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Batching and Mixing of Mortar and Concrete Ingredients

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ABSTRACT:

A concrete plant, also known as batch plant is device that combines various ingredients to form concrete. In general, it is a process of combining gall ingredients of concrete as per the mix design. Batching and mixing are extremely important parts of mortar and concrete manufactures they influence properties of concrete both in plastic as well as in hardened stages. Also, it is one of the important processes, which is to be done to obtain a quality concrete. Many processes are carried out in various parts of the world with many changes and different equipment. There are various types of batching and mixing equipment and methods that is to say from manual to most sophisticated computerized batching and mixing. Mechanization improves quality of batching and mixing ,its speed and there by can most often result in economy. There are number of factors which are to be considered while doing the process which are discussed in this paper. Moreover, the machinery, which is to be required while making concrete or for batching process and discharging and unloading of the mixture, area lso discussed in brief.

Keywords Mechanization improves quality of batching and mixing

1.0 INTRODUCTION:

Concrete is the most widely used construction material in the world. This material is not going to be easily replaced by any other material on account of its economical as well as the technical advantage. This material is generally produced at the site in our country and therefore needs to be carefully supervised and controlled in order that it performs the way it is technically expected to perform.

Concrete is made from raw materials such as cement, natural and manufactured aggregates, water and at times concrete additives (chemicals). It is worth noting that cement and aggregates are manufactured

or obtained from natural solid stone, which is quarried, crushed, screened and processed to give the required physical and chemical properties.

This paper covers the batching and mixing process of concrete manufacture. The processes of batching and mixing of concrete or mortar materials are very similar to preparations of adishin

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cookeryasperarecipe where in various ingredients depending on their individual properties have to be mixed in correct proportions to give the required flavor and taste.

2.0 INFLUENCE OF BATCHING AND MIXING PROCESSED ON FRESH CONCRETE

The factors, which influence the quality of fresh concrete, are as follows:

CONSISTENT QUALITY OF RAW MATERIALS: Consistent quality of raw materials is very essential. Batching and mixing are more consistent if the raw materials with consistent specific gravity, fineness, grainsize, strength and other properties are used. Variation in grading and fineness can create variations in concrete quality as the water demand or work ability for the same proportions may increase ordecrease.

ACCURACY OF BATCHING (VOLUMETRIC / WEIGHMENT): Batching accuracy is also important. It is preferred to do weigh batching and not volumetric batching of cement and aggregates. However, if accurate weigh batchers are not available it is preferable to do proper volumetric batching. Bulkage correction for natural moists and is necessary in the case of volumetric batching.

ADEQUACY OF MIXING (MANUAL / MECHANICAL): Mixing is generally practiced manually in case of mortar and at times even for concrete. Manual mixing is not recommended until and unless trained skilled worker carries out the work in a systematic manner. Machine mixing is faster and more efficient than manual mixing .It is often observed that mixers used in our country are not properly designed to cater adequate mixing of concrete materials. Care should be taken that mixers available on site are capable of mixing the concrete ingredients.

MIXINGTIME: It is necessary to ensure that adequate time is given for proper mixing of concrete ingredients. However, mixing time may greatly depend on the work ability of concrete mix, type of mixer and its size or capacity.

BATCHING AND MIXING, EQUIPMENT AND METHODS: There are various types of batching and mixing equipment and methods that are to say from manual to most sophisticated computerized batching and mixing. Mechanization improves the quality of batching and mixing, its speed and there by can most often result in the economy. Manual batching and mixing is more prone to errors and showers in speed than mechanical arrangement. Volumetric batching if done with proper boxes(farmas) and filled up to the brimand level ledisquite accurate for batching aggregates.

PROPERTIES OF FRESH CONCRETE, WHICH MAINLY GET INFLUENCED BY BATCHING AND MIXING PROCESS WORK ABILITY OF CONCRETE: Workability of concrete can vary if aggregate and cement are not properly batched and mixed or if mixing water is not added in correct proportion.

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COHESIVENESS OF CONCRETE: Cohesiveness of mixal sovary if cement and fine aggregates are not properly batched or bulkage correction, while batching volumetrically, are not made. Excessive water addition can cause loss of cohesiveness in the mix, which can, in turn, create segregation problems. Loss of cohesiveness can also result in bleeding of concrete and shrinkage.

HOMOGENEITY OF CONCRETE: It is quite obvious that concrete ingredients if batched and mixed properly give a homogeneous mix which is essential so that the properties of concrete are uniform. A non-homogeneously mixed concrete can result in large strength variations, shrinkage, bleeding, segregation and various other defects, which will result in poor quality of concrete or mortar.

PROPERTIES OF HARDENED CONCRETE WHICH MAINLY GET INFLUENCED BY BATCHING AND MIXING PROCESS

- **STRENGTH:** Strength of concrete is mainly dependent on the strength of cement used and the quantum of water added to the mix. The increase in water cement ratio of the mix will resulting lower strength. The strength of concrete structures will also vary, depending on the non-uniformity of the concrete, which may have resulted due to inadequate mixing, segregation and or bleeding.
- **DURABILITY:** Improper proportioning of water in the mix or increase in water content due to erroneous proportioning of fine aggregates and cement can seriously cause durability problems. The increase in water cement ratio of the mix due to any reason can cause a serious reduction in durability of the concrete. Variation in cement quantity added to the mix from batch to batch can also cause durability problems if the cement quantity is added less than the desired mix proportions
- **SURFACE FINISH AND TEXTURE:** If due to batching error there is a deficiency of the fine aggregates and cement, the surface finish will be poor. If mixing is not adequate it will also lead to poor surface finish and variation of texture. If the mix is lean there is a likelihood of segregation, which will lead to poor finish due to honeycombing and ultimately durability problems.

3.0 BATCHING OF MATERIALS:

There are three modes of batching generally adopted forcement and aggregates. They are as follows:

1. Random volumetric batching with absolute no control on the size and shape of containers used resulting in large errors and variations. Cement is batched assuming each bag contains 50kg.

2. Proper volumetric batching of all ingredients, using measured boxes (farmas) and with control of filling them to brimand levelling. Sometimes cement is batched by volumetric measure or weighed.

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3. Proper weighing is done of all ingredients either using a weigh batcheror utilizing the weighing system on the batching mixing plant.

Batching of water should be generally carried out by using the measured container or by using water measuring meters or gauges. Random adding of water can cause great harm to concrete by way of strength variations and loss of durability.

Accuraciesrequiredformeasuringvarious materialsofconcretearerecommendedas follows:

Materials	Accuracyofmeasurements%of batchquantity Aggregates + 2 to3
cement	+1 to3
water	+1 to3
admixture	+3 to5

It is always preferable to weigh batch cement and aggregates separately. This is necessary because the weight of cement in a batch is small and critical in comparis on to that of the weight of combined fine and coarse aggregates. There is always some amount of moisture present in the aggregates, particularly in sand. Therefore, if cement and aggregates are batched in the same container some particles of cement and wetsand will stick to the sharp corners of the hoppers and eventually set thereby reducing the capacity of the hopper and also resulting in innocent weightiest.

3.1 VOLUMETRICBATCHING

For volumetric batching, it is convenient to make steel or wooden boxes of various sizes/ volumes. It is generally preferred to have boxes of various sizes readily available at the sites othatany adjustment, which is required to be made by way of change in mix design or due to bulkage of sand, can be done easily.

3.2 WEIGHBATCHING:

Weigh batching of aggregates is generally preferred. However, the locally available weight batchers do not function properly because of the poor metallurgy of their components like levers, knife-edge sand springs. Besides, maintenance and regular calibration are most often neglected at the site. Generally, the workers dump the head load of material into the weighing pans. This dumping causes an impact at regular intervals on the

- should be properly briefed about the danger of adding excess water in the mixer.

5.0 LOADING THE SKIP OR HOPPER OF THE MIXER:

5.1 The following sequence of loading the skip or hopper with dry materials is advantageous

a) Coarseaggregates

b) Fineaggregates

c) Cement

If there is a chance of cement being flown

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away due to strong wind, cement is loaded before the sand.

5.2 The following sequence of loading the skip or hopper, when

a) One-half quantity of coarse aggregates
b) Cement
c) Moistsand
d) Balance half quantity of coarse aggregates

This is to prevent choking of the skip mouth due to dampness in sand.

5.3 Smaller size mixers have no skip. Materials are therefore directly added into a drum in the following sequence:

a) Cement
b) Fineaggregates
c) Coarseaggregates

The coarse aggregates are added last as they help push in any cement or sand that may adhere to the mouth of the mixer.

6.0 ADDITION OF WATER:

Water is added in the drum separately after allowing of surface moisture present in the aggregate and absorption that may take place if aggregates are dry.

Water is required to chemically react with cement and to give work ability to concrete so that it can be placed and compacted to the desired shape. Generally, water required to be added for cement hydration is very less as compared to the water required for workability. Hence, the addition of water into the mix is mainly governed by the work ability required for concrete rather than forcement hydration.

However, water addition must be limited as far as possible. Water addition more than necessary can cause loss of strength hand durability problems. Top reduce concrete of uniform and consistent quality it is of prime importance that to tal water content should be the same for each batch through out the job.

There are several ways to control water addition in each batch. The eye judgement of an experienced mixer operator or the workability test give safairly good idea of whether or not the required quantity of water is added. However, on the modern batching plant the entire water addition and adjustment from batch to batch due to the use of moist aggregate is done automatically.

7.0 VARIETIES OFMIXERS:

Mixing Equipment can be generally classified into 4 types.

7.1 ROTATING NON-TILTINGTYPE

In this type of mixer ,the drum rotates around the horizontal axis. The drum is loaded by

Means of loaded skip/ hopper, which is pulled up or lowered by means of a wire rope and a pulley movement. The discharge chute at the other end unloads the mix when it is manually dropped to allow the mixed concrete to slide and drop. The non-tilting type mixers have generally higher capacities than tilting type mixers.

The interior of the drums is fitted with helical blade lifters, which scoop up the concrete material on the way up and drop it on the way down as the drum rotates.

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This causes intermixing of batch materials. There are basically two types of non-tilting mixers. One with achute, which rotates only in one direction, called the non-reversible type and the other reversing type mixer, which hast wosets of a blade in the drum. One set isused to mix the concrete when the direction of rotation is reversed.

7.2 ROTATING TILTINGMIXER

In this type of mixer, the drum is conical and revolves around an inclined axis. The mixing is generally carried out at a drum inclination of 20 to 30 degrees to the horizontal. It is either charged by means of a skip, which is lifted up by means of a wire rope, and pulley movement as stated above or by means of manual feeding directly into the mouth.
However, manual feeding is generally done for small capacity mixers. The tilting drum mixer is more suitable for every stiff work ability as the entire mix can be easily emptied or discharged by tilting the drum.

The interior of the drum is fitted with blades and baffel plates to act as scoops. The appropriate speed of drum rotation and internal alignment of blades/ baffel plates causes disruptive forces between the wall of the drum and its contents resulting in the concrete materials being intensively turned over and agitated. These types of mixers are good if the concrete mix is designed for medium or high workability. Their performance and efficiency reduce if mixes of lesser or stiffer work ability are to be mixed.

7.3 PANTYPE:

In this type of mixer, the drum is stationary or free running with blades rotating around the vertical axis. These mixers are very efficient as mixing process is faster and spraying of water on the mixis uniform and assists inefficient mixing. The mixer scan have much larger capacities than the types of mixers described above. The loading of these mixers is generally done in a similar manner as for drum mixers. The skip unloads the aggregate material from the top; cement is separately added through another hopper, which is loaded by as crew convey or or manually.

Water is added through the nozzle in let son the circumference of the pan. The mixing arms are centrally mounted. However, at times to tackle very stiff and difficult mixes it has one or more eccentrically mounted arms oranagitator, which also rotates as it revolves. The mixed material is unloaded from the sliding gate at the bottom of the mixer.

There are different types of pan available depending on their mechanical design. They are as follows:

1. Stationarypan
2. Free runningpan
3. Co-rotating power drivenpan
4. Counter rotatingpan

Generally, stationary pan with rotating mixing arms is in use at construction sites. In pan mixers, the mixing arms rotate in an anticlockwise direction and positive action of these elements upon the material to be mixed achieve efficient

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mixing. This action is further improved by scraping blades which force the material back into the mixing area.
The design feature in the counter-rotating pan is that it rotates clockwise, while the mixing elements rotate anticlockwise or performa transverse motion. The entire volume of the pan in the concrete gets mixed thoroughly achieving high mixing speed

7.4 THE PADDLETYPE:

The paddle mixers are yet another type of mixers which are available. The paddle mixers consist of cylindrical non-rotating open through in which materials are mixed by paddle rotating around the horizontal axis on one or two shafts. In a twin shaft paddle mixer, two shafts rotate in opposite directions. The high-intensity mixing takes place in the region of overlap of two sets of paddles. The paddles are mounted helically so as to produce 3-dimensional mixing movement of materials. The electric drive of the mixer shaft is spring mounted to improve trouble free mixing function. As compared to pan mixer the single shaft paddle mixer has compact advantageous inner dimensions. The helical inclination of the paddle gives an optimum mixing effect producing an intensive counter-flow mixing. The paddle mixers are found more suitable where dry mixes are required. However, they are generally suitable for all ranges of workability from stiff to very high.

8.0 BATCHING AND MIXING PLANTS:

The modern batching and mixing plants have revolutionized concrete production using microprocessor controls with the latest state-of-the-art technology. These plants have very high capacity of production, very great accuracy and can be handled by just a single operator. They are fully computerized and automatic, semi-automatic or can be even run in the manual mode of operation. The capacities of these plants range from 30Cu Mper hour to 200Cu Mper hour. These plants have sometimes two mixers, which can work simultaneously. The weigh batching is extremely accurate and sturdy not requiring repeated calibration. The moisture and water adjustments are automatically controlled depending on the work ability required.

These batching plants have different types of aggregate storage such as star pattern open bins; tall clover leaf silo, pocket silo or in line silo. The aggregate materials are fed into a weighing system automatically and loaded into the mixer. Cement is stored in bulk in a silo and is weighed separately in a different hopper. Cement is generally conveyed by as crew convey or from the silo to the weighing hopper and unloaded into the mixer separately. The correct quantity of water is added into the mixing drum directly. Water is sprayed uniformly on the concrete materials as they are being mixed.

The batching plant mixers have generally high discharges that the transit mixers can be loaded conveniently below them for transporting the concrete to the desired location.

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9.0 DISCHARGING OR UNLOADING A MIX

The entire content of the mixer drum should be emptied before recharging the drum with next batch. The drum must be emptied into a single hopper or container from which it can be picked up and transported either manually by gamelans or by wheel barrows.
Discharging the mix directly in gamelans or wheelbarrows may cause segregation.

The mix should not be dropped or discharged through a large height to avoid segregation. Generally, the discharge height is restricted, between 60 to 120cms for tilting, non-tilting and reversing drum type mixers and about 150cms for high discharge type mixers. The wet or highly workable mix has atendency to segregate; hence it is advisablet ore mix it with as hovel before filling up the wheel barrow or gamela.

The mix from the batching plant is generally discharged from a greater height into a transit mixer, which agitates the mix and helps the mix to get uniformly remixed in case it has segregated. If the mixer discharges into a long chute the concrete will segregate and lose finer materials. It is, therefore, necessary to prepare a mix, which has adequate cohesiveness and correct workability to slide down the chute with ease but without segregation.

10.0 CLOSING OPERATING:

Before the mechanical mixing operation is closed, it is very important to clean the drum and blades free from all adhering concrete materials before it hardens. It is generally advisable to add around three gamelas of coarse aggregate and around10 to15litres of water into the drum and allow it to rotate for a couple of minutes till all adhering material have come off. The contents are then discharged and the mixer drum is once again flushed with water.

There is always a tendency, of the workers, to leave as soon as concreting operations are over. The mixer operator must be made responsible for the closing operation. Leaving uncleaned unwashed mixer will result in loss of time prior to then extmixing operation. Chipping and banging damages the mixer body, destroy its efficiency and results in poor mixing. Uncleaned internal surface also reduces the mixer capacity due to building up of concrete/ mortar on the blades and the internal surface of the drum. It would be even advisable to brush and wash the mixer with soap water and then flush it with clean water.

11.0 PERFORMANCE OF AMIXER:

The performance of the mixer is judged basically from the consistency of the concrete from batch to batch as well as within the batch. While strength Clean and inspect for wear all moving parts at least once a day. Check and thighten all bolts, nuts, keys etc.

- Avoid overloading the equipment.
- Clean and inspect wire ropes atleast once a day. Worn out wire ropes must be replaced immediately.
- Check the blades; drum surfaces for worn out signs and leakage.
- The worn out blade and wear

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plates must be replaced in the case found to be unsuitable.

- The equipment should be free from caked cement by rubbing down the outside clean with an oily cloth.
- Water gauges must be checked for leakages and accuracy. Check and clean the clutch and brake
- Check the engine or powder loader and their control arrangement. Wash and clean the mixer after every concreting operation
- The rotating part of the mixer should be kept covered if the machine is not in operation for a few days. Sand and cement particles may accidentally fall on the mixer parts and cause damage.

Hitting or hammering the loading skip or mixer drum to remove the adhering materials is not to be allowed as it damages/dents the equipment, reduces its efficiency and shorten sits service life.

13.0 CONCLUSION:

Accuracy and precision of batching concrete and mortar materials and the uniformity of mixing are important requirements of good quality concrete production. The bigger the mixer and better the automation the better is the quality of mixing. The quality of concrete mixes is far superior if prepared by batching and mixing in microprocessor controlled batching plant to in small conventional mixers. The quality and speed of concrete production are much superior if manual control sand work force are avoided or reduced. Large dependence on labour deployment can cause quality and speed problems and can result in extra costs even though the first costs may appear to be lower.

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