Topic 7 CONCRETE HANDLING IN FIELD

The design of concrete is very important to strength and durability, however, attention should be placed on handling, placing, and curing to ensure uniform quality throughout the mix. In this section we will discuss the proper handling and placing techniques.

Batching and Mixing

- **Batching** -- Batching of aggregates and cement should always be done by weight. Other components, like water and admixtures, can be batched by volume. Batching by weight allows rapid and convenient adjustment of mix parameters if desired. Material quantities should be measured with a high degree of accuracy.

- **Batching Equipment** -- Any piece of batching equipment should allow free and unobstructed flow of materials while minimizing segregation. Machines of this type may be divided into three categories: (1) manual - used for small jobs or low output requirements; (2) semiautomatic - batching process is manually started but is automatically terminated; (3) fully automatic - in this device a single switch activates the entire batching procedure. All of this devices should be kept clean and as dust free as possible. Avoid free fall of fine particles, like cement and admixtures to reduce dust and material loss. Weighing device should be checked often to ensure that the proper amounts of each material is being batched correctly.

- **Handling of Aggregate** -- The main objective in handling aggregate is to prevent segregation and control moisture of the material. Segregation problems can be minimized by storing coarse aggregate in coarse, medium, and fine factions. This will allow the proper gradation of the aggregate. Protection from the weather can prevent wide variation in moisture content.

- **Mixing** -- Proper mixing is essential to produce homogeneous, uniform concrete. Inadequate mixing will result in concrete with lower strengths and greater batch-to-batch variations. Excessive mixing will reduce the output of a batching operation and can lead to breakdown of the aggregate.

- **Mixing Times** -- The optimum mixing time depends on several factors; (1) the type of mixer, (2) the condition of the mixer; (3) the speed of the mixer; (4) the size of the charge; (5) the nature of the materials. In general, mixing time should be assessed in the field based upon batch-to-batch variations. Lean, dry, or harsh mixes require longer mixing times. Concrete made with angular aggregates required more time than do concretes with more rounded aggregates.

- **Charging the Mixer** -- This refers to the pre-blending of materials. Generally, it is desired to add about 10% of the mixing water before the aggregates are added and continuously added throughout the charging of the aggregate. The cement should be added after about 10% of the aggregate has been added. Admixtures should batched separately to avoid any potential adverse interactions between them.

- **Types of Mixers** -- Generally, mixers can be divided into three types; (1) drum mixers - a series of interior fixed blades which ensure end-to-end mixing of the materials. The concrete can be removed by dumping the mix or reversing the direction of rotation; (2) pan mixers - in this type the mixing blades are fixed and the pan rotates; (3) continuous mixers - the materials are proportioned at one end of a drum, mixed in the drum, and exit the other end of the drum as concrete.

- **Ready-Mixed Concrete** -- By using automated equipment and trained personnel ready-mix operations can obtain better quality control. This type of operation also eliminates the need for mass storage of materials on the job site. There are several ways to handle this type of operation; (1) central-mixed - completely mixed at the batching plant, truck is used mainly for transportation, mixing in the truck reduces slump loss and prevents segregation; (2) transit-mixing - concrete is partially or completely mixed in transit; (3) shrink-mixed - concrete is partially mixed at the plant to reduce the volume and completed in the truck mixer (4) truck-mixed - completely mixed in the truck after being charged at the plant.

- **Remixing** -- Concrete is often remixed at the job site to ensure proper slump is achieved. If this is the case, at least half the mixing time should occur during the remixing. Remixed concrete is likely to set more rapidly than concrete mixed only once.

Transportation

There are many different ways to handle concrete and the choice will depend many factors. In general, any means of transportation should protect the concrete from weather and avoid segregation.

Pumping

Concrete pumping technique were developed in the 1930's but remained uncommon until 15 to 20 years ago. Typically, concrete can be pumped more than 1500 feet horizontally and 500 feet vertically. There are three basic types of

concrete pumps; (1) piston pumps; (2) pneumatic pumps; and (3) squeeze pumps. Pipelines are made of rigid or flexible material. Generally the rigid pipe performs better allowing up to 8 in. diameter section, while flexible pipe is limited to about 4 in. inner diameter.

- **Pumping Distances** -- The distance concrete can be pumped depends on many factors; (1) the capacity of the pump, (2) the size of the pipeline, (3) obstructions top uniform flow, (4) velocity of pumping, and (5) the characteristics of the concrete. The concrete is pumped as a plug lubricated by a thin layer of mortar or grout at the pipe wall. The is achieved by priming the pump with a mortar or a concrete with the coarse aggregate removed.

- **Mix Design** -- If concrete is to pumped it should be designed to be plastic and cohesive with emphasis on quality control and uniformity of components. Harsh or dry mixes do not pump well. Most failures in pumping occur because of segregation and high frictional resistance. To avoid such problems, the maximum aggregate size should be restricted to

33% of the inside pipe diameter for angular aggregates and 40% for rounded aggregates. Special attention must be given to the amount of fine aggregate in the mix since the mortar fluid is the pumping medium in which the coarse aggregate is suspended. Admixtures are available which increase the viscosity of the mixing water preventing excessive bleeding and reducing frictional resistance. Concrete of high slump can segregate in the pipeline and cause blockage. Air-entrained concrete can be pumped if the air content is not too high. The compressibility of air reduced pumping capacity.

Placement of Concrete

Proper handling of concrete during placement should minimize segregation of coarse aggregates. Basically, concrete should be placed by a vertical drop, however, the material should not be allowed to free fall for long distances. Concrete should be allowed to flow slowly into the forms at a vertical angle. If placement on a slope is desired the concrete should be constrained to fall vertically by some sort of chute or baffle.

Special Placement

- **Slip Forming** -- A method for the continuous placement and consolidation of concrete. In this technique low slump concrete capable of retaining it shape without formwork shortly after placement is used for horizontal applications. In vertical application the formwork must remain until the adequate strength has been gained. A variation of this method is the jump forming technique. In this method the forms are not moved continuously, but repositioned of jump to the next lift.

- **Preplaced Aggregate** -- In this method, forms are packed with well-graded aggregates and injected with mortar to fill the voids. This method is used for underwater placement of when normal placement is very difficult. Since the aggregate is packed more densely than ordinary concrete, less cement paste is required. The direct contact between aggregate will affect the elastic and fracture properties of concrete.

- **Shotcreteing of Gunniting** -- In this method concrete is applied by spraying it from a nozzle by means of compressed air. Normally, the material are blended dry and the water is injected just before entering the nozzle. The concrete can also be sprayed in a wet state. Generally, fine aggregate and sand are used in shotcreteing operations. The force of the spray compacts the concrete at the surface resulting in high compressive strengths. Up to 1/2 of the mixture rebounds off the surface and is lost. This results in a richer mixture than the design mix.

- **Tremie Concrete** -- This method is used for pouring concrete underwater or placement in deep forms. The concrete is placed by gravity through a long vertical pipe with a funnel-shaped hopper at the end. This method is designed to eliminate trapped air or voids in the concrete. To obtain the high slump, flowing concrete necessary for this technique a high percentage of sand, 40 to 50% by weight of total aggregate, is used. The size of the tremie pipe depends on maximum aggregate size.

- **Underwater Placement** -- The tremie method is only one method for underwater placement. Pumping and preplaced aggregate methods are also used. Special bottom-dump buckets are also used to place concrete underwater.

Consolidation

After placement, the concrete should be consolidated into the forms and around reinforcing bars to eliminate trapped air and voids. Most concrete now placed is consolidated by vibration. The main advantage of this technique over other methods is that concrete can have as little as 1/3 the slump of concrete consolidated by hand. Lower slump mixes are also less prone to segregation. Over vibration will bring excessive paste to the surface, enhances bleeding, and causes loss of entrained air.

- **Concrete Vibrators** -- Basically, a vibrator applies periodic shear forces to the concrete which causes the material to flow. There are generally two types of vibration devices; internal or immersion vibrators or external vibrators. External vibrators clamp direct to the formwork requiring strong, rigid forms which remain watertight to withstand the energy imparted to the system. Internal vibrators are more suited general construction. As the concrete is caused to flow by the vibration it does not flow uniformly. As the vibration starts the dense coarse aggregate is forced away form the vibrator head and mortar begins to flow between the aggregate. The vibrator head must be moved up and down to create a homogeneous mix. To aid in the removal of trapped air the vibrator head should be rapidly plunged into the mix and slowly moved up and down. Any trapped air flows away from the head and to the forms. As the head is pull out the air is forced out along the form sides ahead of the vibrator. Vibration has a limited sphere of influence. Typically, the concrete should be vibrated at 18 inch intervals and at each lift. Revibration can produce better consolidated concrete if done before final set.

- **Vacuum Dewatering** -- A method of consolidation of horizontal surfaces which removes water form the upper 12 inches of the slab, effectively consolidating the material. A filter prevents the removal of fine particles. The lower w/c ratio improves strength and durability.

Casting in Lifts

When casting in lifts units between construction joints should be cast in successive layers. Each layer should be vibrated together by passing the vibrator into the lower lift. If the lower lift hardens before the nest placement, a cold joint or construction joint must be used. The lower lift surface is cleaned to create a roughened state so that a good mechanical bond with the next lift can be made. A layer of mortar helps provide a good bond and reduced the potential for segregation.

Finishing Concrete

Several techniques have been developed for finishing slabs for floors or pavements. Good finishing can provide a maintenance free surface and can offset some deficiencies of a poorly designed mix.

- **Screeding** -- Excess concrete is struck off to bring the surface to the desired level and fill any low spots.

- **Floating** -- After the concrete has hardened and bleed water has disappeared, the surface is floated to a flat blade. This process compacts and removes imperfections from the surface while forcing cement and water to the surface. Excessive floating will cause a high w/c ratio and weaken the surface.

- **Trowelling** -- After floating, a surface may be steel-troweled to provide a really smooth, dense, wear-resistant surface.

- **Texturing** -- If a skid-resistant surface is desired, the freshly screeded surface can be textured by scoring the surface with a wire or fiber broom. Excessive paste can be removed with washing which results in an exposed aggregate finish.

- **Hardening** -- This treatment causes the surface to provide additional durability and wear-resistance. This is the result of a chemical reaction with calcium hydroxide in the paste creating more C-S-H.