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Construction Materials Term Project

Topic: Portland Cement Concrete

By:

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split tension)**

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/ penetration resistance test)**

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of ASTM testing / Conclusion)**

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Introduction

As far as man-made building material use goes, only Portland cement concrete can compete with its widespread use. One cannot stress the relevance of concrete to our everyday life. Buildings, bridges, tunnels and dams are among examples of constructions where it is employed. Many admixtures may be added to the combination of portland cement and aggregates to make it more durable. While portland cement is most often employed in the production of portland cement concrete, additional applications include soil stabilization as well as aggregate bases for roadway building. Different cements have resulted in a wide variety of concrete kinds. However, since portland cement concrete is so widely used, it is presumed to always refer to portland cement concrete when the word concrete is used. The limestone cliffs of England's Isle of Portland inspired Joseph Aspdin to patent Portland cement in 1824.

In order to manufacture concrete using Portland cement, all you need to do is mix it with water. Portland cement's physical and chemical qualities and manufacture should be familiar to those in the field of materials engineering who are involved in the selection, specification, or quality control of such projects. The quality assurance of Portland cement concrete as well as the quantities of the components used in it are directly handled by civil and construction engineers. The chemical composition of Portland cement, hydration as well as formation of the nanostructures, admixtures, and aggregate qualities all have a role in the final concrete's quality and strength. In addition to the placing, consolidation, and curing, the quality is greatly influenced. The processes used to mix; transport, place, and cure concrete in the open have a significant impact on the long-term performance of a concrete construction. An "excellent" concrete may in reality have the same elements as a "poor" concrete.

Engineers and professionals who handle concrete during construction may make a big impact, though. Concrete is now more widely applicable than it was even a few decades ago, thanks to technological advancements in the concrete industry. In addition to ordinary concrete, civil as well as construction professionals should be aware of lightweight concrete, high-strength concrete, polymeric concrete, fibre-reinforced concrete, roller-compacted concrete, and other alternatives to conventional concrete. Engineers need to thoroughly research these alternatives to traditional concrete before deciding whether or not to use them. Among the topics covered in this chapter are the fundamentals of ordinary Portland cement concrete and its mixing and handling, as well as curing and testing. Alternatives to standard

concrete have also been created, increasing the number of uses and enhancing the performance of the material.

The American Society of Testing & Materials, sometimes known simply as ASTM, is recognized as one of the most influential organizations in the realm of product development and certification. The American Society for Testing and Materials (ASTM) is a reputable organization that is based in the United States and enjoys international recognition. Its standards include best practices for determining whether one material grade as well as product are deserving of investment and can be utilized in typical applications. The American Society for Testing and Materials (ASTM) has earned the reputation of being a world leader in the delivery and creation of optional consensus standards. More than 12 thousand of the standards that have been issued by ASTM are now being used all over the globe to increase product quality, boost market commerce and access, improve health and safety, and let consumers know that they can depend on goods. In addition, many other sectors, such as construction, metal processing, consumer goods, petroleum, and others, are served by this organization. Standards have been developed in accordance with the guiding principles that have been established by the World Trade Organization. Companies, people, and organizations located all around the globe may benefit from adhering to these norms. The vast majority of government regulators also reference standards included in laws, codes, and regulations.

ASTM Standards and Testing

The qualities of hardened concrete may be evaluated in the laboratories or in the outdoors using a variety of tests. A few of these tests are damaging, while others are non-harmful. Testing may be done for a variety of reasons, but it is most often done to ensure concrete quality and specification compliance. To determine hardened concrete's compressive strength, the most frequent test is the compression strength test, which is simple to execute and has a good association with many desired qualities. These include split tension, flexural strength test, rebound hammer, penetration resistance, ultrasonic pulse velocity and maturity testing.

Compressive Strength Test

The test of compressive strength is the one that is carried out on hardened concrete the majority of the time. In order to guarantee that the construction will be able to support the load that is planned for it, one of the primary design criteria for structures is their compressive strength. As was said previously, the amount of water to cement should be decreased so that the compressive strength of the concrete might rise. Since the ratio of water to cement has a direct bearing on the quality of the concrete, compressive strength is also used as a quality indicator, particularly in terms of longevity and resistance to the effects of the elements.

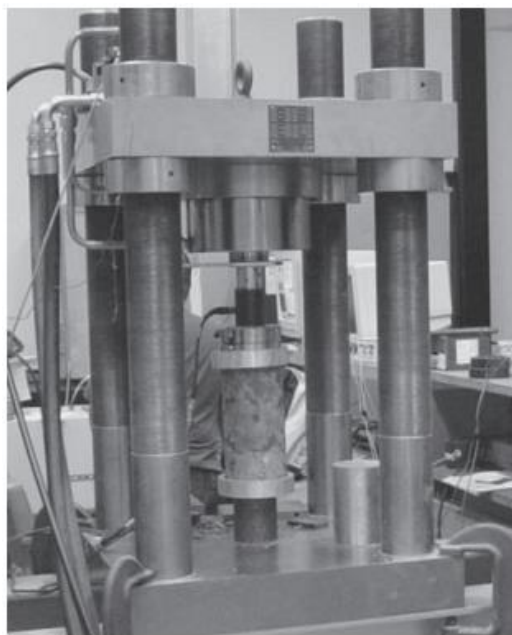


Figure 1: Compressive Strength Testing

Therefore, in many instances, designers prescribe a higher compressive strength of concrete to assure a good quality, although this strength is not required for structural support. This is done in order to ensure that the concrete is strong enough. The ASTM C39 standard dictates how the test should be carried out in the U. S., which calls for the use of cylindrical specimens. The specimen is processed in accordance with ASTM C192 or C31, whichever is applicable, either in the laboratory or out in the field. Additionally, cores might be drilled from the structure in accordance with ASTM C42.

Split Tension Test

The tensile strength of concrete may be determined with the use of the split-tension testing (ASTM C496). In this particular test, a concrete cylinder measuring 0.15 m by 0.30 m (about 6 inches by 12 inches) is exposed to a compressive load that is applied at a steady rate along vertical diameter until it fails.

Because of the stress that was created in the transverse direction, the specimen fails along the diameter that is running vertically. Concrete's normal indirect tensile strength ranges from 2.5 - 3.1 MPa (360 - 450 psi), with the average value falling somewhere in the middle. Concrete's tensile strength is about equivalent to around ten percent of its compressive strength.

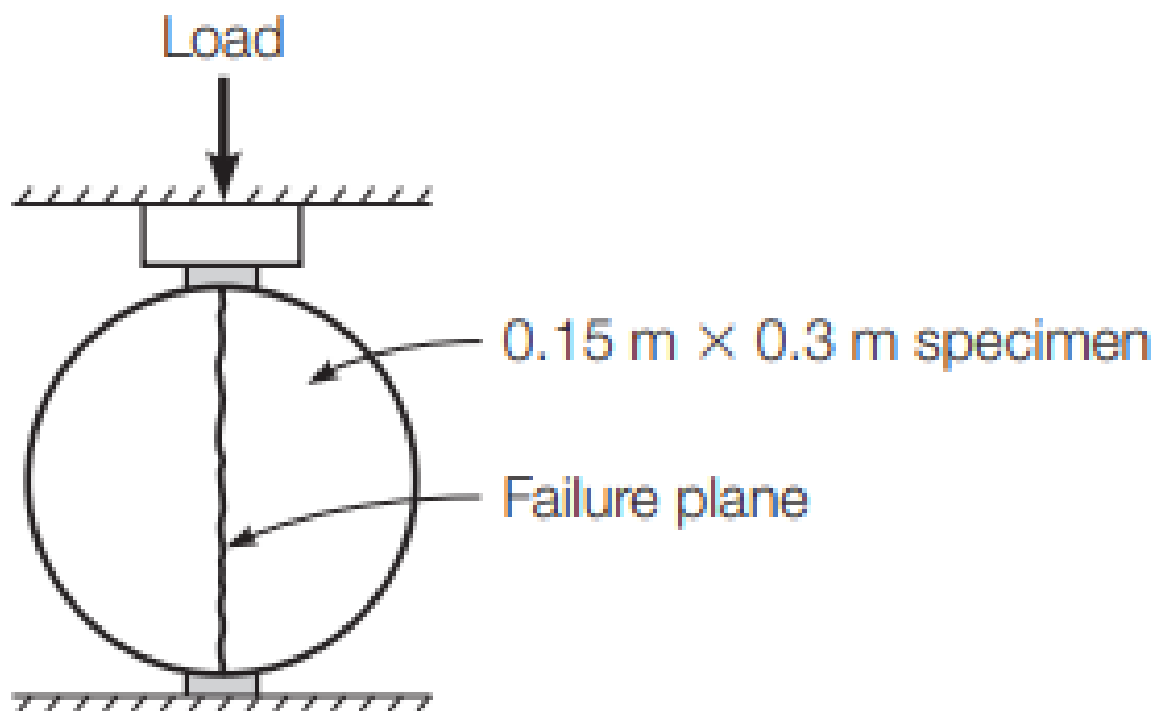


Figure 2: Split-tension test

Flexure Strength Test

The flexure strength test, also known as ASTM C78, is an essential part of the process of designing and building concrete pavements for roads and airports. In line with ASTM C192 or C31, the specimen may be processed either in the lab or out in the field, depending on which standard is being used. There are a few different specimen sizes that may be employed. The sample, on the other hand, needs to have a square cross - sectional area and a span that is three times the depth of the specimen. The cross section is 0.15 meters by 0.15 meters (6 inches by 6 inches), and the span measures 0.30 meters (18 inches).

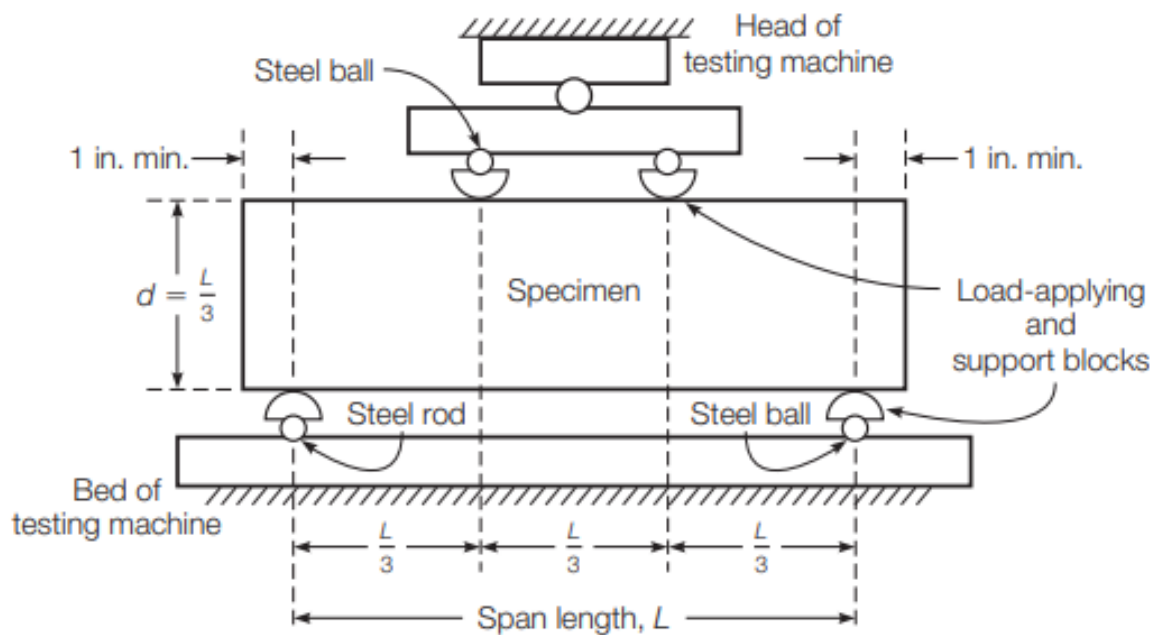


Figure 3: Flexure strength testing

Rebound Hammer Test

The rebound hammer testing, which is also referred as the Schmidt hammer experiment, would be a test that is done on hardened concrete in order to evaluate the surface's level of hardness. This test is non-destructive. It is possible to establish a correlation, at least to some degree, between the hardness of the surfaces and the strength of the concrete. It is usual practice to utilize the rebound hammer in order to get some insight into the strength of the concrete. The apparatus has a length of approximately one foot and is about 0.3 meters in length. It has a mass as well as a spring. The mass that was held in place by the spring is now free to impact the concrete surface. The mass is seen to rebound, and the quantity of this rebound may be read off of a scale that is connected to the apparatus. When the rebound is

bigger, it indicates that the concrete surface is harder, which in turn indicates that the strength is stronger. Graphs that were generated by the manufacturer to link rebound to strength are often included in the package that the device arrives in. In addition to that, the test may be used to examine the degree to which the concrete surface is uniform.

The ASTM C805 standard ensures that the test may be carried out quickly and easily. In order to carry out the test, the hammer has to be positioned such that it is perpendicular to a smooth and spotless concrete surface. In certain circumstances, it could be difficult to fulfil the requirements of this criterion.



Figure 4: Rebound hammer test

Penetration Resistance Test

ASTM C803 is the standard that governs the penetration resistance testing, which is also often referred to as the Windsor Probe test. The tool resembles a pistol and fires probes into the surface of the concrete so that the strength of the concrete may be determined. The degree to which the probe is able to penetrate into the concrete has a relationship that is inversely

proportional to the concrete's strength. Due to the fact that it punches holes into the concrete surface, the test is considered to be practically non-destructive.

The apparatus includes a specialized template that has three openings and is designed to be positioned on top of the concrete. The procedure is carried out for each of the individual craters. A scale and a specialized plate are used in order to calculate an average of the depths to which the three probes were able to penetrate these holes.

Ultrasonic Pulse Velocity Test

The ultrasonic pulse examination, also known as ASTM C597, is a procedure that evaluates the speed at which an ultrasonic wave travels through concrete. In this experiment, the average speed of wave propagation is calculated by dividing the total travel time by the distance that must be travelled between the transducers. There have been several attempts made to link pulse velocity data with the various metrics of concrete strength. The link between pulse velocity as well as strength data was found to be impacted by a variety of factors, including the age of the concrete, the aggregate–cement ratio, the aggregate type, the moisture condition, and the position of the reinforcement. As a result, no significant correlations were identified. In order to identify fractures, discontinuities, or other forms of internal degradation in the structure of concrete, this test is performed.



Figure 5: Ultrasonic pulse velocity test apparatus

Maturity Test

The amount of cement hydration is what determines the maturity of a cementitious material, and this degree varies with both the passing of time and the rising or falling of temperature. Because of this, it is generally accepted that the level of a concrete mixture's strength is directly proportional to its degree of aging. In order to offer a rough estimate of the strength of concrete, maturity monitors have been created. These meters do this by tracking the temperature of the concrete over time. This testing (ASTM C1074) is carried out on newly placed concrete, and it is maintained over the course of many days. Each every batch of concrete requires that the maturity meter be recalibrated.



Figure 6: Concrete maturity monitor

Significance of ASTM Testing

The major purposes of the American Society for Testing and Materials are also the promotion of research on the effect that the physical and chemical properties of materials have on the end uses of those materials, the establishment of processes by which substantial characteristics can be evaluated with adequate precision and accuracy, and the setting of restricting criteria that define the appropriateness of materials for specific uses. Even while these goals are straightforward to understand in theory, it is almost never feasible to put them into practice exactly as intended due to the numerous different factors involved. For instance, there is often neither the data nor the theory necessary to establish a general link between the performance of a property and that of the substance in its final application. In most cases, proper testing procedures have not been created, or the expense of personnel or facilities, or the amount of time necessary for testing, may make it impossible to apply such procedures to the process of selecting and controlling the materials. As a consequence of this, the majority of the methods of testing that are used for the evaluation and control of materials are compromises.

This is due to the fact that these methods might not measure accurately and uniquely the properties that are essential to the adequate properties of the material. In most cases, the practical tests only provide a general reflection of the properties of the material. In addition, the test may only be applicable at all under a specific set of conditions or to only a specific type of material from among the components that can be regarded to be alternatives when choosing materials for specific uses. In addition, the specified limits are typically made on the basis of testing data which may not be broadly applicable or on the basis of past experience which does not encompass important types or sorts of service or effectiveness. Both of these factors contribute to a lack of coverage for important forms or kinds of service or effectiveness. As a result, generic requirements may need to be altered before they're even implemented accurately to a particular piece of work.

The ASTM standards also are important in making these items considerably safer to use, so that there are no associated hazards. This ensures that there are no risks. The standards provide the suppliers the ability to comprehend that their goods are of the highest quality, and that they provide their customers with the greatest possible quality. The providers that adhere to the ASTM standards are in a position to confidently ensure that they provide their clients with the highest quality items. Products must be subjected to stringent testing in order to get

permission for ASTM certification. These tests must ensure that the product is dependable when subjected to high pressure as well as stress calculation-tested scenarios. Customers are provided with the sense of pleasure that comes from being aware that their goods perform admirably in comparison to the benchmarks that are set by their industry.

A 820-96	Standard Specification for Steel Fibers for Fiber Reinforced Concrete	C 127-01	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
C 29-97	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate	C 128-01	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C 31-00	Standard Practice for Making and Curing Concrete Test Specimens in the Field	C 131-96	Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 33-01	Standard Specification for Concrete Aggregates	C 136-01	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 39-01	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	C 138-01	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C 40-99	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete	C 141-97	Standard Specification for Hydraulic Hydrated Lime for Structural Purposes
C 42-99	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	C 142-97	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
C 70-01	Standard Test Method for Surface Moisture in Fine Aggregate	C 143-00	Standard Test Method for Slump of Hydraulic Cement Concrete
C 78-00	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading)	C 150-00	Standard Specification for Portland Cement
C 85	Test Method for Cement Content of Hardened Portland Cement Concrete (Discontinued 1989—Replaced by C 1084)	C 151-00	Standard Test Method for Autoclave Expansion of Portland Cement
C 87-83 (1995)	Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar	C 156-98	Standard Test Method for Water Retention by Concrete Curing Materials
C 88-99	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	C 157-99	Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar, and Concrete
C 91-99	Standard Specification for Masonry Cement	C 171-97	Standard Specification for Sheet Materials for Curing Concrete
C 94-00	Standard Specification for Ready Mixed Concrete	C 172-99	Standard Practice for Sampling Freshly Mixed Concrete
C 109-99	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 50 mm [2 in.] Cube Specimens)	C 173-01	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C 114-00	Standard Test Methods for Chemical Analysis of Hydraulic Cement	C 174-97	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
C 115-96	Standard Test Method for Fineness of Portland Cement by the Turbidimeter	C 177-97	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C 117-95	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing	C 183-97	Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
C 123-98	Standard Test Method for Lightweight Particles in Aggregate	C 184-94	Standard Test Method for Fineness of Hydraulic Cement by the 150- μ m (No. 100) and 75- μ m (No. 200) Sieves
C 125-00	Standard Terminology Relating to Concrete and Concrete Aggregates	C 185-01	Standard Test Method for Air Content of Hydraulic Cement Mortar

Figure 7: List of ASTM Standards for Concrete

Conclusion

Civil engineers are directly responsible for the design and development of long-lasting materials that are comprised of Portland cement concrete. The quality of the concrete that is used in structural applications is determined by selecting the appropriate amounts of Portland cement, water, aggregates, & admixtures, in addition to following sound building procedures. Concrete that has the necessary strength and durability may be produced by using the proportional mix design approach that is detailed in this body of work. The right selection of Portland cement concrete, on the other hand, is completely pointless if the required building processes are not followed. These procedures include the correct mixing, transporting, putting, & curing of the concrete. Numerous quality control tests, including as slump tests, air content experiments, and strength-gain-with-time tests, are carried out by civil engineers in order to guarantee that the concrete that is produced via these methods has the characteristics that are wanted.

Although the great majority of infrastructure projects are built using traditional materials, there are a range of alternative concrete formulas that are vital and are available for use in speciality applications. This chapter provides an introduction to these other options; nevertheless, the technology connected with these alternate options is rather complicated, and more research is necessary in order to completely grasp the behaviour of these materials.

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