CONCRETE TECHNOLOGY MODULE SEMESTER 1 – LECTURE 11

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SEMESTER 1 OUTLINE

Item	Subject	Item	
1	**Introduction: Cement and Aggregate**		
2	**Manufacturing of concrete** - Mixing - Transportation - Placing and compaction - Curing - Finishing	4	**Strength of Concrete** - Compressive strength - Tensile strength - Modulus of rupture - Bond strength with steel reinforcement - Factors affecting concrete strength - Factor affecting concrete test
3	**Properties of Fresh Concrete** - Workability and Consistency - Segregation and Bleeding - Pressure on form work - Stripping of form	5	**Deformation of Concrete** - Creep - Shrinkage - Modulus of elasticity and Poisson's ratio

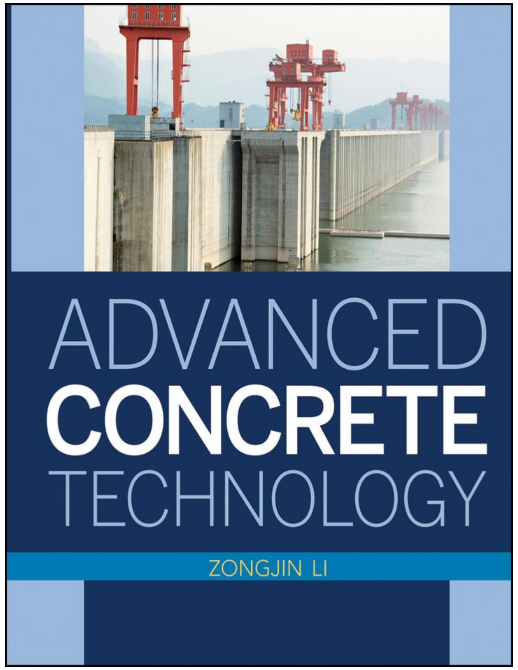
REFERENCES

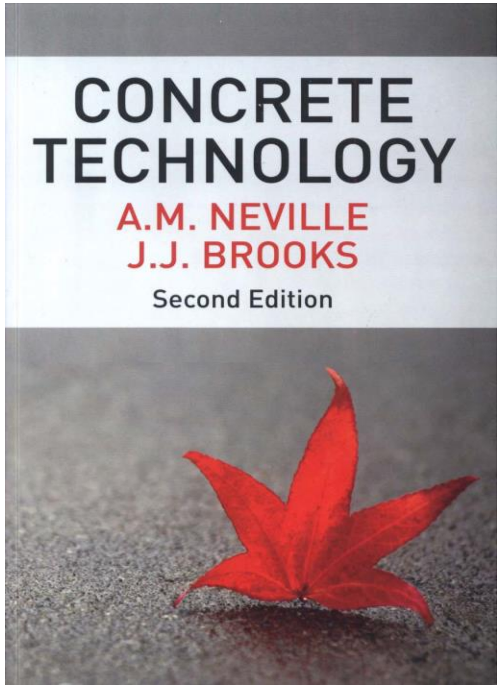
Main Reference

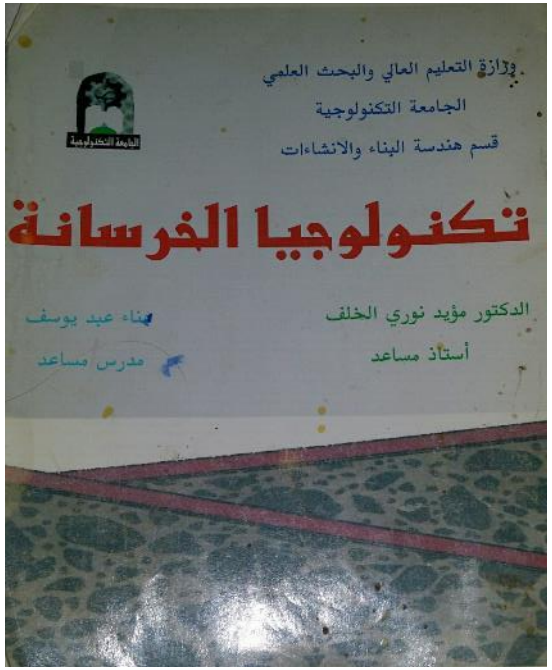
- Advanced concrete technology by Zongjin Li

Other references

- Concrete technology by Dr. Moaid Nory
- Concrete Technology -2dn Ed by A.M. NEVILLE







LECTURE CONTENTS

FRESH CONCRETE

1. 3.6 CONCRETE PLACING
   1. **3.6.3 Depositing concrete in forms**
   2. **3.6.4 Compacting and finishing**
   3. **3.6.5 Curing**

3.6.3 Depositing concrete in forms

Once all the preparation work and equipment are ready, depositing concrete into the formwork can be started.

A basic rule is that concrete should be deposited as close as possible to its final location, especially for vertical dropping.

As long as the concrete is deposited near its final position without undue segregation, any method is acceptable.

If possible, concrete should fall vertically.

In most cases, free fall should be limited to 0.9 to 1.5m to avoid aggregate bouncing off from faces and striking the reinforcing steel, which may increase segregation.

However, when the formwork is open and the concrete drop is unobstructed, free fall to a depth of 45m has proven successful without segregation (Mindess et al., 2003).

Usually, a drop chute or pipe is used to guide or protect the concrete during its fall, as shown in Figure 3-21.

For concrete deposited in the formwork of walls, footings, beams, and shear walls, concrete **should be placed from the ends or corners toward the center, in horizontal layers not exceeding about 450mm in depth.**

Mass concrete in dams and foundations is usually placed in lifts of 1.5 or 2.5m depth, each lift consisting of several layers.

To avoid cold joints, these layers are carried across the form in a series of steps.

For a rock foundation, a layer of mortar with a thickness of 12mm should be placed before depositing the first layer of concrete.

The compatibility between the mortar and concrete should be taken into consideration.

Subsequent layers, continuing to the full height of the structure, should be placed and consolidated before the underlying layer has hardened.

For slope placing and consolidation, the work should be started from the bottom, allowing gravity to aid, rather than to hinder consolidation.

The concrete should be constrained to fall vertically onto the slope.

A strict watch should always be kept for segregation during placement, and action should be taken to correct problems as soon as they arise.

A number of occasions present unique problems in handling, placing, and consolidating concrete. Among these are slip forms, underwater placing, and preplaced aggregate concrete.

3.6.4 Compacting and finishing

After depositing concrete into formworks, it should be compacted right away. The purpose of compacting is to remove the air entrapped during concrete placement and to consolidate plastic concrete into all the spaces in the formworks, including the corners and the gaps in the reinforcing steels.

Compacting can make concrete denser and stiffer and thus have a good compressive strength and low permeability. Without proper compacting, high-quality concrete cannot be achieved.

Many years ago, consolidation was accomplished by laborers wielding a variety of spades, tampers, and similar tools. Now, nearly all concrete is consolidated with high-frequency vibrators.

At a construction site, two vibrators are frequently used, an internal and an external vibrator. An internal vibrator consists of a poker, housing an eccentric shaft driven through a flexible drive from a mortar. The poker can be immersed in concrete and vibrates in a harmonic way, exerting pressure to the surrounding concrete.

The vibration can produce a noise with a level up to 90 dB, and, obviously, poker vibration is not good for people's health.

Self-compacting concrete can completely eliminate the vibration and hence is environmentally friendly. Figure 3-22 shows the vibration process of an internal vibrator.

The external vibrator usually has a flat metal base like a plate, including the surface, and pan or screed vibrators. The mortar on the top of the plate can generate vibration on the plate.

It can be placed on the surface of the fresh concrete and is usually suitable for slab and floor member compacting.

Slabs up to 200mm thick can be consolidated adequately. Thicker slabs require additional internal vibration.

In addition to consolidating the concrete in the slab, the unit strikes off the surface and prepares it for final finishing.

Another type of external vibrator is the form vibrator. Form vibrators are attached to the exterior of the mold or form. They are used in locations where it is difficult to use internal vibrators, such as in tunnel linings or heavily congested forms.

They are also used for making pipes, masonry units, and many other types of precast concrete. Pneumatically driven units develop vibration by the rotation of an eccentric weight.

The speed can be varied by changing the volume of air supplied. When the surface of the concrete takes on a flattened glistening appearance, the rise of entrapped air bubbles ceases, the coarse aggregate blends into the surface but does not disappear, and vibration can be stopped.

Overvibration sometimes occurs. If so, the coarse aggregate will have sunk below the surface, and the surface may have a frothy appearance.

In this case, the slump should first be reduced, and the amount of vibration then has to be adjusted.

A simple finishing on the fresh concrete is usually done by trowel just before initial setting.

The purpose of finishing is to make a smooth surface on the concrete member and to achieve a denser, compact, and properly graded surface layer to prevent water evaporation and increase wear resistance.

Proper finishing of good-quality concrete can minimize the maintenance cost of a structural member.

In addition to simple finishing, many special techniques have been developed to achieve a decoration effect, as shown in Figure 3-23.

3.6.5 Curing

For concrete to develop strength, the chemical reactions need to proceed continuously.

Curing refers to procedures for maintaining a proper environment in fresh concrete for the hydration reactions to proceed.

Curing is a simple procedure, and is frequently ignored. However, it is most important in producing a strong, durable, and watertight concrete.

In concrete curing, the critical thing is to keep a sufficiently moist condition for the concrete, so that the hydration will not stop. Moist curing is provided by water spraying, ponding, or covering the concrete surface with wet sand, plastic sheets, burlap, or mats.

Curing compounds, which can be sprayed onto the concrete surface to form a thin continuous sheet, are also commonly used, especially for vertical surfaces such walls and columns.

Loss of water to the surrounding areas should be minimized.

If concrete is cast on a soil subgrade, the subgrade should be wetted to prevent water absorption.

In exposed areas (such as a slope), windbreaks and sunshades are often built to reduce water evaporation.

For Portland cement concrete, a minimum period of 7 days of moist curing is generally recommended.

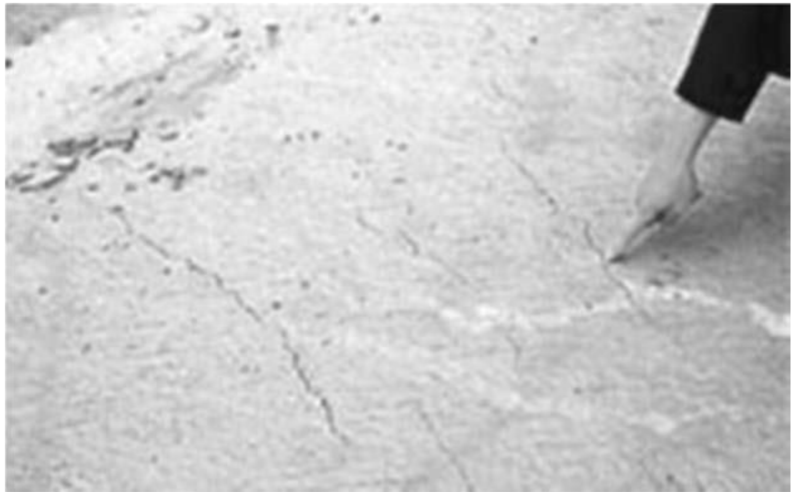
Under normal curing (at room temperature), it takes 1 week for concrete to reach about 70% of its long-term strength.

Strength development can be accelerated with a higher curing temperature.

In the fabrication of precast concrete components, steam curing is often employed, and the 7-day strength under normal curing can be achieved in 1 day. The mold can then be reused, leading to a more rapid turnover. If curing is carried out at a higher temperature, the hydration products form faster, but they do not form uniformly. As a result, the long-term strength is reduced. This is a worry when casting in hot weather. The concrete may need to be cooled down by the use of chilled water or crushed ice. In large concrete structures, cooling of the interior (e.g., by circulation of water in embedded pipes) is important, not only to prevent the reduction of concrete strength, but also to avoid thermal cracking as a result of nonuniform heating/cooling of the structure.

If fresh concrete is not properly cured, surface water evaporation is fast and the internal water has almost no change. Plastic shrinkage may occur if the rate of water loss (due to evaporation) exceeds the rate of bleeding. Shrinkage is the reduction in volume due to the loss of water. Such early shrinkage occurs when concrete is still at the plastic state (not completely stiffened), especially internal concrete, and thus it is called plastic shrinkage.

The small amount of volume reduction due plastic shrinkage is accompanied by the downward movement of the surface layer material. If this downward movement is restrained, by steel reinforcements or large aggregates, cracks will form as long as the low concrete strength is exceeded. Plastic shrinkage cracks often run perpendicular to the concrete surface, above the steel reinforcements. A typical plastic shrinkage crack is shown in Figure 3-24. The presence of plastic shrinkage cracks can affect the durability of the structure, as they allow corrosive agents to easily reach the steel. If care is taken to cover the concrete surface and reduce other water loss (such as absorption by formwork or subgrade), plastic shrinkage cracking can be avoided. If noticed at an early stage, it can be removed by revibration.

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