691200	649.7	691200	3.9	831.38	0.76990
10	12960	240	777600	2 hr	777600	649.8	777600	4.0	881.82	0.78964
15	21600	360	1296000	2 hr	1296000	649.2	1296000	3.4	1138.42	0.67119

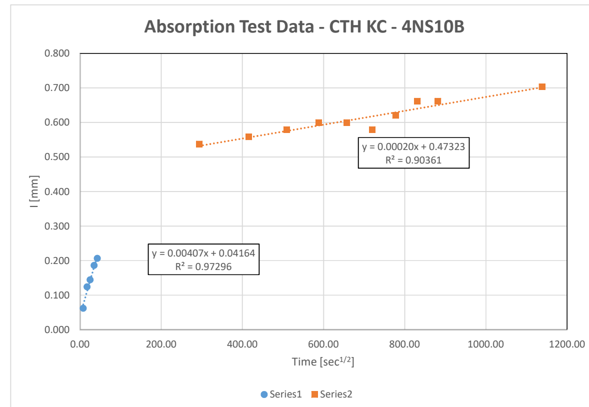


WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4NS10B	
Saw Cut Depth After Trimming, in	1.863	1.856
Face Width After Trimming, in	4.019	4.044
Maximum Depth After Trimming, in		3.320
Mass Before Sealing, g		824.0
Mass after Sealing, g		830.5

Exposed Area, mm^2
4836.5

Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:16:00 AM	830.0				
1	1		60	2 s	60	830.3	60	0.3	7.75	0.06203
1	5		300	10 s	300	830.6	300	0.6	17.32	0.12406
1	10		600	2 min	600	830.7	600	0.7	24.49	0.14473
1	20		1200	2 min	1200	830.9	1200	0.9	34.64	0.18609
1	30		1800	2 min	1800	831.0	1800	1.0	42.43	0.20676
1	60	1	3600	2 min	3600	831.2	3600	1.2	60.00	0.24811
1	120	2	7200	5 min	7200	831.4	7200	1.4	84.85	0.28947
1	180	3	10800	5 min	10800	831.5	10800	1.5	103.92	0.31014
1	240	4	14400	5 min	14400	831.6	14400	1.6	120.00	0.33082
1	300	5	18000	5 min	18000	831.8	18000	1.8	134.16	0.37217
1	360	6	21600	5 min	21600	831.8	21600	1.8	146.97	0.37217
2	1440	24	86400	2 hr	86400	832.6	86400	2.6	293.94	0.53758
3	2880	48	172800	2 hr	172800	832.7	172800	2.7	415.69	0.55826
4	4320	72	259200	2 hr	259200	832.8	259200	2.8	509.12	0.57893
5	5760	120	345600	2 hr	345600	832.9	345600	2.9	587.88	0.59961
6	7200	144	432000	2 hr	432000	832.9	432000	2.9	657.27	0.59961
7	8640	168	518400	2 hr	518400	832.8	518400	2.8	720.00	0.57893
8	10080	192	604800	2 hr	604800	833.0	604800	3.0	777.69	0.62028
9	11520	216	691200	2 hr	691200	833.2	691200	3.2	831.38	0.66164
10	12960	240	777600	2 hr	777600	833.2	777600	3.2	881.82	0.66164
15	21600	360	1296000	2 hr	1296000	833.4	1296000	3.4	1138.42	0.70299



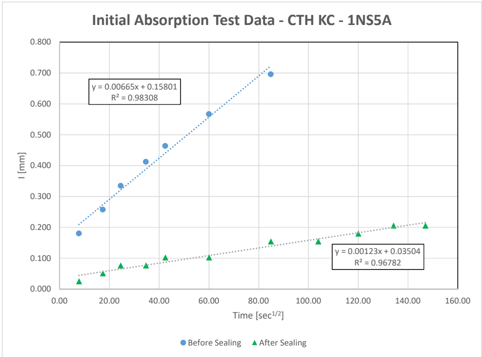
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

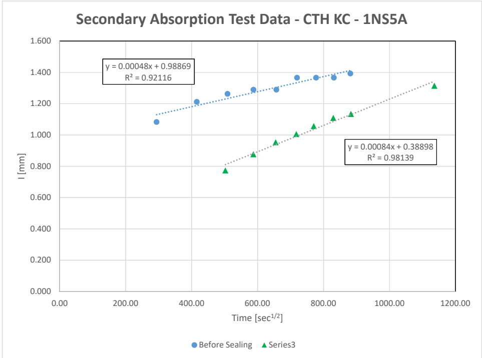
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 1NS5A	
Saw Cut Depth After Trimming, in	1.505	1.521
Face Width After Trimming, in	3.958	3.991
Maximum Depth After Trimming, in		3.277
Mass Before Sealing, g		698.5
Mass after Sealing, g		704.4

Exposed Area, mm^2
3879.6

					Before Sealing						After Sealing					
Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		9:04:00 AM	704.1					8:09:00 AM	699.4				
1	1		60	2 s	60	704.8	60	0.7	7.75	0.18043	60	699.5	60	0.1	7.75	0.02578
1	5		300	10 s	300	705.1	300	1.0	17.32	0.25776	300	699.6	300	0.2	17.32	0.05155
1	10		600	2 min	600	705.4	600	1.3	24.49	0.33508	600	699.7	600	0.3	24.49	0.07733
1	20		1200	2 min	1200	705.7	1200	1.6	34.64	0.41241	1200	699.7	1200	0.3	34.64	0.07733
1	30		1800	2 min	1800	705.9	1800	1.8	42.43	0.46396	1800	699.8	1800	0.4	42.43	0.10310
1	60	1	3600	2 min	3600	706.3	3600	2.2	60.00	0.56707	3600	699.8	3600	0.4	60.00	0.10310
1	120	2	7200	5 min	7200	706.8	7200	2.7	84.85	0.69594	7200	700.0	7200	0.6	84.85	0.15465
1	180	3	10800	5 min	10800	707.0	10800	2.9	103.92	0.74750	10800	700.0	10800	0.6	103.92	0.15465
1	240	4	14400	5 min	14400	707.1	14400	3.0	120.00	0.77327	14400	700.1	14400	0.7	120.00	0.18043
1	300	5	18000	5 min	18000	707.4	18000	3.3	134.16	0.85060	18000	700.2	18000	0.8	134.16	0.20621
1	360	6	21600	5 min	21600	707.3	21600	3.2	146.97	0.82482	21600	700.2	21600	0.8	146.97	0.20621
2	1440	24	86400	2 hr	86400	708.3	86400	4.2	293.94	1.08258	7:22:00 AM	701.1	83580	1.7	289.10	0.43819
3	2880	48	172800	2 hr	172800	708.8	172800	4.7	415.69	1.21146	7:45:00 AM	701.9	171360	2.5	413.96	0.64439
4	4320	72	259200	2 hr	259200	709.0	259200	4.9	509.12	1.26301	6:20:00 AM	702.4	252660	3.0	502.65	0.77327
5	5760	120	345600	2 hr	345600	709.1	345600	5.0	587.88	1.28879	8:04:00 AM	702.8	345300	3.4	587.62	0.87638
6	7200	144	432000	2 hr	432000	709.1	432000	5.0	657.27	1.28879	7:25:00 AM	703.1	429360	3.7	655.26	0.95370
7	8640	168	518400	2 hr	518400	709.4	518400	5.3	720.00	1.36611	7:12:00 AM	703.3	514980	3.9	717.62	1.00525
8	10080	192	604800	2 hr	604800	709.4	604800	5.3	777.69	1.36611	5:11:00 AM	703.5	594120	4.1	770.79	1.05681
9	11520	216	691200	2 hr	691200	709.4	691200	5.3	831.38	1.36611	7:32:00 AM	703.7	688980	4.3	830.05	1.10836
10	12960	240	777600	2 hr	777600	709.5	777600	5.4	881.82	1.39189	8:50:00 AM	703.8	780060	4.4	883.21	1.13413
15	21600	360	1296000	2 hr	1296000	708.7	1296000	4.6	1138.42	1.18568	6:53:00 AM	704.5	1291440	5.1	1136.42	1.31456



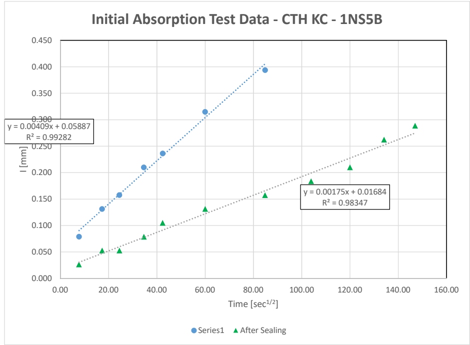


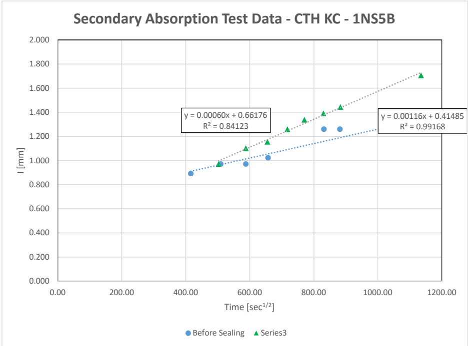
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability
Absorption Test Data - ASTM C1585-13

Specimen ID	**CTH KC - 1NS5B**	
Saw Cut Depth After Trimming, in	1.534	1.539
Face Width After Trimming, in	3.826	3.864
Maximum Depth After Trimming, in		2.429
Mass Before Sealing, g		495.3
Mass after Sealing, g		501.5

Exposed Area, mm^2
3811.5

											After Sealing					
Day of Testing	**Time, min**	**Time, hr**	**Time, s**	**Tolerance**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**
1	0		0		9:05:00 AM	501.3					8:07:00 AM	498.2				
1	1		60	2 s	60	501.6	60	0.3	7.75	0.07871	60	498.3	60	0.1	7.75	0.02624
1	5		300	10 s	300	501.8	300	0.5	17.32	0.13118	300	498.4	300	0.2	17.32	0.05247
1	10		600	2 min	600	501.9	600	0.6	24.49	0.15742	600	498.4	600	0.2	24.49	0.05247
1	20		1200	2 min	1200	502.1	1200	0.8	34.64	0.20989	1200	498.5	1200	0.3	34.64	0.07871
1	30		1800	2 min	1800	502.2	1800	0.9	42.43	0.23613	1800	498.6	1800	0.4	42.43	0.10495
1	60	1	3600	2 min	3600	502.5	3600	1.2	60.00	0.31484	3600	498.7	3600	0.5	60.00	0.13118
1	120	2	7200	5 min	7200	502.8	7200	1.5	84.85	0.39355	7200	498.8	7200	0.6	84.85	0.15742
1	180	3	10800	5 min	10800	502.9	10800	1.6	103.92	0.41978	10800	498.9	10800	0.7	103.92	0.18365
1	240	4	14400	5 min	14400	503.4	14400	2.1	120.00	0.55096	14400	499.0	14400	0.8	120.00	0.20989
1	300	5	18000	5 min	18000	503.2	18000	1.9	134.16	0.49849	18000	499.2	18000	1.0	134.16	0.26236
1	360	6	21600	5 min	21600	503.4	21600	2.1	146.97	0.55096	21600	499.3	21600	1.1	146.97	0.28860
2	1440	24	86400	2 hr	86400	504.4	86400	3.1	293.94	0.81333	7:22:00 AM	500.4	83700	2.2	289.31	0.57720
3	2880	48	172800	2 hr	172800	504.7	172800	3.4	415.69	0.89204	7:44:00 AM	501.3	171420	3.1	414.03	0.81333
4	4320	72	259200	2 hr	259200	505.0	259200	3.7	509.12	0.97075	6:19:00 AM	501.9	252720	3.7	502.71	0.97075
5	5760	120	345600	2 hr	345600	505.0	345600	3.7	587.88	0.97075	8:04:00 AM	502.4	345420	4.2	587.72	1.10193
6	7200	144	432000	2 hr	432000	505.2	432000	3.9	657.27	1.02322	7:25:00 AM	502.6	429480	4.4	655.35	1.15440
7	8640	168	518400	2 hr	518400		518400		720.00		7:13:00 AM	503.0	515160	4.8	717.75	1.25935
8	10080	192	604800	2 hr	604800		604800		777.69		5:11:00 AM	503.3	594240	5.1	770.87	1.33805
9	11520	216	691200	2 hr	691200	506.1	691200	4.8	831.38	1.25935	7:33:00 AM	503.5	689160	5.3	830.16	1.39053
10	12960	240	777600	2 hr	777600	506.1	777600	4.8	881.82	1.25935	8:51:00 AM	503.7	780240	5.5	883.31	1.44300
15	21600	360	1296000	2 hr	1296000	506.1	1296000	4.8	1138.42	1.25935	6:09:00 AM	504.7	1288920	6.5	1135.31	1.70536





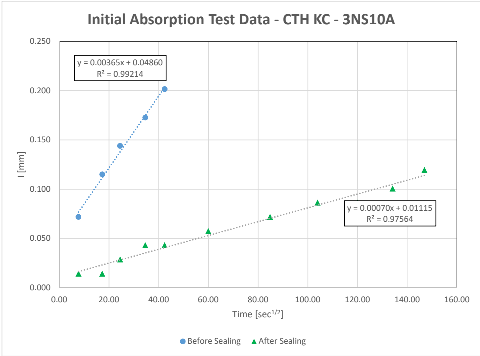
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

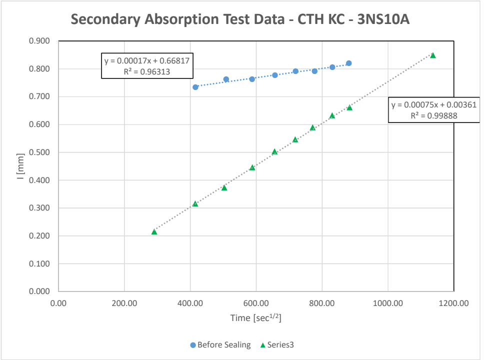
Absorption Test Data - ASTM C1585-13

Specimen ID	**CTH KC - 3NS10A**	
Saw Cut Depth After Trimming, in	2.690	2.679
Face Width After Trimming, in	4.036	3.991
Maximum Depth After Trimming, in		2.779
Mass Before Sealing, g		1047.7
Mass after Sealing, g		1055.3

Exposed Area, mm^2
6951.1

											After Sealing					
Day of Testing	**Time, min**	**Time, hr**	**Time, s**	**Tolerance**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**
1	0		0		9:15:00 AM	1054.9					7:51:00 AM	1047.0				
1	1		60	2 s	60	1055.4	60	0.5	7.75	0.07193	60	1047.1	60	0.1	7.75	0.01439
1	5		300	10 s	300	1055.7	300	0.8	17.32	0.11509	300	1047.1	300	0.1	17.32	0.01439
1	10		600	2 min	600	1055.9	600	1.0	24.49	0.14386	600	1047.2	600	0.2	24.49	0.02877
1	20		1200	2 min	1200	1056.1	1200	1.2	34.64	0.17263	1200	1047.3	1200	0.3	34.64	0.04316
1	30		1800	2 min	1800	1056.3	1800	1.4	42.43	0.20141	1800	1047.3	1800	0.3	42.43	0.04316
1	60	1	3600	2 min	3600	1056.6	3600	1.7	60.00	0.24457	3600	1047.4	3600	0.4	60.00	0.05754
1	120	2	7200	5 min	7200	1057.1	7200	2.2	84.85	0.31650	7200	1047.5	7200	0.5	84.85	0.07193
1	180	3	10800	5 min	10800	1057.3	10800	2.4	103.92	0.34527	10800	1047.6	10800	0.6	103.92	0.08632
1	240	4	14400	5 min	14400	1057.6	14400	2.7	120.00	0.38843	14400	1047.6	14400	0.6	120.00	0.08632
1	300	5	18000	5 min	18000	1057.8	18000	2.9	134.16	0.41720	18000	1047.7	18000	0.7	134.16	0.10070
1	360	6	21600	5 min	21600	1057.9	21600	3.0	146.97	0.43159	21600	1047.8	21600	0.8	146.97	0.11941
2	1440	24	86400	2 hr	86400	1059.3	86400	4.4	293.94	0.63299	7:19:00 AM	1048.5	84480	1.5	290.65	0.21579
3	2880	48	172800	2 hr	172800	1060.0	172800	5.1	415.69	0.73370	7:42:00 AM	1049.2	172260	2.2	415.04	0.31650
4	4320	72	259200	2 hr	259200	1060.2	259200	5.3	509.12	0.76247	6:17:00 AM	1049.6	253560	2.6	503.55	0.37404
5	5760	120	345600	2 hr	345600	1060.2	345600	5.3	587.88	0.76247	8:05:00 AM	1050.1	346440	3.1	588.59	0.44597
6	7200	144	432000	2 hr	432000	1060.3	432000	5.4	657.27	0.77685	7:26:00 AM	1050.5	430500	3.5	656.12	0.50352
7	8640	168	518400	2 hr	518400	1060.4	518400	5.5	720.00	0.79124	7:13:00 AM	1050.8	516120	3.8	718.41	0.54668
8	10080	192	604800	2 hr	604800	1060.4	604800	5.5	777.69	0.79124	5:12:00 AM	1051.1	595260	4.1	771.53	0.58983
9	11520	216	691200	2 hr	691200	1060.5	691200	5.6	831.38	0.80563	7:34:00 AM	1051.4	690180	4.4	830.77	0.63299
10	12960	240	777600	2 hr	777600	1060.6	777600	5.7	881.82	0.82001	8:52:00 AM	1051.6	781260	4.6	883.89	0.66176
15	21600	360	1296000	2 hr	1296000	1060.5	1296000	5.6	1138.42	0.80563	6:53:00 AM	1052.9	1292520	5.9	1136.89	0.84879





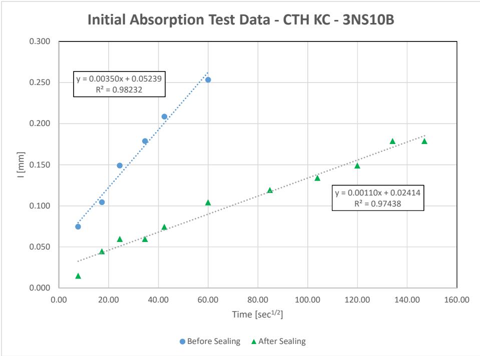
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

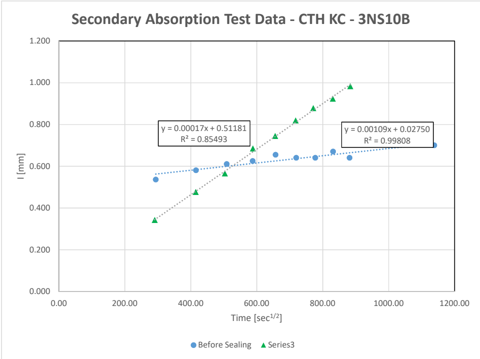
Absorption Test Data - ASTM C1585-13

Specimen ID	**CTH KC - 3NS10B**	
Saw Cut Depth After Trimming, in	2.728	2.718
Face Width After Trimming, in	3.813	3.830
Maximum Depth After Trimming, in		2.988
Mass Before Sealing, g		1042.0
Mass after Sealing, g		1049.7

Exposed Area, mm^2
6713.5

											After Sealing					
Day of Testing	**Time, min**	**Time, hr**	**Time, s**	**Tolerance**	**Actual Time**	**Mass, g**	**Elaspsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**	**Actual Time**	**Mass, g**	**Elapsed, s**	**ΔMAss, g**	**$s^{1/2}$**	**I**
1	0		0		9:10:00 AM	1049.1					7:53:00 AM	1039.5				
1	1		60	2 s	60	1049.6	60	0.5	7.75	0.07448	60	1039.6	60	0.1	7.75	0.01490
1	5		300	10 s	300	1049.8	300	0.7	17.32	0.10427	300	1039.8	300	0.3	17.32	0.04469
1	10		600	2 min	600	1050.1	600	1.0	24.49	0.14895	600	1039.9	600	0.4	24.49	0.05958
1	20		1200	2 min	1200	1050.3	1200	1.2	34.64	0.17874	1200	1039.9	1200	0.4	34.64	0.05958
1	30		1800	2 min	1800	1050.5	1800	1.4	42.43	0.20854	1800	1040.0	1800	0.5	42.43	0.07448
1	60	1	3600	2 min	3600	1050.8	3600	1.7	60.00	0.25322	3600	1040.2	3600	0.7	60.00	0.10427
1	120	2	7200	5 min	7200	1051.1	7200	2.0	84.85	0.29791	7200	1040.3	7200	0.8	84.85	0.11916
1	180	3	10800	5 min	10800	1051.4	10800	2.3	103.92	0.34259	10800	1040.4	10800	0.9	103.92	0.13406
1	240	4	14400	5 min	14400	1051.6	14400	2.5	120.00	0.37238	14400	1040.5	14400	1.0	120.00	0.14895
1	300	5	18000	5 min	18000	1051.8	18000	2.7	134.16	0.40217	18000	1040.7	18000	1.2	134.16	0.17874
1	360	6	21600	5 min	21600	1051.8	21600	2.7	146.97	0.40217	21600	1040.7	21600	1.2	146.97	0.17874
2	1440	24	86400	2 hr	86400	1052.7	86400	3.6	293.94	0.53623	7:20:00 AM	1041.8	84420	2.3	290.55	0.34259
3	2880	48	172800	2 hr	172800	1053.0	172800	3.9	415.69	0.58092	7:43:00 AM	1042.7	172200	3.2	414.97	0.47665
4	4320	72	259200	2 hr	259200	1053.2	259200	4.1	509.12	0.61071	6:18:00 AM	1043.3	253500	3.8	503.49	0.56602
5	5760	120	345600	2 hr	345600	1053.3	345600	4.2	587.88	0.62561	8:05:00 AM	1044.1	346320	4.6	588.49	0.68519
6	7200	144	432000	2 hr	432000	1053.5	432000	4.4	657.27	0.65540	7:26:00 AM	1044.5	430380	5.0	656.03	0.74477
7	8640	168	518400	2 hr	518400	1053.4	518400	4.3	720.00	0.64050	7:14:00 AM	1045.0	516060	5.5	718.37	0.81924
8	10080	192	604800	2 hr	604800	1053.4	604800	4.3	777.69	0.64050	5:13:00 AM	1045.4	595200	5.9	771.49	0.87883
9	11520	216	691200	2 hr	691200	1053.6	691200	4.5	831.38	0.67029	7:34:00 AM	1045.7	690060	6.2	830.70	0.92351
10	12960	240	777600	2 hr	777600	1053.4	777600	4.3	881.82	0.64050	8:52:00 AM	1046.1	781140	6.6	883.82	0.98309
15	21600	360	1296000	2 hr	1296000	1053.8	1296000	4.7	1138.42	0.70008	6:54:00 AM	1047.5	1292460	8.0	1136.86	1.19163





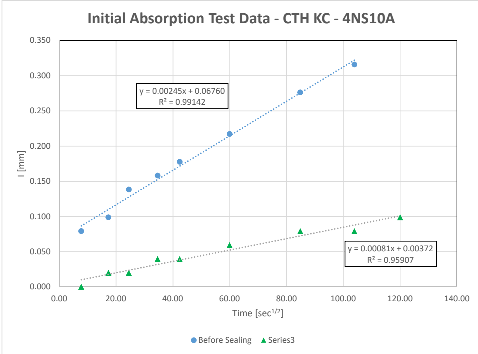
WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

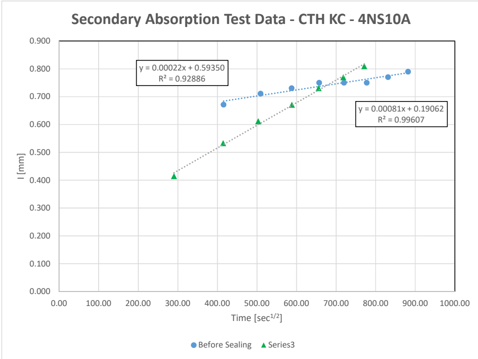
Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4NS10A	
Saw Cut Depth After Trimming, in	1.925	1.922
Face Width After Trimming, in	4.112	4.052
Maximum Depth After Trimming, in		2.497
Mass Before Sealing, g		639.0
Mass after Sealing, g		646.1

Exposed Area, mm^2
5065.6

											After Sealing					
Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$S^{1/2}$	I
1	0		0		9:23:00 AM	645.8					7:55:00 AM	640.7				
1	1		60	2 s	60	646.2	60	0.4	7.75	0.07896	60	640.7	60	0.0	7.75	0.00000
1	5		300	10 s	300	646.3	300	0.5	17.32	0.09870	300	640.8	300	0.1	17.32	0.01974
1	10		600	2 min	600	646.5	600	0.7	24.49	0.13819	600	640.8	600	0.1	24.49	0.01974
1	20		1200	2 min	1200	646.6	1200	0.8	34.64	0.15793	1200	640.9	1200	0.2	34.64	0.03948
1	30		1800	2 min	1800	646.7	1800	0.9	42.43	0.17767	1800	640.9	1800	0.2	42.43	0.03948
1	60	1	3600	2 min	3600	646.9	3600	1.1	60.00	0.21715	3600	641.0	3600	0.3	60.00	0.05922
1	120	2	7200	5 min	7200	647.2	7200	1.4	84.85	0.27637	7200	641.1	7200	0.4	84.85	0.07896
1	180	3	10800	5 min	10800	647.4	10800	1.6	103.92	0.31585	10800	641.1	10800	0.4	103.92	0.07896
1	240	4	14400	5 min	14400	647.5	14400	1.7	120.00	0.33560	14400	641.2	14400	0.5	120.00	0.09870
1	300	5	18000	5 min	18000	647.6	18000	1.8	134.16	0.35534	18000	642.1	18000	1.4	134.16	0.27637
1	360	6	21600	5 min	21600	647.7	21600	1.9	146.97	0.37508	21600	642.1	21600	1.4	146.97	0.27637
2	1440	24	86400	2 hr	86400	648.8	86400	3.0	293.94	0.59223	7:21:00 AM	642.8	84360	2.1	290.45	0.41456
3	2880	48	172800	2 hr	172800	649.2	172800	3.4	415.69	0.67119	7:44:00 AM	643.4	172140	2.7	414.90	0.53300
4	4320	72	259200	2 hr	259200	649.4	259200	3.6	509.12	0.71067	6:18:00 AM	643.8	253380	3.1	503.37	0.61197
5	5760	120	345600	2 hr	345600	649.5	345600	3.7	587.88	0.73041	8:06:00 AM	644.1	346260	3.4	588.44	0.67119
6	7200	144	432000	2 hr	432000	649.6	432000	3.8	657.27	0.75015	7:27:00 AM	644.4	430320	3.7	655.99	0.73041
7	8640	168	518400	2 hr	518400	649.6	518400	3.8	720.00	0.75015	7:15:00 AM	644.6	516000	3.9	718.33	0.76990
8	10080	192	604800	2 hr	604800	649.6	604800	3.8	777.69	0.75015	5:13:00 AM	644.8	595080	4.1	771.41	0.80938
9	11520	216	691200	2 hr	691200	649.7	691200	3.9	831.38	0.76990	7:35:00 AM	645.0	690000	4.3	830.66	0.84886
10	12960	240	777600	2 hr	777600	649.8	777600	4.0	881.82	0.78964	8:53:00 AM	645.2	781080	4.5	883.79	0.88834
15	21600	360	1296000	2 hr	1296000	649.2	1296000	3.4	1138.42	0.67119	6:54:00 AM	646.2	1292340	5.5	1136.81	1.08575





WHRP Project 72298 - Joint Sawing Practices and Effects on Durability

Absorption Test Data - ASTM C1585-13

Specimen ID	CTH KC - 4NS10B	
Saw Cut Depth After Trimming, in	1.863	1.856
Face Width After Trimming, in	4.019	4.044
Maximum Depth After Trimming, in		3.320
Mass Before Sealing, g		824.0
Mass after Sealing, g		830.5

Exposed Area, mm^2
4836.5

											After Sealing					
Day of Testing	Time, min	Time, hr	Time, s	Tolerance	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I	Actual Time	Mass, g	Elaspsed, s	ΔMAss, g	$s^{1/2}$	I
1	0		0		9:16:00 AM	830.0					8:18:00 AM	823.2				
1	1		60	2 s	60	830.3	60	0.3	7.75	0.06203	60	823.2	60	0.0	7.75	0.00000
1	5		300	10 s	300	830.6	300	0.6	17.32	0.12406	300	823.3	300	0.1	17.32	0.02068
1	10		600	2 min	600	830.7	600	0.7	24.49	0.14473	600	823.3	600	0.1	24.49	0.02068
1	20		1200	2 min	1200	830.9	1200	0.9	34.64	0.18609	1200	823.3	1200	0.1	34.64	0.02068
1	30		1800	2 min	1800	831.0	1800	1.0	42.43	0.20676	1800	823.4	1800	0.2	42.43	0.04135
1	60	1	3600	2 min	3600	831.2	3600	1.2	60.00	0.24811	3600	823.5	3600	0.3	60.00	0.06203
1	120	2	7200	5 min	7200	831.4	7200	1.4	84.85	0.28947	7200	823.6	7200	0.4	84.85	0.08270
1	180	3	10800	5 min	10800	831.5	10800	1.5	103.92	0.31014	10800	823.6	10800	0.4	103.92	0.08270
1	240	4	14400	5 min	14400	831.6	14400	1.6	120.00	0.33082	14400	823.7	14400	0.5	120.00	0.10338
1	300	5	18000	5 min	18000	831.8	18000	1.8	134.16	0.37217	18000	823.8	18000	0.6	134.16	0.12406
1	360	6	21600	5 min	21600	831.8	21600	1.8	146.97	0.37217	21600	823.8	21600	0.6	146.97	0.12406
2	1440	24	86400	2 hr	86400	832.6	86400	2.6	293.94	0.53758	7:23:00 AM	824.5	83100	1.3	288.27	0.26879
3	2880	48	172800	2 hr	172800	832.7	172800	2.7	415.69	0.55826	7:46:00 AM	825.1	170880	1.9	413.38	0.39285
4	4320	72	259200	2 hr	259200	832.8	259200	2.8	509.12	0.57893	6:20:00 AM	825.5	252120	2.3	502.12	0.47555
5	5760	120	345600	2 hr	345600	832.9	345600	2.9	587.88	0.59961	8:07:00 AM	825.9	344940	2.7	587.32	0.55826
6	7200	144	432000	2 hr	432000	832.9	432000	2.9	657.27	0.59961	7:28:00 AM	826.2	429000	3.0	654.98	0.62028
7	8640	168	518400	2 hr	518400	832.8	518400	2.8	720.00	0.57893	7:15:00 AM	826.5	514620	3.3	717.37	0.68231
8	10080	192	604800	2 hr	604800	833.0	604800	3.0	777.69	0.62028	5:14:00 AM	826.8	593760	3.6	770.56	0.74434
9	11520	216	691200	2 hr	691200	833.2	691200	3.2	831.38	0.66164	7:36:00 AM	827.1	688680	3.9	829.87	0.80637
10	12960	240	777600	2 hr	777600	833.2	777600	3.2	881.82	0.66164	8:54:00 AM	827.3	779760	4.1	883.04	0.84772
15	21600	360	1296000	2 hr	1296000	833.4	1296000	3.4	1138.42	0.70299	6:56:00 AM	828.3	1291080	5.1	1136.26	1.05448