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5.23 MATERIAL SAMPLING

5.23.1 Introduction

To fully determine the condition of a structure, it may sometimes be necessary to extract material samples from the structure so that laboratory tests may be run to better determine the condition of the structure's materials or states of deterioration or damage. Typical laboratory tests may include compressive tests and petrographic examination of concrete; tension tests, Charpy tests, or crack surface investigations of steel; or even simple integrity examination of timber.

Prior to obtaining any samples, the extent and purpose of the sampling must be determined. The sample size is often stipulated in the specific test methods to be used. In most cases, particularly where deterioration is present, it is advisable to take samples from both good and bad areas so that a comparison can be made. Once the number and location of samples is determined, they should be plotted on a drawing of the structure both to aid in fieldwork and serve as a record for the evaluation of the test results.

5.23.2 Applications

All materials can be sampled and tested either in the field or in a laboratory to provide useful information as to the strength, extent of deterioration, and material characteristics. Specimens should come from representative areas of the structure and typically three samples are required.

All material samples should be collected and tests conducted in accordance with applicable American Society for Testing and Materials (ASTM) and American Association of State Transportation and Highway Officials (AASHTO) methods for the respective materials.

5.23.3 Limitations

The removal of material from the structure should only be conducted when a specific piece of information is required and the information attained provides useful information in the evaluation of the structure.

The extracting of samples will leave holes or voids in the tested component and therefore, repairs are required. Concrete and timber repairs are relatively easy, but steel repairs may be more complex. Welding requires the use of experienced personnel and care should be taken to minimize any residual stresses or fatigue prone details associated with the repair.

5.23.4 Concrete Testing

Concrete material sampling most often consists of drilled cores, though sections may also be obtained by sawing or breaking off a portion of the component. The core size should be determined by the tests to be run; however, in most cases a four-inch diameter core is extracted. Core holes are normally filled with grout; other sample areas should also be repaired with a suitable mortar material. When feasible, steel reinforcement should typically be avoided unless sampling specifically requires it to be part of the core.

Samples should be marked for location and orientation, and packed to prevent damage during transport. As part of the sampling operation, reinforcing steel is typically located and marked to avoid cutting it during the sample extraction. In some instances, it may be desirable to include reinforcing steel as part of the sample. In these cases, it is necessary to confirm that the cut reinforcing steel will not jeopardize the structure's integrity. Refer to Figure 5.23.4-1 for a view of a concrete coring machine and core sample.

Some of the concrete tests that require samples are the following:

1. Carbonation
2. Chloride Ion Content
3. Permeability
4. Cement Content
5. Percent Air Content
6. Moisture Content
7. Steel Reinforcing Yield Strength
8. Concrete Compressive Strength
9. Modulus of Elasticity (static & dynamic)
10. Concrete Splitting Tensile Strength

Figure 5.23.4-1: Concrete Coring Machine (Left) and Core Sample (Right).

5.23.5 Steel Testing

Material coupons for steel members are usually obtained by sawing, coring, or by collecting drill shavings. Coupons may be flame cut; however, the heat induced by the cutting operation alters the material's properties in the vicinity of the cut both in the sample and remaining base material. These heat-affected areas must then be removed by grinding prior to testing. Repair to the base material is also often required. For these reasons, flame cutting should typically be avoided. In selecting coupon locations to test material properties such as yield strength or toughness, it must be remembered that the properties of steel members vary over the cross-section as a result of varying rates of heat loss due to fabrication techniques and rolling/production practices. Note that the orientation of the steel samples should be recorded prior to removal.

Some of the steel tests that require samples are the following:

1. Brinell Hardness Test
2. Charpy Impact Test.
3. Chemical Analysis
4. Tensile Strength Test

Refer to Figure 5.23.5-1 for a view of the Charpy Impact Testing Machine.

Figure 5.23.5-1: Charpy Impact Testing Machine.

5.23.6 Timber Testing

Historically Timber sampling often consisted of the use of incremental borer to extract cores, though sections may also be obtained by sawing off a portion of the component. Core holes should be plugged with a treated hardwood dowel.

Some of the timber tests that require samples were the following:

1. Extent of Rot

2. Location of Voids

3. Preservative Penetration

. Refer to Figure 5.23.6-1 for a view a several incremental borer core samples.

These cores are assessed to determine if bacterial or fungal decay is present, the extent of interior rot, and to determine the species of timber, if required. However, these methods typically do not produce a global sample specimen; however, several local specimens from random locations can be effective. Any holes should be plugged with a treated hardwood dowel.

Moisture content and rot can also be assessed on specimens using electrical devices, such as the Shigometer. These devices require electrodes to be driven into the timber or that small holes be drilled to insert probes into the timber. These detect the presence of timber rot; however, drilling or coring should be conducted to determine the extent of the rot.

Figure 5.23.6-1: Typical Incremental Borer Core Samples.

The presence of decay in timber bridges can be difficult to detect. But the extent and location of such decay can have significant effect on the engineering characteristics of timber and the load rating of timber bridges.

Sounding the timber elements with a hammer is the most basic type of inspection (Chapter 3). But this can be difficult to interpret, and at best, can only give you an indication that decay is present, but cannot be used to determine the extent of the decay. It also has limited detection on large timber members, on members like piles that have surface delamination near the water line (giving a false positive), and on large preservative treated timbers that may have an intact exterior, where the preservative treatment has penetrated, but has a decayed core.

In the past, incremental boring tools were used to better judge the extent of the decay. But that tool is slow, takes a lot physical strength by the inspector, is difficult to interpret, and is a destructive testing methods. Increment boring should only be used as a last resort.

1. Non-Destructive Testing (NDT) should now be used on timber structures. There are two methods used: Stress Wave Timbers (SWT) (Chapter 21) can both be used to detect the extent of decay. SWT measures the time that a pulse travels through a timber. The pulse travels much faster in sound, dense wood than in decayed wood, so decay can be detected and its extent can be estimated.

2. Resistance micro-drilling (Chapter 20) pushes a small 1.5 mm bore (with a flared 3mm tip) into the wood and a microprocessor measures the relative resistance. The bore does not drill into or remove wood, but forces its way into the fibers, thus it is a NDT. In most cases, the timber's preservative treatment envelope is not violated. The wood's resistance to the micro-bore is either recorded on paper or is saved to a computer file.

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