IRC: SP: 96-2012

GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF CONCRETE BATCHING AND MIXING PLANTS

Computerised Inline Concrete Batching and Mixing Plant

INDIAN ROADS CONGRESS
2012

GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF CONCRETE BATCHING AND MIXING PLANTS

Published by :

INDIAN ROADS CONGRESS

Kama Koti, Marg,
Sector 6, R.K. Puram,
New Delhi - 110 022

MAY , 2012

Price ₹. 600/-
(Plus Packing & Postage)

IRC:SP:96-2012

First Published : May, 2012

Printed at : Aravali Printers Pvt. Ltd. W 29-30, Okhla Phase - II, New Delhi - 110 020
(500 Copies)

CONTENTS

PERSONNEL OF GENERAL SPECIFICATIONS & STANDARDS COMMITTEE (GSS)

(As on 23rd September, 2011)

1.	Indoria, R.P. (Convenor)	Director General (RD) & Spl. Secretary, Ministry of Road Transport & Highways, New Delhi
2.	Kandasamy, C. (Co-Convenor)	Addl. Director General, Ministry of Road Transport & Highways, New Delhi
3.	Kumar, Manoj (Member-Secretary)	Chief Engineer (R) (S&R), Ministry of Road Transport and Highways, New Delhi
	Members	
4.	Banchor, Anil	Head-Business Expansion, ACC Concrete Limited, Mumbai
5.	Bhasin, Col., A.K.	Senior Joint President, M/s Jaypee Ganga Infrast. Corp Ltd., Noida
6.	Bordoloi, A.C.	Chief Engineer (NH), Assam, Guwahati
7.	Chahal, H.S.	Vice Chancellor, Deenbandhu Chhoturam University of Science & Technology, Murthal, Sonepat
8.	Chakraborty, Prof, S.S.	Managing Director, Consulting Engg. Services (I) Pvt. Ltd., New Delhi
9.	Chandra, Ramesh	Chief Engineer (Rohini), Delhi Development Authority, Delhi
10.	Choudhury, Pinaki Roy	Managing Director, Lea Associates (SA) Pvt. Ltd., New Delhi
11.	Das, S.N.	Chief Engineer (Mech.), Ministry of Road Transport & Highways, New Delhi
12.	Datta, P.K	Executive Director, Consulting Engg. Services (I) Pvt. Ltd., New Delhi
13.	Dhodapkar, A.N.	Chief Engineer (Retd.), MoRTH, New Delhi
14.	Gupta, D.P.	DG(RD) & AS, MoRTH (Retd.), New Delhi
15.	Jain, Vishwas	Managing Director, Consulting Engineers Group Ltd., Jaipur
16.	Kumar, Ashok	Chief Engineer (Retd.), Ministry of Road Transport & Highways, New Delhi
17.	Kumar, Krishna	Chief Engineer, U.P. PWD, Lucknow
18.	Kumar, Shailendra	Engineer-in-Chief (NH), M.P.P.W.D., Bhopal
19.	Mahajan, Arun Kumar	Engineer-in-Chief, H.P. PWD, Shimla

20.	Marathe, D.G.	Chief Engineer, Nashik Public Works Region, Mumbai
21.	Narain, A.D.	DG (RD) & AS (Retd.), MoRTH
22.	Pradhan, B.C.	Chief Engineer, National Highways, Bhubaneshwar
23.	Rajoria, K.B.	Engineer-in-Chief (Retd.), Delhi PWD, New Delhi
24.	Ram, R.D.	Engineer in-Chief-cum-Addl. Comm.-cum-Spl. Secy., Rural Construction Deptt., Patna
25.	Ravindranath, V.	Chief Engineer (R&B) & Managing Director, APRDC, Hyderabad
26.	Roy, Dr., B.C.	Executive Director, Consulting Engg. Services (I) Pvt. Ltd., New Delhi
27.	Sharma, D.D.	Chairman, M/s D2S Infrastructure, New Delhi
28.	Sharma, N.K.	Secretary to the Govt. of Rajansthan, PWD, Jaipur
29.	Sharma, Rama Shankar	Past Secretary General, Indian Roads Congress, New Delhi.
30.	Shrivastava, Col., O.P.	Director (Design), E-in-C Branch, Kashmir House, New Delhi
31.	Singhal, K.B. Lal	E-in-C (Retd.), Haryana PWD, Panchkula (Haryana)
32.	Tamhankar,Dr., M.G.	Director-Grade Scientis (SERC-G) (Retd.), Navi Mumbai
33.	Tandon, Prof. Mahesh	Managing Director, Tandon Consultants Pvt. Ltd., New Delhi
34.	Tiwari, Dr. A.R.	Deputy Director General (WP), DGBR, New Delhi
35.	Tyagi, P.S.	Chief Engineer (Retd.), U.P. PWD, Ghaziabad
36.	Vala, H.D	Chief Engineer (R&B) Deptt., Govt. of Gujarat, Gandhinagar
37.	Verma, Maj. V.C.	Executive Director, Marketing, Oriental Structural Engrs. Pvt. Ltd., New Delhi

Corresponding Member

1.	Merani, N.V.	Principal Secretary (Retd.), Maharashtra PWD, Mumbai

Ex-officio Members

1.	President, IRC	(Yadav VSM, Dr. V.K), ADG, BRO, New Delhi
2.	Director General (RD)& Spl. Secretary	(Indoria, R.P.), Ministry of Road Transport & Highways, New Delhi
3.	Secretary General, IRC	(Indoria, R.P.), Indian Roads Congress, New Delhi

GUIDELINES FOR SELECTION, OPERATION AND MAINTENANCE OF CONCRETE BATCHING AND MIXING PLANTS

1 INTRODUCTION

1.1 There has been considerable growth in the construction of Concrete Roads over the last two decades. To create awareness among the various stakeholders like Consultants,Contractors, Planning and Construction Engineers about the technical details of various road construction machinery, a need to prepare document titled “Guidelines for Selection Operation and Maintenance of Concrete Batching & Mixing Plant” was realized. This document will help in the Selection, Operation and Maintenance of the plant.

1.2 The growing emphasis on mechanization in Road Construction projects in the country has made it necessary to create awareness among the various stakeholders like consultants, contractors, planning and construction engineers about the technical details of various road construction machinery. This document covers the details in respect of concrete batching and mixing plant. The pace of construction of rigid pavements has been on the rise because of its better performance with minimum maintenance. There is a demand for a higher volume of quality concrete in a shorter duration to execute mega projects. This has led to the introduction of Concrete Batching and Mixing plants to meet the requirements of the Road Construction Projects. A comprehensive document titled “Guidelines for Selection, Operation and Maintenance of Concrete Batching and Mixing Plants” has been prepared, which will be helpful in selecting the appropriate type of plant, better operation of the plant, reducing the down time and creating awareness about the maintenance aspects of the plant. It will also be helpful in production of quality concrete. It is hoped that this document will serve its intended purpose.

1.3 The base document was prepared by the Convenor, Mechanization Committee, (Shri S.N. Das) with the assistance of the officers of the Mechanical Zone of MoRTH. Thereafter, a subcommittee was constituted comprising of Shri Satender Kumar, Scientist (Retd.) CRRI to discusss the various issues relating to the preparation of the document. The meetings of the subcommittee were supervised by the connenor and regularly attended by Shri Satender Kumar, Scientist (Retd.) CRRI, Shri. S.V. Patwardhan from M/s Madhucon, Shri Kapil Kumar Jain from M/s Greaves Cotton, Shri Kalpesh Soni from M/s Conmat Systems, Shri K.C. Sharma EE (Mech) and Shri Jitendra Kumar EE (Mech) MoRT&H. The outcome of the sub-committee was reviewed by the Connenor along with the officers of the Mechanical Zone and the final draft document was prepared and circulated among the members of the Mechanization committee during its meeting on 03.08.2011 (Personnel given below):

Das, S.N.	-	Convenor
Verma, Maj. V.C.	-	Co-Convenor
Basu, Kaushik	-	Member-Secretary

Members

Balasubramanian, V.	-	Raj. Hans
Bharadwaj, R.S.	-	Raza, M.A.
Gyani, P.S.	-	Sachdev, V.K.
Jain, Rajesh Kumar	-	Saxena, R.K.
Kalita, N.K.	-	Shankar, P. Ravi
Kumar, Niwas Shree	-	Sharma, K.C.
Kumar, Sudhir	-	Sharma, M.P.
Lall, B.N.	-	Sharma, Rajesh
Paramanik, M.K.	-	Singh, Mahendra
Patwardhan, S.V.	-	Rep, IOCL

Ex-Officio Members

President, IRC	-	DG (RD), MoRTH & Secy. Gen., IRC
(Yadav, Dr., V.K.)	-	(Indoria, R.P.)

1.4 The finalized document was submitted to the General Specifications and Standards Committee (GSS) of IRC for their consideration. The document was approved by the General Specifications and Standards Committee (GSS) in its meeting held on 23.9.2011. The Executive Committee in its meeting held on 7th October, 2011 approved the document for placing before Council. The document was approved by the IRC Council in its meeting held on 03.11.2011 at Lucknow. The DG (RD) & SS requested the Convenor of the, Mechanization Committee & CE (Mech.) MoRT&H to incorporate the comments offered by the Council members. The comments have been incorporated and the document has been finalized for printing as one of the Special Publications of IRC.

1.5 The guidelines broadly covers the following areas:

1) Background
2) Purpose
3) Functions
4) Classification
5) Components
6) Operation
7) Maintenance
8) Quality control
9) Selection

2 BACKGROUND

2.1 In the past, wheel barrows were used to “batch” and load the concrete mixer. Tipping trucks were used to haul the fine and coarse aggregate to the work site and dump the material in piles along the roadside. With hand shovel, the workman was loading the material into wheel barrows: which also served as a volumetric measure to load the skip hoist with two-bags, in a stem-powered concrete mixer. Cement bage were loaded by hand into the skip hoist.

2.2 The next step was to reduce labour to achieve volumetric batching during early 1920s. Material was piled along roadside and workers used to hand-shovel them into the volumetric hoppers. A mobile (steel wheels) belt conveyor arrangement was devised with three-or four-wheeled volumetric hoppers. The pioneer plant manufacturers started to construct aggregate bins with batch gates and volumetric batchers.

2.3 Between 1925 and 1960 there were significant improvements in the fabrication of such plants. Prior to 1930, volumetric batching was used to proportion the material. This was replaced by weigh batching with a beam fitted with dial scales, being more accurate in proportioning the material. The first ready-mix plant was built in the 1930.

2.4 With the increase in paving capacity the demand of paving concrete also increased. Mostly stationary plants were designed and constructed for specific application, through modular concept approach. The plant was divided into three distinct modules: aggregate storage and batching, cement silos, and the mixer unit.

2.5 In India, the Concrete Plants were introduced in 1970's and their use was restricted to major construction projects. Bhakra Dam was the first project where RMC was used. Later on Concrete Plants were used for other large projects such as construction of long span bridges, industrial complexes etc. In 1993, first Concrete Batching and Mixing Plant was used for NH-2 Delhi-Mathura Road concrete pavement project of the Ministry of Road Transport and Highways.

2.6 Modern concrete plants employ computer aided control system to assist in fast, accurate measurement of input ingredients, as well as to synthesize the various parts and accessories for coordinated and safe operation. With the performance of concrete being dependent on accurate water measurement, systems will often use moisture probes to measure the amount of water that is part of the aggregate (sand and coarse aggregates) while it is being weighed, and then automatically compensate to account for in mix design for water target. The plant can be supplied for virtually any type of batching, whether wet, dry, and half-wet or slurry (colloidal).

3 PURPOSE

3.1 Infrastructure development has resulted in increase in the demand for quality concrete. The two main criteria determining the quality of concrete are its strength and durability. The process of achievement of strength and durability of concrete begins with its production. The ease with which quality control measures can be implemented at the production stage is not available in later stages of transportation and placement of concrete.

3.2 Ready-mix concrete is a type of concrete that is manufactured in a factory or in batching plant, according to a set recipe, and then delivered to the work site. A Concrete Batching and Mixing Plant, combines various ingredients like sand, water, aggregates, chemical and mineral admixtures (fly ash, plasticizer etc), and cement by weight to form concrete. Capacity of the plant is measured in cum per hour. It depends upon capacity of mixer, number of mixers, charging, mixing and discharge time of each mixer. The purpose of Concrete Batching and Mixing Plant is to produce homogenous and uniform concrete, as indicated by physical properties such as unit weight, slump, air content, and strength in individual batches and successive batches of the same mix proportions.

3.3 Functions of Concrete Batching and Mixing Plant:

Functions of the Plant are as under:

(i) To coat the surface of all the aggregates with cement paste, and to blend all the ingredients of the concrete into a uniform mass.

(ii) To mix homogenously the cement, water, coarse and fine aggregates, admixtures (if required) and fibers (when provided in mix design) and other material as per job mix formula in proportion as per pre-determined specification to make concrete cohesive and plastic which is easy to transport, place, compact, texture , finish and which will set, and harden, to give a strong and durable pavement.

(iii) To measure the cement, water, coarse, fine aggregates and admixtures within specified tolerance limits and to maintain the desired grading of aggregates.

(iv) To provide greater freedom in design.

(v) To achieve the production of concrete at a faster rate.

(vi) To provide concrete at any location

(vii) To maintain the quality of mix through monitoring various processes like mixing, batching, etc. and controlling the variations e.g. ingredients proportion, moisture, etc.

(viii) Cooling and heating of dry aggregates in the mix (before adding water), if required, to produce concrete within specified temperature limits.

(ix) View and print the report of concrete production, report of produced concrete, batch wise, recipe wise etc.

(x) To maintain batch wise, date wise data of the concrete produced in the on board computer.

4 CLASSIFICATION

The concrete Batching and Mixing Plant is classified based on the following criteria:

Mobility	**Batcher**	**Mixer**	**Control**
Stationary Mobile	Manual Semi Automatic Automatic	Free fall mixers - Tilting - Non Tilting - Reversible Power Mixers - Pan Mixer - Trough Mixer	Manual Computer & Programmable Logic Control (PLC)

4.1 Based on the Mobility the Plants are Classified as Under:

(a) Stationary Plant

(b) Mobile Concrete Plant

(a) Stationary Plants : Stationary plants are central mix plants. A central mix plant consist of batching facility and a mixer which completely mixes the concrete before discharging it into a dump truck, agitator truck, mixer truck, conveyor or some other means of transporting the concrete to the work site . Central-mix plant is sometimes referred to as wet batch plant. Principal advantages of the central-mix plants are as under:

- higher production capability
- better concrete quality control and consistency,
- reduced wear on the truck mixer drums.

Concrete material is batched into three groups. One group is the aggregate group, and another is the cementitious material group (like fly ash,). The material is either weighed individually or cumulatively. Water and admixtures comprise the third group. In many central mixing plants, the batching is done by computerized control system.

Fig. 1 Central Mix Concrete Plant

Transit mixers or truck mixers are used to transport concrete from the concrete batching and mixing plant to the work site.

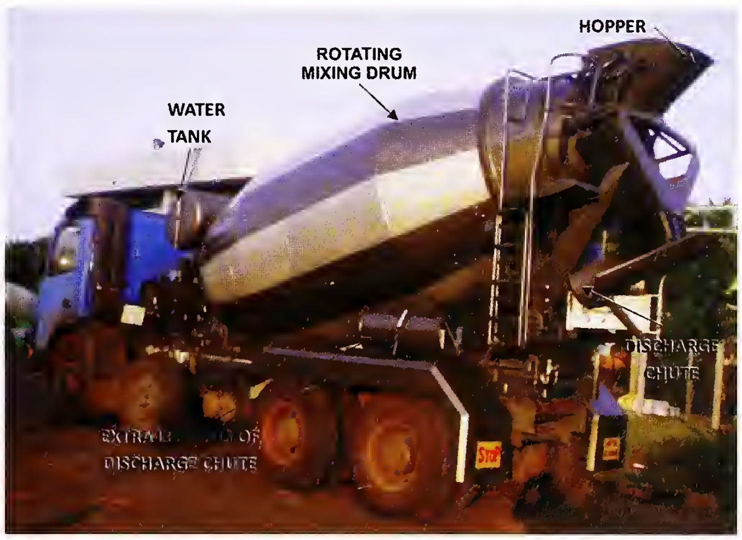
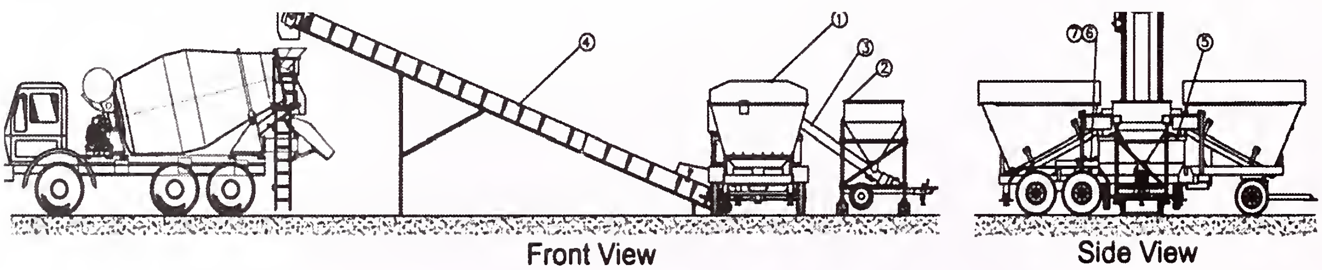


Fig. 2 Transit Mixer

Transit mixer has a revolving drum with the axis inclined to the horizontal. Inside the shell of the mixer drum are pair of blades or fins that wrap in a helical (spiral) configuration from the head to the opening of the drum. This configuration enables the concrete to mix when the drum spins in one direction and causes it to discharge when the direction of spin is reversed. The mixing drum can rotate at different rotational speeds: at the highest speed while being filled or emptied, at a lower speed during mixing and at the lowest speed during travel. For this reason a hydraulic drive is commonly used for rotation of the drum. After the concrete is loaded, it is normally hauled to the work site with the drum rotations at a speed in the range of 2 to 6 rpm.

The factor limiting the distance over which concrete mix can be transported by the Transit mixers is the setting time, determined mainly by the ambient temperature, temperature of the mix and the type of cement. Concrete should be delivered and discharged to maintain onsite quality control . For further details IS:4926: 2003 may be referred.

(b) **Mobile Concrete Batching and Mixing Plant:** The trailer-mounted mobile concrete batching and mixing plant carries cement, sand, and coarse aggregates in different bins. The cement is carried in a separate bin located across the rear of the unit, and the sand and aggregates are carried on each side of the unit. Water is carried in a single tank mounted in front of the aggregate bins and is pumped to the mix auger. Under the normal circumstances, concrete pump is used to pour concrete at the delivery site. However, if the delivery site is beyond the reach of the concrete pump, concrete is transferred to the site in a transit mixer. Concrete is poured in a Transit mixer with the help of a concrete conveyor. Sand and aggregates are accurately proportioned by weight or volume and dropped one after the other with cement from the material feed system into the charging end of the mix auger/conveyor at the rear of the unit. At this point, a pre-determined amount of water enters the mix auger. The action of this combined auger and paddle homogenizer mixes the ingredients and water rapidly, thoroughly, and continuously to produce the concrete of uniform quality. The material mixing action is a continuous process that can proceed until the aggregate bins are empty. On the other hand, mixing and delivery may be stopped at any time and then started again as per requirement . These are often used for pouring sideways and other applications where concrete is needed in multiple areas for small works.



1. Aggregate Hopper 2. Cement Hopper 3. Cement Screw Conveyer 4. Concrete Belt Conveyer 5. Mixing Unit 6. Water Weighing System

Fig. 3 Mobile Concrete Batching and Mixing Plant

Salient features of Mobile Concrete Batching and Mixing Plant are as mentioned below:

- Fast dismantling, shifting and commissioning at another location.

- State of the art control system designed for in house concrete production.
- Discharging of concrete directly into pump hopper.
- Less load helps keeping the electricity costs lower.
- Very low operation and maintenance costs.

Limitations of Mobile Concrete Batching and Mixing Plant:

1. Capacity of mobile concrete batching plant is low.
2. Low discharge height and it is difficult to pour directly into transit mixer. It can be done by the use of concrete conveyer.
3. Storage capacity of aggregate is limited
4. Wastage of Aggregate due to frequent shifting of the plant.

4.2 Classification Based on Type of Batcher:

Batching controls are the part of the batching equipment that provides means for operating the batching device for an individual material. They may be mechanical, hydraulic, pneumatic, electrical, etc. or a combination of these means. A batching system is a combination of batching devices and batching controls necessary for the accurate and consistent batching of concrete ingredients in the desired proportions. Normally a batching system would include batching devices and controls for cementitious material, aggregates, water and admixtures. Some may not include admixture if they are not used at the plant or may not have batching equipment for water if it is entirely batched through the truck mixer water system.

Weigh Batcher Controls : Cementitious material and aggregates must be batched by weight; water and admixtures may be batched in a weigh batcher or by volume measured by a flow meter.

(a) Manual Control : Manual weigh-batcher control exists when the batching devices are actuated manually. The accuracy of the batching operation is dependent on the operator's observation of the scale.

(b) Semi-Automatic : In semi automatic plant except weighment of the Aggregate, water, cement and admixtures, all other operations are controlled manually. By using digital display meters, load cells, junction box, pneumatic controlled gates, the weighing of the concrete ingredients are done automatically and rest i.e. starting up the motors, controlling the mixing time, discharging the concrete into truck or transit mixers are done manually.

The semi-automatic controls are further classified into the following two types.

(i) **Semi-Automatic Control :** When actuated by one or more starting mechanisms, a semi-automatic weigh-batcher control shall start the weighing operation of the material and stop the flow automatically when the designated weight has been reached. No interlocks are required.

(ii) **Semi-Automatic Interlocked Control :** When actuated by one or more starting mechanisms, a semi-automatic interlocked weigh-batcher control shall start the weighing operation of the material and stop the flow automatically when the designated weight has been reached. It shall be interlocked to assure that the discharge mechanism cannot be opened until the weight is within the tolerance limit.

(c) **Automatic Control :** When actuated by a single starting signal, an automatic weigh-batcher control shall start the weighing operation of cementitious material, aggregate, water, or admixture, and stop the flow automatically when the designated weight/volume has been reached. It will also do all the operations like starting of all the motors at right time, mixing and discharging of concrete etc. automatically. It shall be interlocked to ensure that:

(i) the charging gate or valve cannot be opened until the scale has returned to zero balance within -0.3 per cent of scale capacity.

(ii) the charging gate or valve cannot be opened if the discharge mechanism is open.

(iii) the discharge mechanism cannot be actuated if the charging gate or valve is open; and

(iv) the discharge mechanism cannot be actuated until the weight of material is within the tolerance limit.

Automatic control provides greater accuracy for High speed production than any of the above type of weigh batcher controls.

Volumetric Batching Controls for water and admixture : This pertains to the controls used for measurement of admixtures in a volumetric admixture dispenser or the measurement of water with a water meter or a volumetric batcher tank.

(i) **Manual Control :** Manual volumetric control for water or admixture exists when the volumetric measuring device is actuated manually with the accuracy of the measuring operation being dependent on the operator's visual observation of a volumetric indicator (such as a digital meter display or a sight gauge) and manual cut-off of the flow at the desired volume. The flow of liquid may be controlled manually, or by pneumatic, hydraulic, or electrical power.

(ii) **Automatic Control :** When actuated by a single starting signal, an automatic volumetric control shall start the measuring operation and stop the flow automatically when the designated volume has been reached.

4.3. Classification Based on type of Mixer:

Based on mixing technique mixers are classified as (a) Drum mixer or free fall mixers or gravity mixers (b) power mixers. The size of mixer is measured by volume. Manufacturers commonly categorize mixers by nominal volume or drum size rather than by the "total volume" or the "dry charge". The nominal volume is the maximum batch capacity, the output of mixer. The total volume of the dry charge is the maximum volume of unmixed ingredients which the drum can hold. Maximum batch capacity is commonly two-thirds of total drum volume.

(a) Drum Mixer :

This is also called as free fall mixer or gratify mixer. In this type of mixer, concrete is mixed by lifting the ingredients with the help of fixed blades inside a rotating drum and then dropping the material by overcoming the friction between the mixture and the blades. The drum of the mixer can be filled and emptied by changing its direction of rotation, opening it, or tipping it up. Rotation speed must carefully follow machine-specific instructions and should not be too fast so that the free fall of the mixture is not interrupted by the centrifugal force. The drum mixer suits concretes that are not too stiff, usually with a slump, upto 50 mm is commonly used on construction sites. Truck mixers also use freefall mixing. Since the ingredients in a free fall mixer fall from height, there is some attrition of aggregates.

This type of mixer is used for producing large volume of concrete. These mixers are noted for having high production speeds, low maintenance, and ideal for slump concrete.

This drum mixer is available in the following three forms:- (i) tilting mixers (ii) reversible mixers (iii) non - tilting mixers

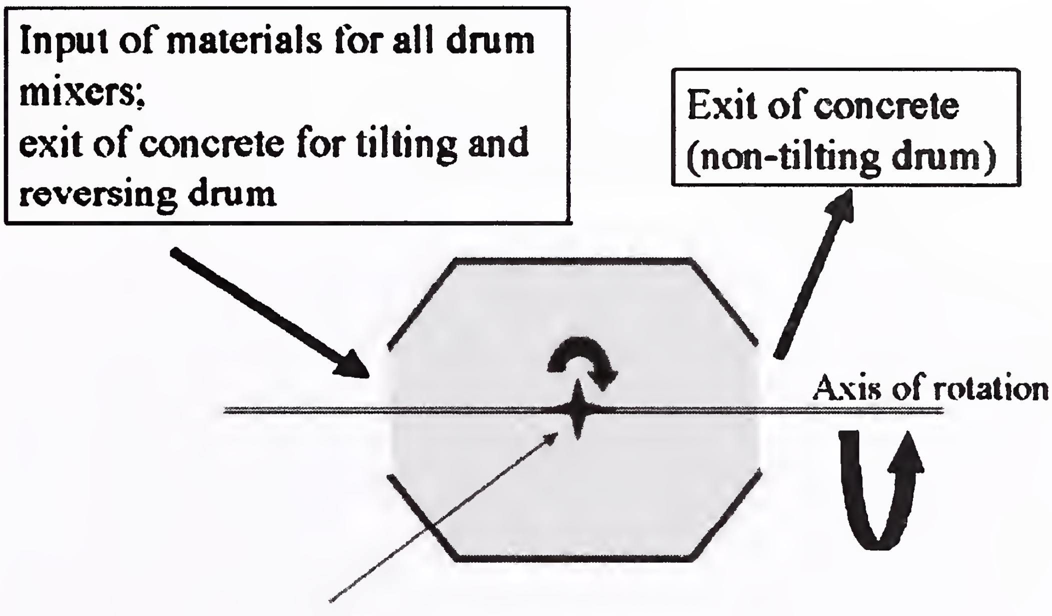


Fig. 4 Cross Section of Freefall Mixers

(i) Tilting Mixers:

Tilting mixers are usually trailer-mounted or otherwise portable, small to mid-size mixers, used either as main concrete mixing equipment on small sites or as ancillary equipment on sites served by concrete plant. The drum has two axes: one around which the drum rotates and another that serves to change from loading and mixing position (drum opening up) to discharging position (drum opening down). This position change is done manually by a dump wheel (or handle, in the smaller mixers), while drum rotation is electric, gasoline, or diesel powered. Drums are traditionally made of steel, but polyethylene drums for easier cleaning are now offered. Most mixers are of the side-dump type, but end-dump mixers are also manufactured. Material is generally loaded manually, directly into the drum. There are larger-size self-loading units equipped with a tilting hopper. After being filled manually at ground level, the hopper is tilted up mechanically and dumps the material into the drum. A built-in mechanical drag shovel to facilitate aggregate loading into the hopper is optional in some models.

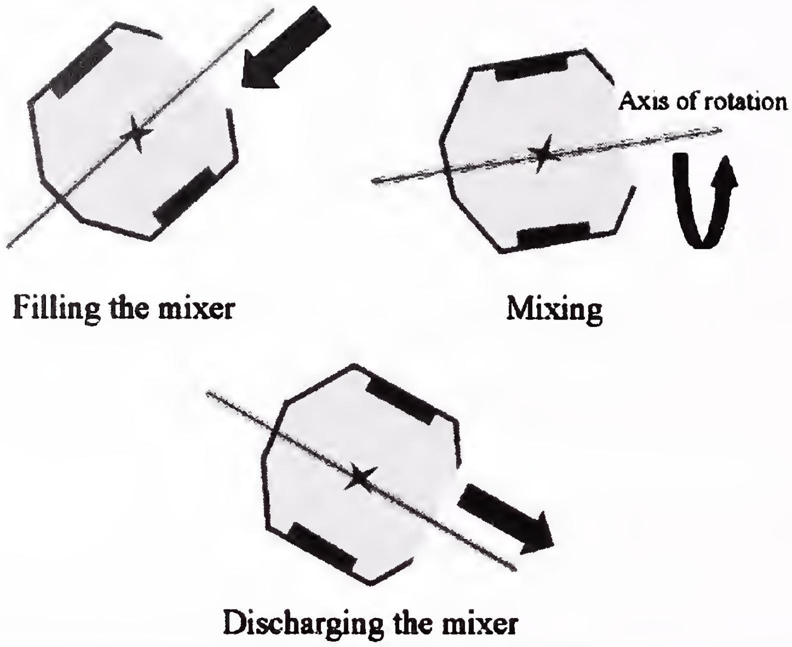


Fig. 5 Cross Section of Tilting Mixer

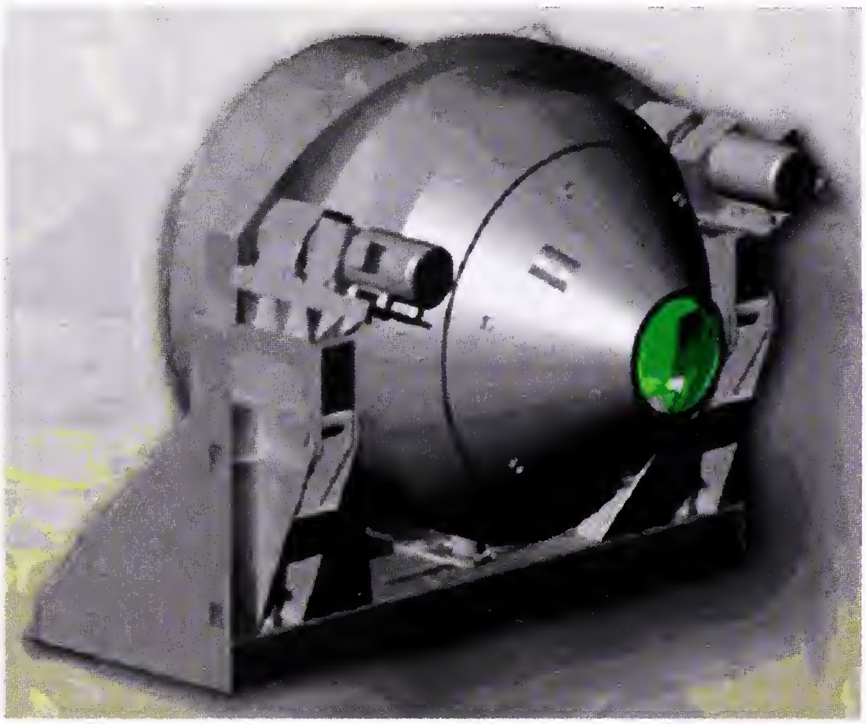


Fig. 6 Tilting Mixer

The drum is conical or bowl shaped with internal vanes and the discharge is rapid and unsegregated so that these mixers are suitable for mixes of low workability and for those containing larger size aggregate. The drum axis usually stays at an angle of 15 degree from horizontal during mixing. Tilt mixer offers consistent mixing with lower operating and maintenance cost. Tilting drum is the most common type of drum mixers for small batches. Tilting mixers can handle larger size aggregates more easily and will discharge mixed concrete rapidly than a non tilting mixer.

(ii) Reversible Mixers:

The reversible drum mixer is similar to the non tilting mixer except that the same opening is used to add the constituents and to discharge the aggregate. The drum on a reversible mixer has one horizontal axis around which it rotates. In mixing position, the drum rotates in one direction; while for discharging, the rotation is reversed. Commonly self-loading, reversible mixers are mid-size to large-size units mounted on a two-or four–wheeled trailer for transportation between sites. The mixer is equipped with a tilting hopper similar to that occasionally found on a tilting mixer, or with a hoist-like hopper that moves up and down on a short inclined set of rails and that dumps the ingredients through a bottom opening into the drum. A built-in mechanical skip to facilitate aggregate loading into the hopper is optional on many models. Most models of this mixer type are equipped with a water tank and meter, and optionally (the larger models) with a built-in aggregates batcher.

(iii) Non-tilting mixers

A non tilting drum mixer is one in which the axis of the mixer is always horizontal, and discharge takes place by inserting a chute into the drum or by reversing the direction of rotation of drum. Because of slow rate of discharge, some segregation may occur. There are two openings, one at each end of the drum: one for feeding the ingredients, the other for discharging the mixture.

Fig. 7 Non-Tilting Drum Mixers

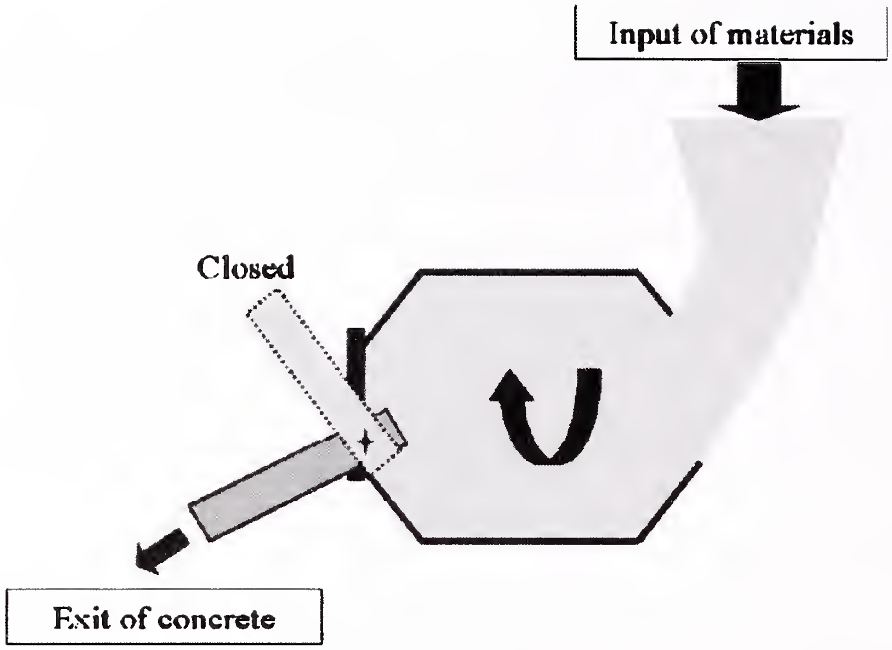


Fig. 8 Cross Section of Non Tilting Mixer

(b) Power Mixers: Power mixers, also known as forced mixers, or compulsory mixers, mix concrete by rapid rotary motion of paddles (or mixer heads) moving in centric or eccentric courses inside the mixing drum. To prevent the concrete from sticking to the drum sides and bottom, some of the paddles must constantly clean the concrete off the sides and bottom and redirect it to the drum center. The intensive mixing also causes excessive wear to drum surface, which is not present in free fall mixers. To prevent this wear, the inside of the drum is lined with small, easily replaceable plates that are made of specialized abrasion resistant material. The mixing output of power mixer is higher than free fall mixers. Power mixers can also handle extra dry mixtures unmanageable by free fall mixers. They have either one or two mixing shafts that impart significantly higher horsepower in mixing than the typical drum mixer. The intensity of the mixing action is somewhat greater than that of the tilt drum mixer. There is also no danger of attrition as the ingredients are not made to fall from gravity. The softer aggregates can also be used.

Power Mixers are classified as follows:

(i) Vertical Shaft Mixers or Pan Mixers
(ii) Horizontal Shaft Mixers or Trough Mixers

(i) Vertical Shaft Mixers or Pan Mixers:

A pan mixer is a forced–action mixer. It consists of a cylindrical or annular pan (fixed or rotating) shaped drum contains the concrete to be mixed, while the blades rotate inside the pan around vertical axis to mix the material and a blade suspended with the inner wall of the pan scrapes the wall of the pan. The shapes of the blades and axis of rotation vary. Pan mixers are available in six types e.g., turbo concrete mixers, planetary concrete mixers, turbo planetary concrete mixers, countercurrent operation concrete mixers, concurrent operation concrete mixers, and concrete mixers with high speed stirrer. These days, the first three types of concrete mixers i.e. turbo concrete mixers, planetary concrete mixers, turbo planetary concrete mixers are commonly used.

(a) Turbo Concrete Mixers: In turbo mixers the vertical shaft is fixed and located in the centre of the drum. There are models in which (1) the drum is stationary while all paddles rotate, in the same direction, (2) the drum is stationary but paddles rotate in counter directions, (3) both drum and paddles rotate in counter direction. The turbo mixers upto 60 cum per hr. capacity are available with the manufacturers. It can handle upto 40 mm aggregate. Turbo Mixers are suitable for ready mix concrete and Pre-cast products performing better on wet mixes. They are easily discharged and can be used for coloured mixes. They are simple mechanically and they need less maintenance.

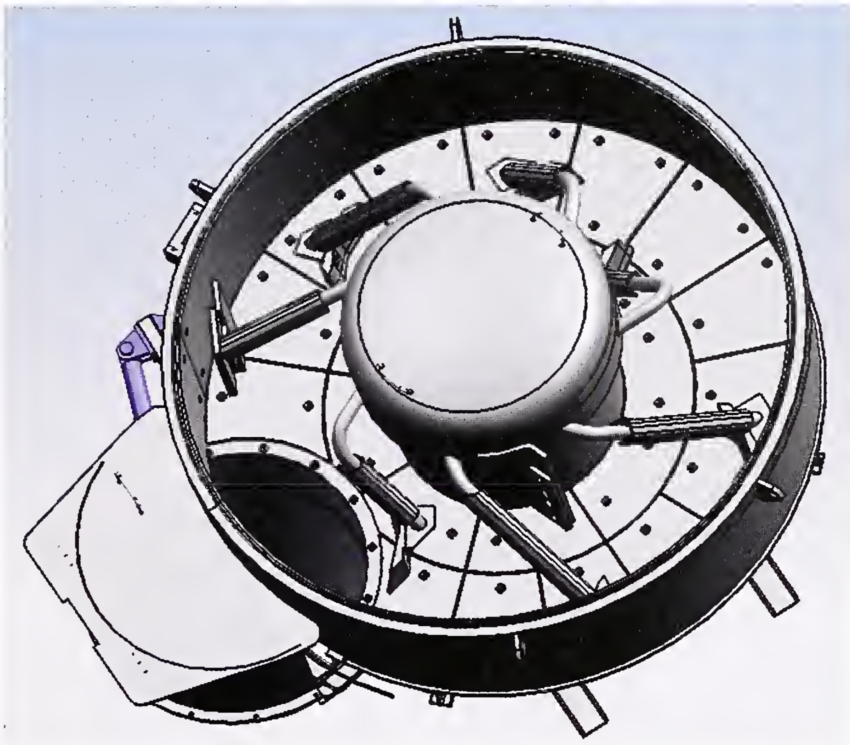


Fig. 9 Turbo Mixer

(b) Planetary Concrete Mixers: In planetary mixers, the vertical shaft is rotary and located eccentrically in the stationary drum. Due to this the intensity of mixing is increased. Planetary mixers are generally used to mix material in a fast manner and utilize the multiple discharge gates to serve multiple production lines. The planetary mixer has one or two mixing stars that rotate themselves while also rotating around a central point, allowing each arm to cover the whole mixer floor in a number of revolutions. This powerful mixing action is both fast and thorough, resulting in lowering of the mixing time. The result is more production of concrete per hour for the same size plant, as well as better consistency and greater strength or, saving on cement. These are used for precast concrete and dry mixes, self compacting concrete, coloured concrete mixes, specially high strength, wet and dry mortar. This mixer is efficient in handling stiff and cohesive mixes. Planetary Mixer is the best choice for Pre-cast products and dry mixes. They are designed for high speed homogenization. Cleaning towards the end of the shift is easy. Due to their low height they are also used in mobile Ready Mix plants. They need medium maintenance but they require proper blade adjustment. The planetary mixers upto 30 cum per hr capacities are available with the manufacturers. It can handle upto 40 mm size aggregate.

Fig. 10 Planetary Mixer

Comparison between Turbo and Planetary type Pan Mixer:

S. No.	Description	Turbo	Planetary
1.	Mixing	Good	Better than turbo
2.	Wear & Tear	Lower	Higher
3.	Aggregate size	Large size aggregate may be used	Large size aggregate may not be used
4.	Capacity	Higher	Lower
5.	Cost	Lower	Higher
6.	Type of mixes	More suitable for wet mixes	More suitable for dry mixes

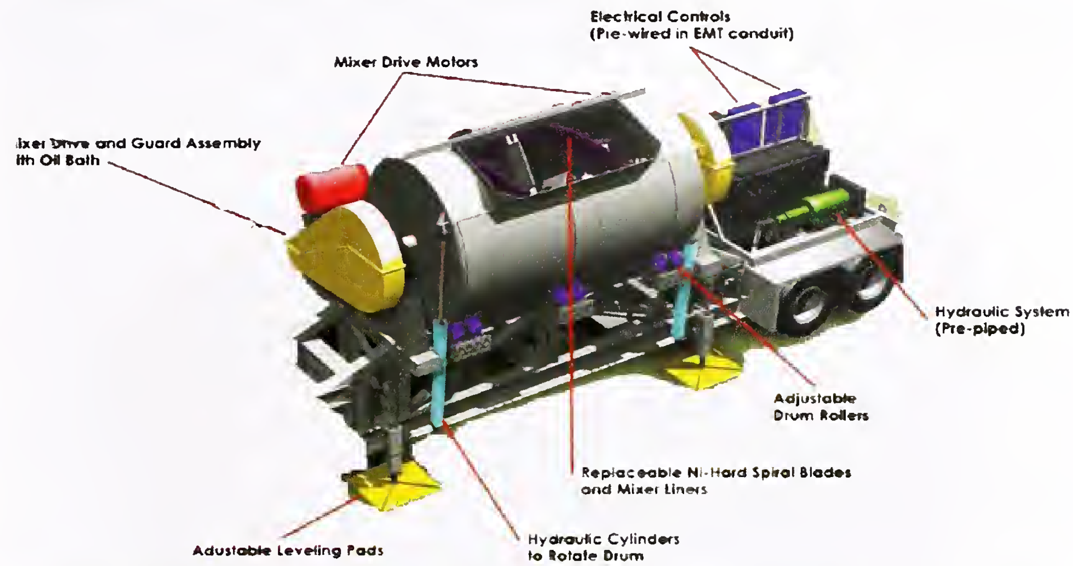
(ii) Horizontal Shaft Mixers

Horizontal Shaft Mixers are also known as Trough mixers. Horizontal shaft mixers are of two types.

(a) Single Shaft Mixer

(b) Twin Shaft Mixer

(a) Single Shaft Mixer: This is a power mixer which has a trough-shaped drum (i.e. resembling a horizontally placed barrel cut by half). The single shaft mixer has horizontal shaft onto which the paddles are connected in a spiral-like arrangement; in some models, wave shaped mixing arms replace the paddles. The combination of radial (rotary) and axial (horizontal) movements obtained produces a three dimensional circular path that further increases mixing intensity and therefore results in short mixing time. Some single shaft mixer models are used in central mixing plants as climbing mixers; the drum moves up on an inclined track in the course of mixing, and discharge is accompanied by tilting the drum at the top of the truck.



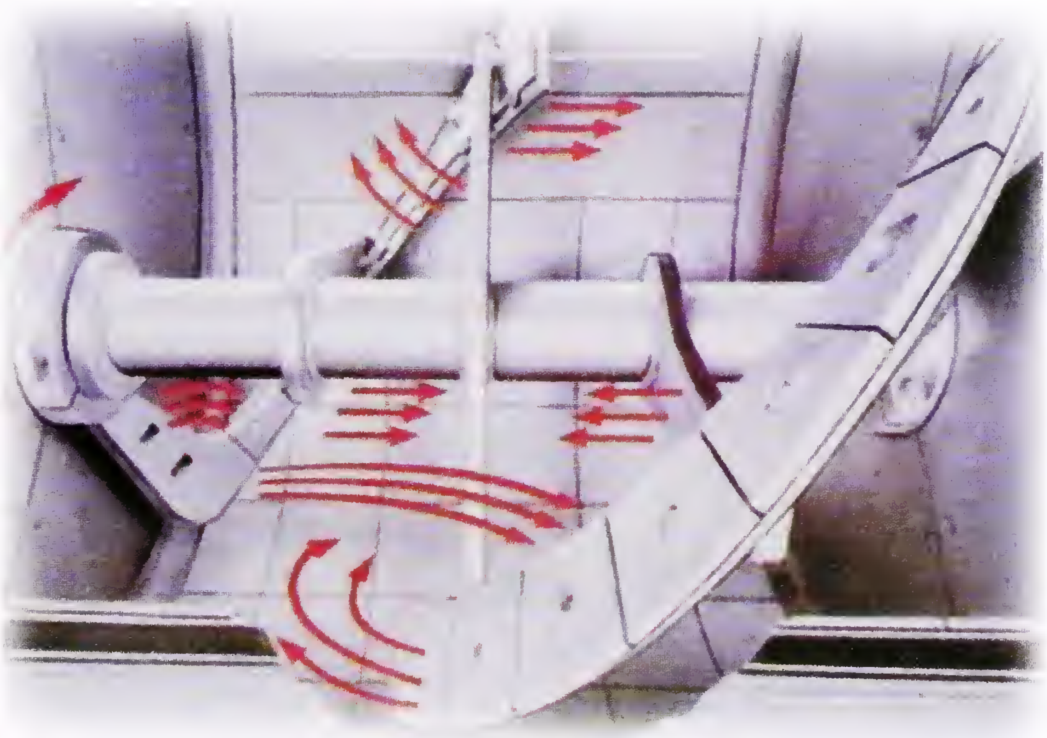


Fig. 11 Blade View Horizontal Shaft Mixer

(b) **Twin Shaft Mixer:** A twin shaft mixer has two parallel horizontal shafts with end scrappers. The mixing technique is similar to single shaft mixer, but due to high degree of turbulence developed in the intersection zone of the two mixing circles, better mixture homogeneity is effectively achieved with minimum mixing time. Additionally, due to the design of the twin shaft mixer and build up of the mix between the shafts, wear is considerably reduced as compared to single shaft horizontal mixer and pan type mixer. Because the mixing occurs in free space above the mixer floor, the wear on the liner plates are very low. Only thirty percent of the tiles or liners are subjected to wear. Hence maintenance cost is low.

The powerful twin-shaft mixer, with counter rotating shafts, delivers fast and homogeneous mixing action, and rapid, complete discharge and handles mix designs with coarse aggregates

Fig. 12(i) Twin Shaft Blades and Shaft

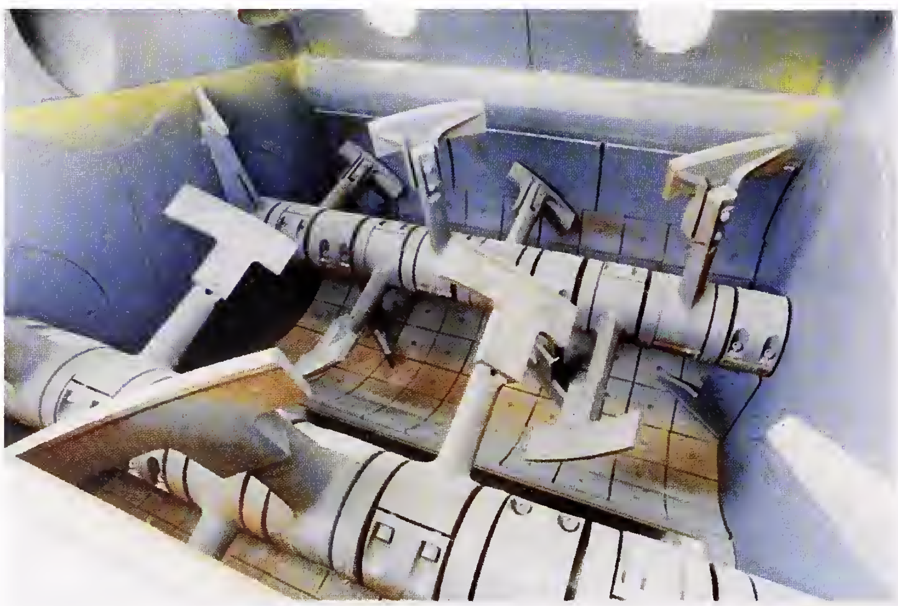


Fig. 12(ii) Twin Shaft Blades and Shaft

may be upto 150 mm size. Twin shaft mixers are used for production of large quantities of concrete in a very short time period. They are also commonly used for mixing high strength concrete. Twin shaft mixers upto 240 cum per hr. are available.

Advantage of Twin Shaft Mixer:

- Suitable for Mass production.
- Capacity varies from 1 to 8 cubic meter per batch.
- Optimum filling level due to exceptionally large mixing area.
- Uniform distribution of fine and coarse aggregates and water.
- Fast homogenization, uniform quality of mix, faster discharge without segregation.
- Low wear and maintenance.
- Suitable for mixing of large grain size aggregates.

Limitations of Twin Shaft Mixers:

Twin shaft mixers require more time for cleaning at the end of the shift compared to other mixer types.

- Twin shaft mixer does not empty completely during batches and thus is not recommended for several colour mix.
- Twin shaft mixers are not recommended for dry mix or waterless mixtures. (In such a case, planetary (vertical shaft) mixers are suggested.

Comparison Between Horizontal and Vertical Shaft Mixer

S. No.	Description	Vertical Shaft Mixer	Horizontal Shaft Mixer
1.	Mixing Intensity	Lower	Higher
2.	Mixing Time	Longer	Shorter
3.	Capacity	Lower	Higher
4.	Wear & Tear	Higher	Lower
5.	Grain size	Larger grain size may not be used	Larger grain size may be used
6.	Discharge Height	High	Short
7.	Cost	Lower	Higher

4.4 Types of Controls:

The following two types of controls are available in concrete Batching & Mixing Plant

(a) Manual control
(b) Computer and Programmable Logic Control (PLC)

a) **Manual Control:** It allows to control all actuators of the concrete-mixing plant by hand. Manual control systems are those systems in which all the activities are manually controlled. Its use is anticipated only for emergencies, when the computer and PLC control is out of order. In such systems, the collection of material is flow based.

b) **Computer and PLC (Programmable Logic Control) Control:** The concrete batching and mixing plant fitted with PLC facilitates the complete control and interlocks for operating the system in auto mode. It improves the productivity of the plant to a great extent and provides a foolproof method of producing the right mix. It can be operated by even a semi-skilled operator, and at the same time, avoids any chance of wrong doings by interlocks. The supervision of operations is done by the Programmable Logic Control (PLC) and the control, operator interface and report generation is done by the computer.

The batch control unit of the system ensures only the exact set quantity of the ingredients is fed into the process, first time and each time. The PLC assures the quality of the mix and at the same time avoids the wastage of the raw material. This system automatically re-feeds the aggregates if there is shortage of weight, warns if there is overweight.

Fig. 13 Computer System Integrated with Batching Plant

Fig. 14 Control Panel with Weighing Indicators

The instantaneous weight in the weigh hoppers are displayed on the batch controllers and the annunciations on the computer gives working condition of each equipment at any given point of time. Any malfunction or fault in the operation can be identified from the custom engineered computer screen, which makes the rectification quick and easy. The various sensors and limit switches provides the necessary feedback signal to the PLC. The PLC is again connected to the computer and the supervisory control and data acquisition (SCADA) software controls the functioning. The SCADA package makes the PLC flexible and user friendly. The annunciations like operating conditions; fault indications etc. can be very easily displayed on the computer screen with the help of SCADA. The software makes the data storage and printout very flexible and easy. The live weight of the ingredient in the weigh hoppers are continuously upgraded on the computer along with the operating status of equipments.

The recipes can be entered from the computer. The history of all the batches is stored, and is available for printout. The daily, monthly and yearly report are available for print.

The automation of Concrete Batching and Mixing Plant comprises of the load cells, batch controllers, PLC with SCADA package and software, control desk. The main function of this equipment is to produce the right grade mix in the fastest possible time. The Concrete Batching and Mixing Plant comprises of storage bunker for various raw material, aggregate weigh hopper, skip hoist, cement weigh hopper, storage silos and feeding screw conveyors, weigh tanks and storage tanks for water and admix along with feeding and discharge devices, mixer etc. The raw material like aggregate, sand dust, cement, water and admixure are initially loaded into the storage hoppers. The material from storage bunkers for the aggregate, sand and dust are extracted through sector gates. The extracted material is collected at a weigh hopper below as per the preset recipe, before discharging into the skip hoist. The skip hoist delivers material to the mixer. From the storage into silo, the cement is extracted to the cement weigh hopper through the screw conveyor depending on the recipe value. Similarly, the required quantity of water and admix also are collected separately at the weigh hoppers. These weighed raw material is then discharged into the mixer as per the preset sequence. The operations like the mixing time and sequence of operations are controlled by the PLC.

The quantity of material to be fed from each hopper is set prior to the operation. The setting can be done as recipe on the computer. The required recipe for the mix can be selected from the memory or new values can be entered in the blank recipe format. The load indicator units on the control desk sends the weight data continuously to the PLC in the form of 4-20 mA and the PLC controls the feeding gates and screw conveyor at the bottom of the storage hoppers. Once the correct weight quantity is achieved, the weigh hoppers discharge sequentially into the mixer. The mixer is run for a certain preset period of time and then empties the material into the truck.

The load cells are mounted on support frame, which in turn is bolted to the weigh hoppers. There are at least four weigh hoppers in the system one each for aggregates, cement, water and admix.

Fig. 15 Automatic Concrete Batching and Mixing Plant

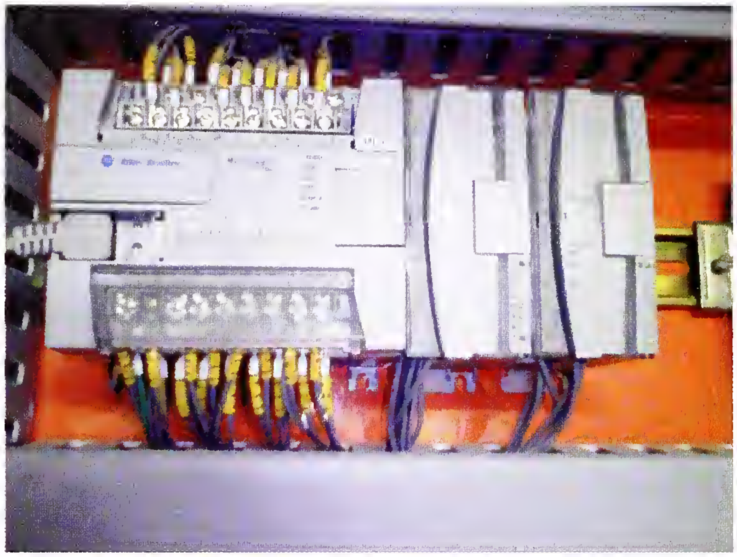


Fig. 16 Programmable Logic Controller

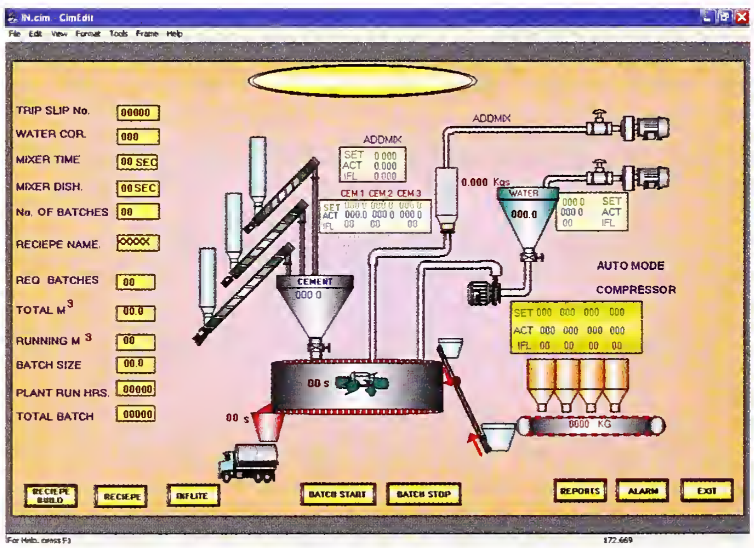


Fig. 17 Human Interface Screen - Supervisory Control and Data Acquisition (SCADA)

The aggregate weigh conveyor is mounted on load cells, whereas the cement and water weigh hoppers are also supported on load cells and admix on single load cell. These load cells are having parallel termination onto a junction box. From each junction box, a single four Core shielded cable connects to the corresponding load indicator on the control panel. There are four load indicators in the control panel corresponding to four weigh hoppers. The load cells give milli volt (mV) signal corresponding to the load applied. These signals are amplified at the load indicator converted to digital, processed and then displayed as weight data. The weight data is transferred to the PLC and as per the recipe settings, the relays are energised. These control relays in turn operate the field devices viz. pneumatically operated gates, screw conveyor and ball valves. Limit switch inputs are used for various inter-locks to make the system fool proof. Additional controls and data regarding batch time, date, individual raw material weight etc., is provided at the computer.

The PC, PLC System and weighing/flow controllers ties together plant administration, production, material ordering, consumption monitoring, process supervision, costing, and maintenance into a single efficient control solution. With the introduction of Programme Logical Controller, it has become possible to route each signal from and to “the process” directly in accordance with a standard scheme and to input all the logical programme in the memory of the device. PLC devices are almost invariably multifunctional micro processors, each optimized for a particular function such as sequential control, measuring, monitoring, indicating, signaling etc.

5 COMPONENTS OF CONCRETE BATCHING AND MIXING PLANTS

5.1 Storage Equipments:

The storage equipment consists of aggregate storage, cement storage, water storage and admixture storage.

Aggregates Storage:

Aggregates storage components should be of adequate size to accommodate the productive capacity of the plant. Storage bins shall be provided for different sizes of fine and coarse aggregates. Sand bin should be equipped with vibrator for free flow of sand.

The aggregate bins should be designed so that material can not hang up in the bins or spill from one compartment to the other. Graded aggregate shall be provided in the bins.

There are three types of aggregate storage systems

(a) Star Type
(b) Mushroom Type
(c) Inline Bin Type

(a) Star Type: In Star type aggregate storage system, five walls are fabricated at site. The star batchers are attached to the backside of the batching plant in which, various sizes of aggregates are stored with partitions . Drag line with a rotating boom cabin is provided to accumulate the aggregates towards the pouring point.

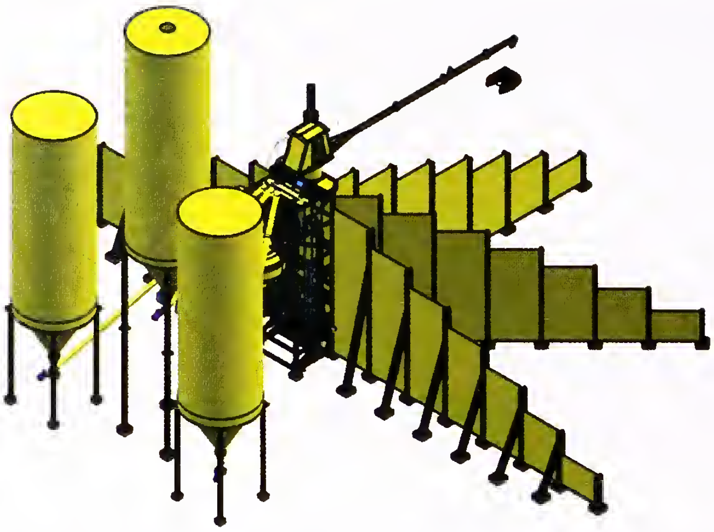


Fig. 18 Star Type Storage Batching Plant

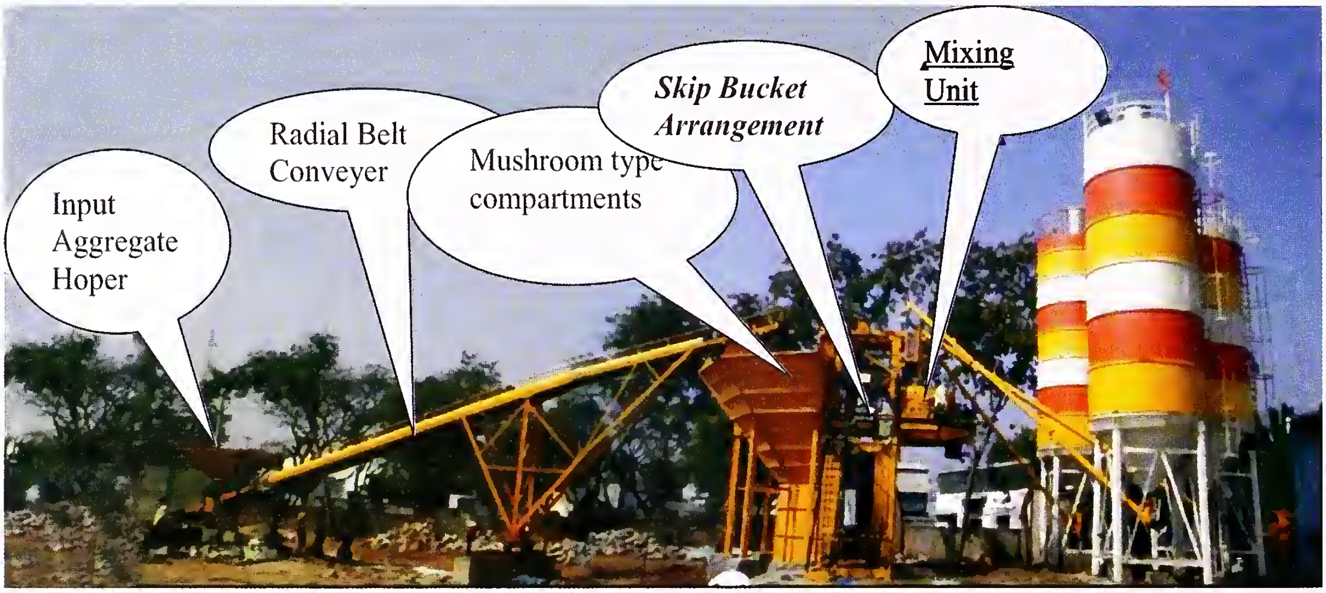


Fig. 19 Mushroom Type Storage Batching Plant

(b) Mushroom Type: In mushroom type aggregate storage system, four bins are attached to the back side of the batching plant which is used to store the various types of aggregates. To feed the aggregates two methods are used:

(i) Using wheel loader with Ramp
(ii) Using belt Conveyor.

(c) Inline Bin Type: In the inline bin type, four pre-fabricated bins are assembled one behind the other on the back side of the batching plant as a separate unit.

To feed the aggregate, two methods are used. One is using wheel loader with ramp. Another method is using belt conveyor.

In this type, Belt conveyor is used to send the aggregates from bin to Skip bucket.

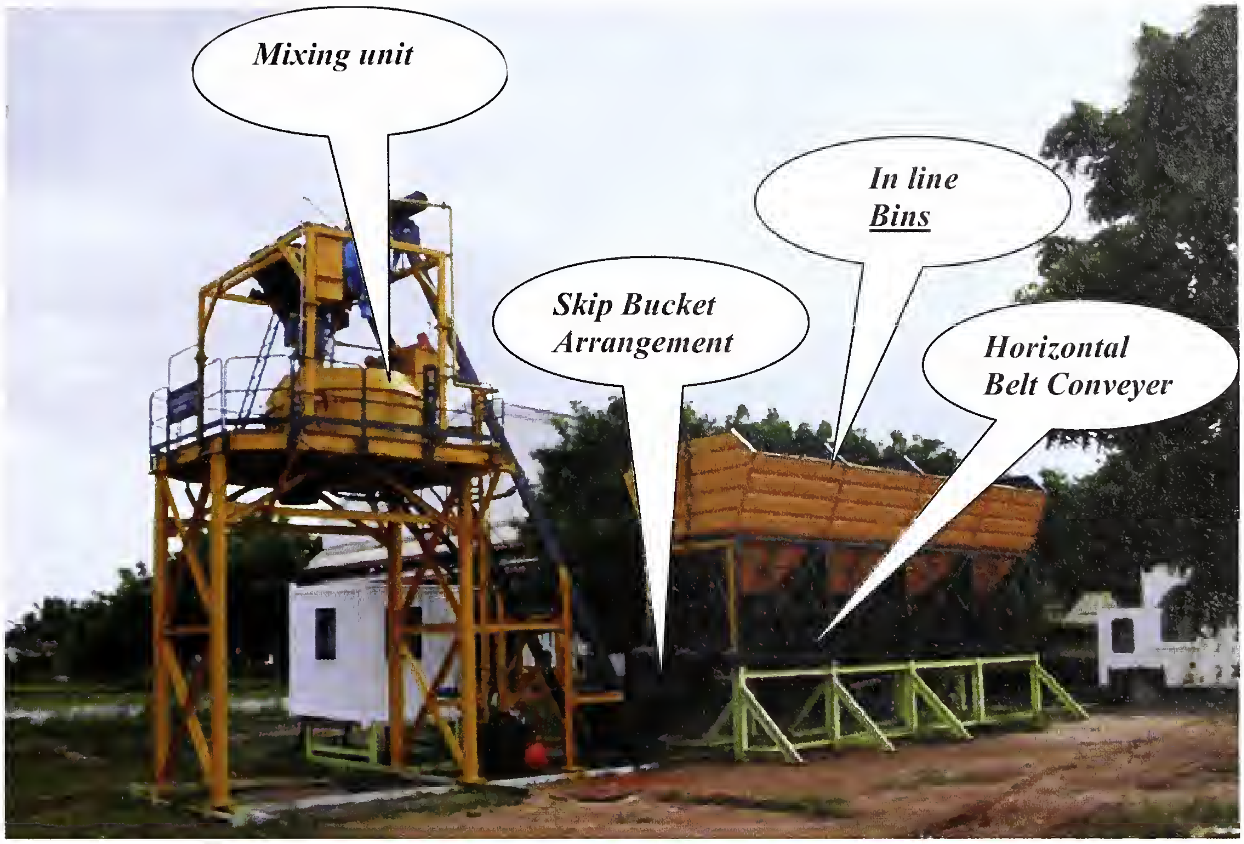


Fig. 20 Inline Compartment Type Batching Plant.

Silo Type Aggregate Storage System:

The aggregates can be stored in silos positioned above the mixing unit or in bins near the concrete plant. This type of aggregate storage is used in higher capacity batching plants.

STORAGE OF CEMENTS:

Cements Storage are of two types

1. Godown storage
2. Silo Storage

1. Godown Storage: In godown storage type cement is stored in bags. The cement is sent to the cement weighing hoppers using manual feeding through screw conveyor or bucket elevators.

2. Silo Storage: In higher capacity plants i.e. 30 cum or above, the said system (through manual unloading of cement bags) is not able to provide the continuous feed of the cement to the plant and thus the full capacity of the plant is not utilized. In such cases 100 MT or above capacity of cement silo which are air tight, are attached to the plant for supplying uninterrupted cement to the plant. Cement stored in bags or carried to the plants in mobile cement bunkers are unloaded in these silos by using low pressure pneumatic cement pumps. Also the cement bags are cut by using Bag slitting machines. The main component of the Slitting machine and the cement pumps are as follows:-

1. Horizontal Belt conveyor for carrying cement bags to the slitting machine
2. Inclined belt conveyor
3. Bag slitting machine
4. Screen for separating cement from its package and lumps if any
5. Compressor
6. Blower
7. Rotary Air Lock valve
8. Special type of Hose to carry cement from the Blower to the silo pipeline

The cement is sent to the cement weighing hopper through screw conveyor.

Cement silos can be used as large amount of storage solutions. Cement Silos are vertical tanks used to store bulk material as a reservoir. Cement silo can be a stable configuration, or a transportable type that can be transferred when necessary. Like many other types of silos, the cement silo usually is equipped with a blower to help in expelling the stored contents into the receptacle. The permanent and the portable cement silo are generally set with various types of blowers. The blower makes it simpler to emit the product from the silo. Blowers are frequently driven by power, although there are types that use propane or even gasoline for operation. Blower equipment with the portable silos takes little time to set up, and can also be stored easily when not in use. Highest quality cement silos are manufactured by using laser cutting technique and special equipments with high sensitivity. The interior of cement silos should be smooth, with a minimum bottom slope of 50 degrees. Bolted type cement silos which are manufactured in different capacities, provide great advantages especially in transportation.

Following accessories are essential for a cement silo

1. Dust collector/Filter
2. Level Indicator
3. Pressure relief valve
4. Vibrator/Aeration system
5. Double flange butter fly valve with manual lever

1. Dust Collector: Dust collector is used for venting pneumatically filled silos. Cement is separated from the air flow by filter elements and can be re- introduced into the silos by an integrated automatic compressed air cleaning system.

2. Level Indicator: This device is used for level monitoring in silos. It is used to monitor the level of cement and gives indication to the operator, such as top level and bottom level. For each level, one level indicator will be used.

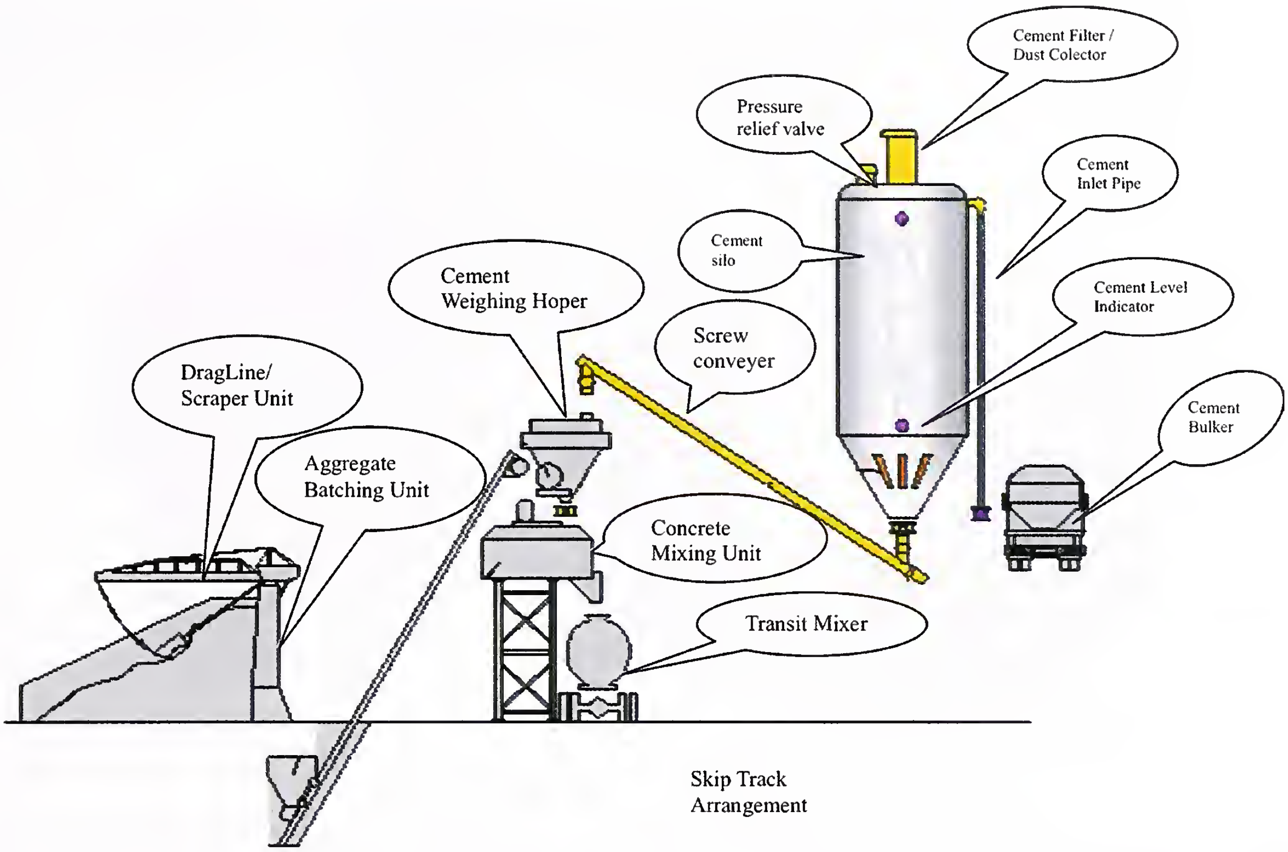


Fig. 21 Reverse Air-Jet Dust Collector

Fig. 22 Level Indicator

3. **Pressure Relief Valve:** On top of silos pressure relief valve are installed. Its main function is to avoid overpressure and negative pressure which prevent problems that could severely damage both silo and filter.

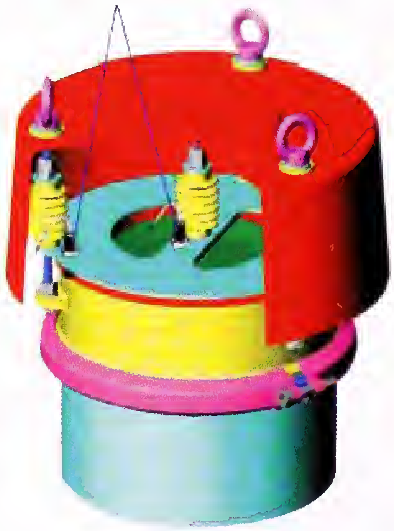


Fig. 23 Pressure Relief Valve

4. **Vibrator/Aeration System:** Vibrator Bin aerators combine aeration and vibration which favours material flow from silos in an efficient way. Fluidization pads offer high performance in partial pulse jet fluidization. Both type can be used individually or in combination. These are usually fitted on the bottom cone of the silos.

Pneumatic Vibrator | Fluidization Pad | Electrical Vibrator

Fig. 24 Vibration/Aeration System

5. **Double Flange Butter Fly Valve with Manual Lever:** The Valve can be operated either manually, electro pneumatically or by a gear motor.

Fig. 25 Double Flange Butterfly Valve

Storage of Water: Water is stored in separate lined tanks and is supplied using water pump to the batching plant.

Storage of Chemicals: Chemicals are stored in tanks supplied by the manufacturers. These chemicals are conveyed to plant by using a special pump supplied by the plant manufacture.

5.2 Batching Equipment

Batching by weight is the best and most accurate method. Therefore, load cells are used and weigh-batching of cement, aggregates and admixtures is done. Even water is added by weight with the use of a pulse meter or water gauge. Cement hopper is a self-cleansing type and is connected to the mixing unit through a hose to avoid any pollution. For higher capacity plant, cement hopper is also equipped with vibrator for free flow of cement. The types of aggregates to be used need to be pre-decided as their number affects the concrete plant specifications. The maximum size of aggregates is also required to be fixed. When there are frequent changes in plant locations, a compartment type batcher is preferred. The weighing hoppers should be manufactured so as to discharge efficiently and prevent the buildup of material. Dust seals should be provided on cement hoppers between the loading mechanism and weigh hopper.

Weigh Batcher:

- Weigh Batchers should be charged with easily operated clam shell or undercut radial type.
- Gates used to charge the semi automatic or automatic batchers should be power operated and equipped with a suitable control to allow the desired weighing accuracy.
- Load Cells: Load cells are designed to resist the moisture, dust, leakage, damage from overload, drift from high voltage to high temperature, line noise or radio frequency interference.

The batchers are vented to permit the escape of air. It shall be self cleaning and may be fitted with the vibrator to ensure complete discharge.

Aggregate Weighing System:

The aggregate weighing system is used for weighing the aggregates i.e., gravel of different sizes and sand, accurately before feeding into the mixer.

It consist of weighing frame suspended with load cells and a skip bucket where the aggregates are collected and transferred to the mixer for mixing.

Fig. 26 Aggregate Weighing System on Skip

Fig. 27 Aggregate Weighing System on Belt Conveyor

Cement Weighing System:

The cement weighing system is used for weighing the cement accurately before feeding into the mixer. It consist of weighing hopper suspended with load cells where the cement is collected and transferred to the mixer for mixing.

Fig. 28 Cement Weighing System

Water Weighing System:

The water weighing system is used for weighing the water accurately before feeding into the mixer. It consist of weighing hopper suspended with load cells where the water is collected and transferred to the mixer for mixing.

Fig. 29 Water Weighing System

Admixture Weighing System:

The admixture weighing system is used for weighing the admixture accurately before feeding into the mixer. It consists of weighing jar suspended with load cell, where the admixture is collected and transferred to the mixer for mixing.

Fig. 30 Admixture Weighing System

5.3. Conveying Equipment:

The concrete batching and mixing plant is equipped with a mixer discharge hopper with a rubber hose to fill the transit mixers, feeder skip, belt conveyor and screw conveyor of suitable diameter for cement with lengths generally varying from 6 to 12 m. The aggregate and sand as conveyed to the top of the bins shall be charged by a power-operated or manually operated in the case of smaller plants, centrally revolving heavy duty chute mounted on central pivot and capable of operation from the top of bins.

The screw conveyor body and the screw is generally manufactured from heavy duty 'C' class pipe and the flutes are fabricated from thick plate. Running clearances are provided between body and flutes for smooth running. The screw is supported on both ends by bearing and at center by hanger bearing having renewable hard bush. The screw conveyor is provided with suitable vertical supports.

It is a system which transfers the material to the mixer after weighing of aggregates. Various types of conveying systems are used. Few conveying equipments are illustrated below:-

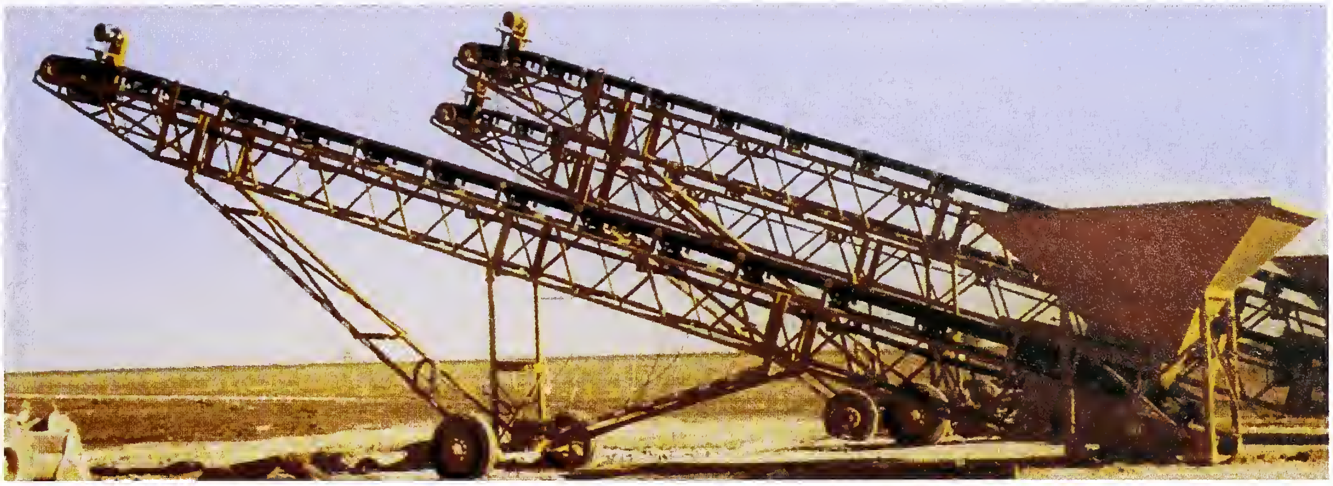


Fig. 31 Radial Conveyor

Fig. 32 Belt Conveyor Type

5.4 Mixing Equipment

The mixing equipment used for mixing concrete ingredients play a vital role in deciding the quality of concrete produced. For small capacity batching plants, pan or drum type mixers are used while for large capacity plants, twin shaft mixers are most suitable.

The basic requirements of the mixers are as under:

1. The shaft end should be sealed by oil pressure and mechanism. (for twin shaft mixers only).
2. Concrete mixer should be designed with oversized discharge gate that is controlled by an advanced hydraulic/pneumatic system. Thus, the cycle time is shortened for quick production.

3. Mixing arms, blades and liners should be made of wear-resistant alloys with high hardness and toughness, so that concrete mixing equipment has a long service life.

4. Pressurized water spraying system shall be used in high capacity plants for conveying of water.

5. The motor used for driving the mixer should have sufficient power to mix the ingredients of required capacity.

6. Concrete mixers with elastically suspended mixing blade arms are better suited for the purpose of using large size coarse aggregates than those with rigid suspension of the mixing blade arms.

7. Environmental Compatibility: The design of the upper cover of the mixer should protect the environment against cement dust emission and concrete mix splashing. The seal of discharge gate should prevent concrete mix leakage.

8. The use of hydraulic torque converters prevents drive system overload and ensures a smooth start of the rotation of agitators as the mixer is filled. It acts as a protection against agitator drive system overload. Also elastic suspension of mixing blades protects the drive from overloading and deformation of the mixing blade arms.

9. Several suitably arranged water nozzles ensures that concrete is quickly mixed homogenously.

10. The concrete mixer dimensions should be suitable for transport on public roads.

11. Better equipped mixers have a mixer trough covering, hinged cover in the covering, safety switch for automatic stoppage of mixer on opening the hinged cover, and a sight flap, inspection window.

5.5. Control Systems

The use of fully automatic micro computer control system ensures, complete control over concrete production. It can give directions for aggregate, cement, water and admixtures as per mix design normally stored in its memory. Control systems allow switching over to the manual system also. An emergency cut-off is also available if erroneous entries have been made. Digital display for all weighing systems for cement, water, admixture and aggregate are part of the control system. Digital weighing indicators provide the interface between the load cell scales and the computer. The number of batches released and pending production can be viewed on the control panel. Batch log print-outs can also be issued by it. The control panel also has the facility of moisture correction for sand and accordingly, automatic reduction in quantity of water can be done. Control systems are facilitated with under and over voltage tripping facility to protect control panel.

Advantage of fully automatic control system:

- production increases the production to cope with the requirement of concrete.

- generates the batch report to calculate the daily consumption of material.
- helps in inventory management at site.
- helps in quality improvement.
- helps in accident prevention by taking corrective action as soon as alarm conditions occur.
- Helps in many reports generation/Concrete production history.

5.6 Automatic Wash Out System

Cleaning of mixers is necessary to produce quality mixes and prevent premature component wear.

Aggregate is taken into the mixer at the end of the production with some quantity of water but without cement and operate the mixer for a minute and discharge into truck. This activity is repeated at least three times and after that mixer is washed by water.

Advantages of the Automated Mixer Cleaning System:

- Production time decreases due to faster cleaning time
- Water conservation, compared to conventional mixer cleaning
- Labour savings
- Safe mixer cleaning
- Improved working conditions for employees
- Enhanced preventative maintenance with clean mixer
- Extends wear life of mixing tools and liners

6 CONCRETE PLANT OPERATIONS

6.1 Principles in Operation of Concrete Batching and Mixing Plant

The following principles govern the operation of modern Concrete Batching and Mixing Plant:

a) The operation should be carefully planned, so that the final product is of a high quality.
b) The operation should be undertaken by a competent manager, and his supporting staff, who are all fully conversant with the plant, its operation and maintenance.
c) The aim should be continuity in operation, avoid break-down and intermittent working.
d) The adequate stock of ingredients must be ensured.

6.2 Operations in the Concrete Batching and Mixing Plant:

Following are the operations in the Concrete Batching and Mixing Plant:

(1) Handling and Storage of the ingredients
(2) Batching

(3) Mixing

(4) Monitoring and controlling the quality parameters through automation

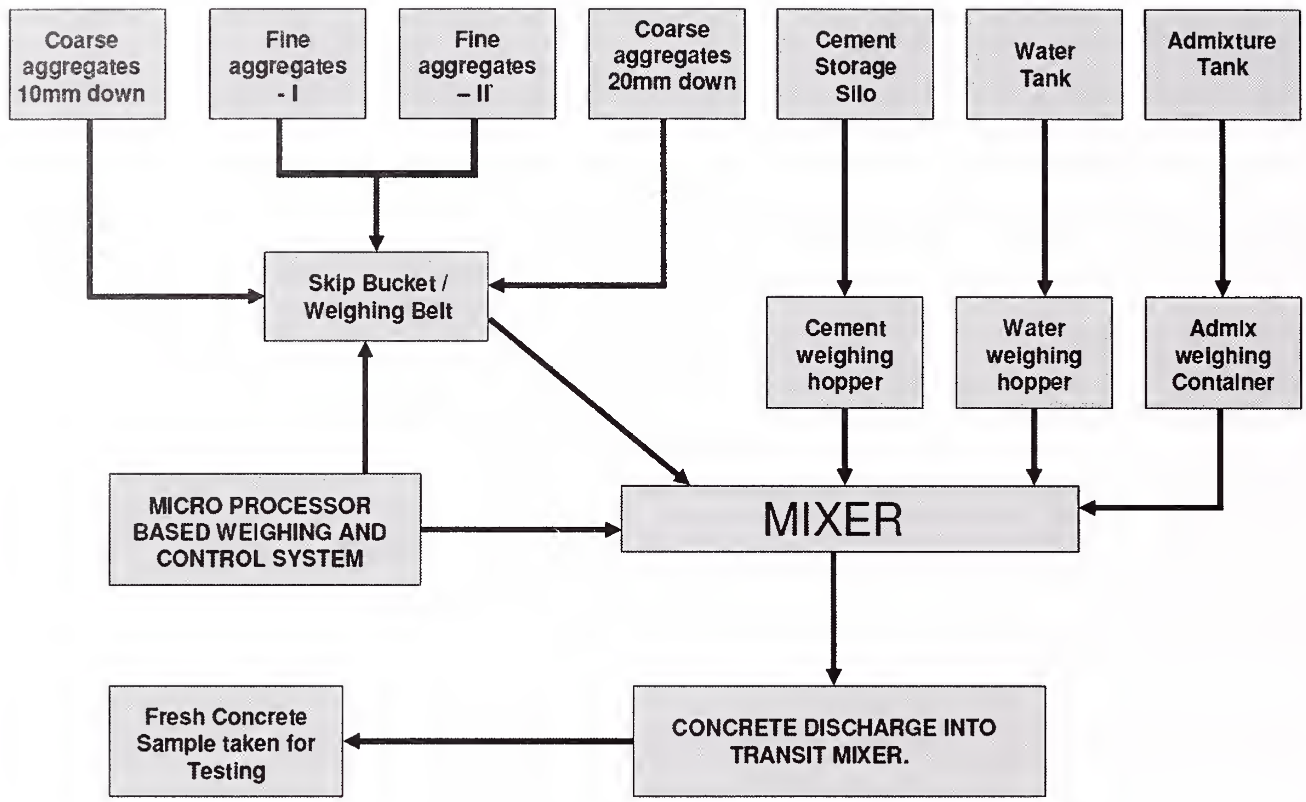


Fig. 33 Operation Flow Chart

6.2.1 Handling and Storage of Ingredients

Proper storage practices are critical to protect material from intermingling, contamination, or degradation, and to maintain consistent aggregate gradation throughout a project. Aggregates have a natural tendency to segregate whenever loaded, natural deposits consist of gravel and sand that can be transported, or otherwise disturbed. Aggregates should be used in concrete after minimal processing. The aggregates should always be handled and stored by a method that minimizes segregation. To produce concrete of high quality, aggregates should be clean, hard, strong, durable and round or cubical in shape. Fine aggregates that are transported over wet, unimproved haul roads can become contaminated with clay lumps. The source of this contamination is usually accumulation of mud between tyres and mud flaps that is dislodged during dumping of the transporting unit. Clay lumps or clay balls can usually be removed from the fine aggregates by placing a scalping screen over the batch plant bin.

The bottom of an overhead charging bin should always slope at least 50 degrees towards the center outlet. If the slope is less than 50 degrees, segregation will occur as the material is discharged. When a bin is being charged, the material should be dropped from a point directly over the outlet. Material dropped in at an angle or discharged against the sides of the bin will segregate. Since a long drop causes both segregation and the breakage of aggregate particles, the length of a drop into a bin should be kept to a minimum by keeping the bin as full as possible at all times. Also, keep storage bins as full as possible to minimize breakage and changes in grading as material is withdrawn. Oversize aggregate should not enter the bin.

Oldest cement should be used first. In case, the cement remains in storage for more than 3 months, the cement should be retested before use and should be rejected if it fails to conform to any of the requirements. Portland cement is a moisture-sensitive material that must be protected from damp air or moisture. Cement not protected when in storage sets more slowly because hydration has already begun; therefore, it has less strength than portland cement that is kept dry. Cement compartment shall be watertight and provided with necessary air vent; aeration fittings for proper flow of cement and emergency cement cut off gate. Fugitive dust should be controlled during loading and transferring. The dust control system of silo shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained to prevent undue emission of cement dust and prevent interference with weighing accuracy by the build up of pressure.

Water is generally stored in tanks located close to the plant. An adequate water supply should be provided and when stored on the plant, such storage facilities shall be designed to minimize the risk of contamination.

Most chemical admixtures are delivered in liquid form and should be protected against freezing. If liquid admixtures are frozen, they should be properly blended before they are used in concrete. Long term storage of liquid admixtures should be avoided. Evaporation of the liquid could adversely affect the performance of admixture. Tanks or drums containing liquid admixtures should be clearly labeled for identification purposes and stored in such a way to avoid damage, contamination or effects of prolonged exposure to sunlight (if applicable).

6.2.2. Batching

Batching is the process of measuring concrete mix ingredients either by volume or by weight and introducing them into the mixer. Accurate proportioning or batching of these material as per approved mix design is essential to produce concrete with satisfactory properties. The first step to achieve proper proportioning is to have all the weighing and measuring equipment properly calibrated. With the increasing use of computerized batching equipment, it is now possible to have the computer do the subtraction and print the weights of individual material in cumulative batcher including recognition of the zero reading or tare. Use of load cells to support the batchers has the potential to simplify a scale by eliminating much of the lever system and dial scale that has typically been used.

Typical Batching Tolerances

As per IS:4925-1968, the batching tolerances are as under:

Ingredients	Individual Batchers and Cumulative Batchers Batching Tolerances
Cement and other cementitious material	± 1 Per cent
Aggregates	± 2 Per cent
Water	± 1 Per cent
Admixture	± 3 Per cent

6.2.2.1 Check points during batching

The following points should be given due care while batching the ingreadients.

(a) Calibration of batching equipment
(b) Isolation of Batching Equipment from plant vibration
(c) Protection of Batching controls from dust.
(d) Frequent checking and cleaning of scales and beam pivot points.
(e) The batching sequence in accordance with the specifications.
(f) Measurement of all the ingredients within tolerances.
(g) Wind protection sufficient to prevent interference with weighing accuracy.

6.2.3 Mixing

The mixing operation consists of rotation or stirring, the objective being to coat the surface of all aggregate particles with cement paste, and to blend all the ingredients of the concrete into a uniform mass; this uniformity must not be disturbed by the process of discharging from the mixer. When it comes to improvements in concrete properties, mixing technology is as important as concrete composition. A concrete is said to be adequately mixed if the samples taken from different portions of a batch will have essentially the same unit weight, air content, slump, and coarse-aggregate content within the permissible errors. It is decisive, that water, cement and admixtures are evenly dispersed and distributed to a fine scale and that agglomerate (jumbled mass) is sufficiently dispersed. Insufficient dispersing or deagglomeration results in inferior concrete properties. Mixing cycle consists of charging of mixer, mixing of all the components and discharging of the concrete.

Charging the mixer consists of transferring all the weighed or measured material from weigh hoppers and silos into the central-mixer. Aggregates are loaded on conveyer belts. There are no general rules on the order of feeding the ingredients into the mixer as this depend on the properties of the mixer and mix.

The particle movement during mixing in power mixers can be divided into a convective and dispersive transport. Convective transport is a forced, directed movement of larger portion of mix, e.g. by the mixing tool (coarse dispersion).

This is superimposed by disruptive transport. Disruptive transport is the random movement of the individual particle due to collision between the particles. This leads to a mixing in small areas (fine dispersion), as well as disintegration of agglomerates.

While in case of free fall mixers, the height to which the concrete climbs against gravity overcomes friction and causes it to fall back towards the bottom of the drum depends upon following two factors:

Linear Velocity: The greater the linear velocity, the higher the break away point of the concrete. However, if the linear velocity is very high break-away is prevented and the spins full circle in contact with the drum.

Workability of concrete: The coefficients of friction both internal and between the concrete and drum surface, increase with reduction in workability. The lower the workability, the higher is the break-away point.

As the concrete breaks away and rolls onto itself, highly efficient local mixing occurs. The efficiency of mixing operation depends upon the shape and size of vanes (blades) fixed inside the drum.

It is important to know the minimum mixing time necessary to produce a concrete of uniform composition, and of reliable strength. Longer mixing time increases the homogeneity of the concrete discharged up to a point. Also, mixing for long periods of time at high speeds, can result in damages to the quality of concrete, tends to grind the aggregate into smaller pieces, increases the temperature of the mix, lowers the slump, decreases air entrainment, and decreases the strength of the concrete. A secondary effect is that of grinding of the aggregate, particularly if soft; the grading thus becomes finer and the workability lower. Of course, shorter mixing times that still obtain an acceptable homogeneity for a given mixture are desired.

This could determine the best mixer for the application, if the loading method is kept constant. Shortening the mixing time may be achieved by increasing the mixing tool velocity. Further, the maximum flowability decreases with increased tool speed due to increase in the temperature of the mix which increases the water demand.

Therefore, the optimum mixing time should be determined for each concrete mixture before starting a large production. Mixing time generally depends on the workability of concrete mix, type of mixer and its size or capacity, working speed etc.

The discharge from the mixer should be arranged so that it increases productivity (fast discharge), and it does not modify (slow discharge) the homogeneity of the concrete. For instance, if the discharge involves a sudden change in velocity—as in falling a long distance onto a rigid surface—there could be a separation of the constituents by size or, in other words, segregation .

Mixer efficiency is defined as the adequacy of a mixer in rendering a homogeneous product within a stated period; homogeneity is determined by testing for relative differences in physical properties or composition of samples extracted from different portions of a freshly mixed batch. In any mixer, it is essential that a sufficient interchange of material occurs between parts of the chamber, so that a uniform concrete is produced. The efficiency of the mixer can be measured by the variability of the samples from the mix.

6.2.3.1 Check points during mixing:

1. A non uniform slump or air content in the concrete throughout the discharge is a sign of poor mixing either due to worn lips or blade or due to excessive buildup of hardened concrete inside the drum.
2. For increasing the output, concrete mixers should neither be overloaded nor be speeded up than the designed capacities and speed. For an increased output, the use of a larger mixer or additional mixers are recommended.

3. Blade wear may adversely affect the mixer performance. Extended mixing time and longer discharge of low slump concrete is usually an indicator of excessive blade wear or blades with excessive hardened buildup. Therefore, for better mixing action the badly worn blades should be replaced to have uniform mixing, as per recommendation of the manufacturer and hardened concrete should be removed preferably after each day of production of concrete.
4. Mixers and agitators should always be operated within the limits of the volume and speed of rotation designated by the equipment manufacturer.
5. The central mixer is equipped with an approved timing device that will not permit the batch to be discharged until the specified mixing time has elapsed.
6. Mixers are free of hardened concrete.
7. All blades are greater than 90 percent of design height.

6.3 Monitoring and Measuring Moisture Content Through Automation

Automatic Moisture Measurement

One of the major problems of inconsistency in batching concrete is the ever varying moisture content of sand and aggregates from one batch to another. Good storage of the sand and aggregates is desirable. Moisture content in stored sand and aggregates can have effects on the water/cement ratio, the aggregate/cement ratio, yield and the colour of the mix. Measuring the moisture content of the raw material can enable the plant controller to adjust water addition into the mix in real time. This enables batch after batch of concrete to be produced of consistent quality.

The installation of moisture measurement sensors into the manufacturing process or entering moisture data into control panel provides the producer with an on-line system that operates in and enables the accurate control of the water/cement or aggregate/cement ratios. Knowing the moisture level of the raw material allows the producer to accurately calculate not only the amount of water to be added to the mix but also the correct amount of cement and aggregates. This will maintain the quality of concrete with reduction in costs and also the level of rejected batches.

Benefits of Monitoring and Control of Moisture Content

(i) Consistent batch quality
(ii) Consistent batch sizes
(iii) Reduction in cement use
(iv) Reduction in wastage due to incorrect moisture or slump
(v) Reduced mix cycle times

The sensors are used for moisture measurement in concrete production, and are built to survive the harsh environment of flowing aggregates and the turbulence of a concrete mixer. Microwave moisture measurement sensors can be installed in a variety of locations depending upon the individual requirements of the plant. Microwave energy is absorbed by moisture in direct proportion to the moisture present in the material.

A microwave moisture sensor can be installed either in or underneath an aggregate bin and measures moisture as the raw material exits the bin. Alternatively, it could be mounted above a conveyor and measure the aggregate as it flows past the sensor head. Measurements may be taken 25 times per second as the material passes over or around the sensor head, meaning that the sensor can rapidly detect changes in moisture levels.

There are microwave moisture sensors which have been designed to fit level with the floor and measures moisture and temperature in the mixer.

Fig. 34 Sensor for Measuring Moisture and Temperature in the Mixer

All sensors connect directly to the plant control system using an analogue output or digital communications. For optimum accuracy of the mixer, sensors will also connect to a water control system, allowing precise control of the water in the shortest possible mixing time. This water control system is a unit that can be connected to a batch control system to easily enable the transfer of mix cycle information. With features such as automatic receipe selection and a colour touch screen display, the unit is designed for simplicity of use and integration into existing control systems. Using the reading from a microwave sensor installed inside a mixer, the unit accurately and continuously monitors, displays and adjusts the moisture levels of the material throughout the mix cycle. Using known recipes, this unit automatically calculates and adds the correct amount of water to the mix. This ensures that the required moisture target can be easily achieved, batch after batch. For optimum control, measurement in the sands and fine aggregates to provide weight correction is also recommended. Measuring only in the aggregates may provide a solution but greater care is required in ensuring the sensors are calibrated.

6.4 Activities before Starting the Concrete Batching and Mixing Plant

i) Check all screws for tight fit and retighten, if necessary
ii) Check the mixing elements and the locking of the adjusting elements
iii) Check oil level of mixer gearing
iv) Lubricate all lubrication points in accordance with the lubrication chart

v) Make sure that there is no foreign matter in the mixer when it is put into operation

vi) Pan mixer may be charged only while the mixer elements are rotating

vii) Re-check the limit switches at the point of discharge for proper functioning

viii) The machine should be put into operation not before all the safety equipments have been fitted and is properly functioning

ix) In mixers with wearing plate, the bottom of the mixing pan should be cleaned with the cement sludge before putting into operation.

7 MAINTENANCE OF CONCRETE BATCHING AND MIXING PLANTS

The most efficient batch plants produce more concrete with less waste of material, lower repair costs, less downtime, and fewer disruptions in employee productivity. Initiatives such as more thorough quality control, understanding modern needs, and installing and operating concrete recycling systems will reduce waste. Proper maintenance system are to be followed for keeping the plant in efficient condition. The different types of maintenance schedule in concrete batching and mixing plant are as under:

7.1 Running Maintenance

- Regular monitoring of the operation of plant/mixer, Conveyor, Feed Gates, Discharge Gates, Material transfer points, Batchers
- Spot the problems - Listen the changes in sounds, smell something out of the ordinary, Touch Vibration, Monitor Temperature of Bearings/Reducers
- Housekeeping - Material build up, Access to maintenance points, Clean equipment makes repairs easier and quicker
- Safer work environment.
- Earthing of plants to protect load cells

7.2 Routine Maintenance

Daily, weekly, monthly, semi annually and annually maintenance are as follows:

7.2.1 Daily Maintenance

- Inspect oil filter on air compressor, drain tank, manifolds and water traps.
- Inspect and fill all oil tanks on plant
- Inspect all V-Belts
- Inspect conveyor belts for alignments and excessive wear
- Check the formation of air pockets
- Check Scales
- Working of Dust Collectors – reclaim material out of dust collectors.
- Requirement of lubricants
- General condition of the equipment
- Inspect all air cylinders

- Drain Pneumatic systems – drain compressor tanks, manifolds and filters.
- Inspect and washout the Mixer

7.2.2 Weekly Maintenance

- Lubricate all bearings including head and tail pulleys on all conveyors, head and tail bearing on cement feeder screws, wheel bearing supports on turn head, aggregate Gate Pivot Points etc.
- Replace or blow clean air filters on air compressor and aeration blowers
- Inspect and tighten all bolts and bearings, set screws, Pulley- Bushings
- Inspect and/or adjust all belt wipers
- Lubricate packing at the bottom and top ends or the cement feeder screws with oil
- Inspect all bags in cement bag filters
- Maintain all hoppers and doors in clean and efficient working order
- Check mixer blades, paddles or arms for wear and tighten and adjust as necessary
- Remove any cement or concrete build up in the mixer
- Check dust seals on cement hoppers for wear
- Clean load cells on weighing equipment
- Check air lines for leaks
- Check pipe works for leaks and wear
- Check wiring and electrical apparatus for correct operation and overheating
- Routine greasing of bearings and gears
- Check area under plant for spillage and trace the source of spillage
- Clean-up yard, checking whether all drains and traps are clear
- Maintain settlement pits, recyclers and wash down areas in efficient working order
- Check all storage bins and doors for efficient operation
- Check conveyors, boom scrapers and bucket elevators for free running and wear, and adjust as necessary

7.2.3 Monthly Maintenance

- Check Oil Levels in Gear Reducers
- Inspect and tighten Conveyor Belts for wear/tear
- Check hydraulic filters and replace as per manufacturer's instructions or if the condition of the filter warrants a change
- Change oil in air compressor
- Check calibration of equipments for weighing of aggregate, cement, water and admixture

7.2.4 Semi-Annual/Annual Maintenance

- Change oil in Speed Reducers

- Inspect Dust Collector Bags
- Inspect hanger bearings in feeder screws and replace as needed
- Tighten/Replace V-Belts
- Inspect Auger Flights/Hanger Bearings
- Check Accuracy of Scales/Meters
- Inspect/Clean Structure
- Inspect and/or replace bin aeration pads

7.3 Preventive Maintenance (PM)

Preventive Maintenance involves scheduling and performing repair tasks on equipment before it becomes necessary. Preventive Maintenance is required to prevent frequent breakdown of the plant. To attain this objective, the periodicity of the change of spares/minor/major assemblies as recommended by the supplier has to be observed.

Plants where a formalized inspection and maintenance schedule is in place tend to have fewer breakdowns. Preventive Maintenance should be undertaken regularly to identify the condition of bearings, belts, leaky air systems, and filter bags and the defective item may be repaired/replaced before breakdowns interrupt plant operations.

A list of spares for maintenance should be made available at the site. Set up a maintenance programme using Preventive Maintenance software, either stand-alone or as part of batching software. For example, some batch control manufacturers offer an integrated Preventive Maintenance schedule. This provides a very useful way to track parts and equipment and can help with spotting failure trends.

7.4 Spare Parts

- Assessing the inventory of spares/major/minor assemblies
- Follow the recommendation of manufacturer
- Availability of components locally
- Availability of parts at Equipment Manufacturer
- Cost of Parts vs. Cost of Down Time/Overnight Delivery
- Check critical components – Bearings, Load Cells, V-Belts, Solenoid Valves, Air Cylinder, Motor Reducers, Electrical Components
- Check running items: Consumable Items, Shrouds, Skirting, Wipers, Filters, and Dust Collector Bags

7.5 Calibration of Load Cells

The process of calibration is carried out once in a month or as per recommendation of the manufacturer, in the following manner.

(i) The calibration is decided based on the per batch capacity. The aim of calibration is to compare the display readings in the digital display unit/computer with standard weights.

(ii) There should be sufficient number of standard weights ranging from 1 kg to 50 kg so that there is a sufficient number of incremental weights for aggregate, cement, water or admixture.

(iii) Scales shall have increments as per IS 4926.

(iv) 50 percent of the capacity of the weigh batcher has to be added sequentially in a gradual manner. The gradual increase of standard weights should be reflected in the digital display unit/computer.

(v) In case of mismatch between the reading of the display unit and the standard weight, calibration of the digital display unit has to be done as per the standard weight loaded.

(vi) The process is repeated and the readings rechecked. If there is no match between the readings of the display unit and the standard weights used, then the following points need to be checked.

(a) Installation of the load cells.

(b) Level of weigh batcher.

(c) Free movement of weigh batcher onto the load cell studs.

(d) Proper Input/Output voltage of the load cells.

(vi) Again repeat the above process until the correct readings are achieved within the tolerance limits.

(vii) Increase the weights from 50 percent to 100 percent of the weigh batcher and repeat the process of incrementally increasing the standard weight and corresponding reading of the digital display unit on the computer screen. The display unit should indicate a zero , the moment the standard weights are removed.

7.6 Plant Safety

Employees working around conveyors, aggregates and electrical panels are exposed to potential injury, which translates from exposure for the plant operator—to downtime as well as legal liability. Safety features that should be in every plant include emergency pull-cord shutoffs and safety disconnects on conveyor and turn head motors, and confined entry access manholes in aggregate and cement bin compartments. Wherever possible, stairs with handrails are preferred over ladders. Going one step further, certain kinds of automation can keep workers away from harm.

7.6.1 Do's and Don'ts

Do's

General

- Be familiar with all controls, gauges, instruments.
- Look around before starting the plant and equipment.
- Operate the equipment only from operator's seat/platform.
- Respirators must be worn by all personnel when handling bag or bulk cement.
- Keep operator's platform clean and free from oil and grease.
- The operator must have maximum unrestricted view of the operating area.
- Inspect all cables of plant periodically.
- Ensure mixer motor is turned off before carrying out mixer cleaning or chipping.
- Also turn off the mains power from panel completely

- Check guard on rotating parts and belts.
- Provide additional emergency lightening in case of power failure.
- Check earthling frequently.
- Create awareness regarding safety among staff.
- Provide proper training to staff on safety.
- Provide first-aid boxes with adequate supplies.
- Ensure that workers wear personal protection equipment such as helmets, safety belts, goggles, gloves and other items as necessary.
- To handle emergency situations each plant must have siren .
- Use proper tools and tackles.
- Ensure proper and clean platform/pathways for the workers to pass through.
- Provide adequate illumination.
- Provide guards and railings where necessary.
- There should be an emergency switch located at a short distance from the plant, which will stop all plant operations in the event of an emergency.
- Lubricate the equipment daily.
- Do keep fast moving parts in store.
- Do ensure that all safety devices are working while the plant is in operation.
- Use antifreeze mixture in the radiator as per the prescribed instructions while working in frosty conditions.
- Maintain Generator, Monitor Voltage and Frequency.
- Keep the control room clean and remove all unwanted material.
- Keep panel power off while carrying out any welding work in the plant.
- Keep all panels under shelter, water should not enter the panels.
- Remove all material from the plant before shut down.
- Load cell frame should be free during operation and locked when plant is not working.
- Check the oil level in all gear boxes.
- Proper setting of thrust wheel of drum .
- Greasing of all bearings.
- Ensure belt center run position.
- Gate opening of all bins should be as per requirement.
- Greasing of bearing and oil checking in all gear boxes.

Transit Mixer:

- Caution must be used at the time of reversing the transit mixer.
- Slow speed is recommended when traveling on a construction site. The stability of the mixer is greatly reduced with the extra weight of the concrete.

- Caution must be exercised during backing of the transit mixer. Backing should be controlled by a signalman, positioned so that operator can clearly observe the directions given.
- Secure the discharge chute properly, using the lock provided.
- Make sure the mixer is stopped before making any adjustments

Mobile Concrete Plant:

- Operators must have thorough understanding of the technical manual before operating the plant.
- Follow all preventive maintenance procedures.
- Wash out the auger within 20 minutes of the last use.
- Keep the entire body clear from all moving parts.

Don'ts

General

- Do not permit the operating staff to leave for the day without ensuring daily maintenance so that there is no delay in the start of operation on the next day.
- When hoppers are being charged with a clamshell or loader, personnel should not be close to the area of falling aggregate.
- Never leave the equipment unattended with its engine running.
- Never permit unauthorized persons to handle the equipment.
- Never operate unsafe equipment.
- Never carry out servicing, adjustment and repairs, when the equipment is running.
- Don't leave the control room, when the equipment is working.
- Avoid loose connections in electrical system.
- Do not overload the engine and the Plant.
- Do not mix various brands of oils.

Mobile Concrete Plant:

- Do not allow any foreign matter in the cement bin.
- Do not allow the waterlines and flow meters to freeze with water in them.
- Do not run the water pump dry.
- Never attempt to repair the machine while in operation (always turn the power source off).
- Never attempt to walk on top of the aggregate bin to cross from the cement bin to the water tank (use the ladder).
- Never climb inside the aggregate bin (use a small pole to dislodge any aggregate that has bridged).
- Never enter the cement bin while in operation (there are moving parts inside the bin).

7.7 Environmental Considerations for Operation of the Concrete Batching & Mixing Plant:

S.No.	Item	Suggested Mitigation Measures
1.	Waste Minimization: Waste generation should be minimized	Waste avoidance/reduction Reuse, recycling and reclamation Waste treatment Waste disposal
2.	Site consideration: Environmental impacts should be minimized by selecting appropriate site	Plants site should not be in flood prone area. Consider the current and future proximity of sensitive land usage Provide vehicle access routes which minimizes impacts
3.	Water quality: It should be ensured that contaminated waste water is discharged into the designated location.	Minimize the area of site which generates contaminated storm water runoff Provide a separate dedicated drainage system to discharge clean storm water from the site Drain all contaminated storm water and process waste water to a collection pit for recycling Regularly clean out solids that accumulate in the pit Use wastewater stored in the recycling system at the earliest possible opportunity There must be no dry weather wastewater discharges from the site
4.	Air quality : Dust Emissions should be reduced	Cover or enclose conveyor belts and hoppers Keep pavement and surfaces clean Fit cement silos with high level alarms, multibag pulsejet filters, airtight inspection hatches, and automatic cut-offs on the filter lines Keep the duct airtight Develop and implement an inspection regime for all dust control components Clear the spillage immediately
5.	Noise Emissions:	Liaise with the local community to identify noise issues Select quieter equipment Alter or enclose equipment to reduce noise at source Use sound absorbing material to prevent the spread of noise by isolating the source Ensure that hooters are not used except for emergencies only

8 QUALITY CONTROL IN CONCRETE BATCHING & MIXING PLANT

The degree of control can be estimated statistically by the variations in test results. The variation in strength results from the variations in the properties of the mix ingredients. This also arises due to lack of accuracy in batching, mixing, placing, curing and testing. The lower the difference between the mean and minimum strengths of the mix, lower will be the cement-content required. The factor controlling this difference is termed as quality control.

Quality Control of concrete can be divided into three convenient areas which basically deal with procedures of quality control to be followed before the production process.

1.	Forward Control	(i) Material storage, (ii) Monitoring of quality of material, (iii) Modification of mix design, (iv) Plant maintenance, (v) Calibration of equipment , and (vi) Plant and transit mixer condition.
2.	Immediate Control	(i) Weighing – correct reading of batch data and accurate weighing, (ii) Visual observation and testing of concrete during production and delivery (assessment of uniformity, cohesion, workability, adjustment of water content) , (iii) Making corresponding adjustments at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in material or concrete qualities, and (iv) Record of material batched, the estimated slump, total amount of water added, delivery ticket number for that load, and the time the concrete was loaded into the truck
3.	Retrospective Control	(i) Sampling of concrete, testing and monitoring of results, (ii) Weighbridge checks of laden and unladen vehicle weights, (iii) Stock control of material , and (iv) Diagnosis and correction of identified faults.

The performance of concrete is determined by its microstructure. Its microstructure is determined by

(i) Composition,
(ii) Homogeneity of the material
(iii) Curing conditions,
(iv) Mixing method and
(v) Efficiency of the mixer

The power consumption is often used to estimate the workability of the concrete. The theory of usage is based on principle of rheometer. A rheometer is an instrument that measures the stress generated by the material tested while applying the strain. In this case, the strain is constant speed of the blades and the stress is measured by the energy consumption. If the power consumption increases, it is an indication that concrete workability is reduced.

To accurately measure the viscosity of the mix , the most direct and accurate measurement in an active process is to measure the input torque to the mixer.

8.1 Factors Affecting Quality of Concrete

1.	Quality of raw material	**Raw material should be consistent with** (i) Specific gravity, (ii) Fitness, (iii) Grain size, (iv) Strength etc. **Quality of raw material includes** (i) Characteristics of material, (ii) Friction between mixer and mix, (iii) Angle of internal friction, (iv) Effective grain diameter, (v) Particle size distribution, (vi) Particle form, (vii) Particle strength, (viii) Mix proportions e.g. Water/Cement ratio, shear strength
2.	Batching and Mixing Equipments	Geometry of mixing chamber and mixer e.g. Chamber diameter, Chamber Height, Mixer Height, Mixer Width, angle of cut, cutting angle etc.
3.	Operational Factors	(i) Over-batching can be at extra expense over time, but even one excessive under-batch can result in major cost through rejection of the concrete. (ii) Proper proportion of water in the mix. Proper water to cement ratio of the mix (iii) Adequate mixing prevention of segregation and/or bleeding. Inadequate mixing will lead to poor finish and variation of texture. (iv) Effective moisture measurement will ensure consistent weighing of material irrespective of the variation of moisture in the aggregates and also the production of concrete with the final moisture content. (i) Mixing cycle time, velocity of mixing tool, efforts, filling height applied by the mixer, batch size, etc.
4.	Mix Design	Quality of the concrete is dependent on the mix design. The design of the mix ensures the proportion of various ingredients, mixing time, temperature, moisture content, curing time, gradation of the aggregate etc. and thus quality and the strength depends on it.

9 CRITERIA FOR SELECTION OF CONCRETE BATCHING AND MIXING PLANT

Selection Item	Options Available	Selection Criteria
1) Capacity	15 to 240 cum per hour	i) Volume of work ii) Completion time iii) Quantity of concrete required to be produced per day iv) Area required vis-à-vis available for plant set up
2) Type	a) Static/Mobile	i) Size of plant ii) Distance between the structures or site of work to be concreted. iii) Volume of mix to be produced and period thereof to meet the local requirement iv) Cost for dismantling and erection vis-à-vis transportation of plant per cum of concrete to be produced.
	b) Mixer unit type	i) Yield of concrete required per hour ii) Tolerance in quality of concrete iii) Maximum size of aggregate iv) Cost and frequency of replacement of moving arms v) Purchase cost.
	c) Aggregate handling	i) Manual ii) Semi automatic iii) Fully mechanized
3) Cement Storage and handling	a) Manual feeding	i) Volume of work ii) Cost iii) Supply of cement in bags/bulk
	b) Bucket conveyor handling	i) Cost ii) Supply of cement in bags/bulk
	c) Pneumatic handling	i) Volume ii) Cost iii) Cement supply in bulk

4) Admixture induction system	a) Without control	i) Cost effective ii) Accuracy requirement of dosage
	b) Integral part of plant	i) Accuracy ii) Extra cost
	c) Tailor made	i) Special requirement ii) Cost iii) Accuracy
5) Pollution Control System	a) Without controls	i) Normally not provided
	b) With controls	i) Additional component with extra cost. ii) By-laws requirement

Selection of Generating Set:

S. No.	Concrete Batching and Mixing Plant Capacity (in cum/hr.)	Capacity of Generator (in KVA)
1.	30	125
2.	120	365/380
3.	240	725

Appendix "A"

INFORMATION REQUIRED BY THE PURCHASER WHILE MAKING AN ENQUIRY WITH THE MANUFACTURER

A. Selection of Site

Following points should be considered while selecting the site.

(a) Availability of aggregates, sand, cement
(b) Presence of electric power source
(c) Depth of water table
(d) Sites for disposal of wastes
(e) Surface drainage
(f) Distance and time of travel between the batch plant site and the work site
(g) Lower congestion- Traffic in and out of the areas at the same time
(h) Area of site
(i) The environmental effect that is noise, vibration, dust, water pollution to prevent any harm to the residents or farm location.
(j) Proper water drainage should be provided for smooth functioning of plant.
(k) Source of supply of cement and flyash, if specified and its lead .
(l) The location should not be flood prone

B. Task Considerations :

(i) Size of work
(ii) Required Production Rate
(iii) Required standards of batching and mixing performance.
(iv) Site conditions
(v) Ingredients used for concrete production

C. Selection parameters of Concrete Batching and Mixing Plant at the time of procurement:

1. **Capacity of Plant:** In order to meet the requirement of project specific parameters as mentioned above, a concrete plant of right capacity should be installed. It should take into account various ingredients proposed for use in the mix like, flyash, admixtures like plasticizer, retarder, air entraining agent etc.

2. **Multiple Mix Design Options:** A batching plant needs to be shifted from site to site on completion of projects and different mix designs are required to be followed at different sites, as per strength and workability requirements of concrete and the quality of locally available aggregates.

3. **Mobility of Concrete Plant:** Depending upon the location of work site the plants' mobility is considered.

4. **Automatic Controls:** Most of the activities in the running of the batching plant should be under automatic controls. Once the directions are fed, the plant should be able to read and operate automatically. However, manual switchover options should also be available.

5. **Type of Mixer:** Suggested criteria for the selection of mixer is as under:

- Size of aggregate
- Easy to clean
- Difficulty of replacing the blades or parts
- Sensitivity of the blades to wear and tear
- Mixer Capacity (Size of drum)
- Mixing energy required
- Efficiency of a mixer
- Mixing time
- Mixing method
- Location of the construction site (distance from the batching plant)
- Amount of concrete needed

6. **Accurate Weigh Batching of Concrete Ingredients:** The batching plant must have accurate weigh batching systems in it, with electronic controls and calibrated gauges for measurements.

7. **Feeding and Storage Mechanisms:** There should be adequate number of bins to feed aggregate of various sizes including sand. Before commencing work, the Contractor has to prepare a plan as to determine how he will produce and transport mix within the specified time limit. Adequate storage facility for cement for carrying out 2-3 days work. feeding facilities for coarse and fine aggregates, cement and other cementitious material like flyash, admixtures should be taken care of.

8. **Safe Operation of Plant:** Safety features of the plant should be studied. Easy access, easy escape, protection against dust and smoke, proper insulation against shocks should be some essential features. The plant should be equipped with automatic emergency stoppage arrangements in case of emergencies to avoid accidents on site.

9. **Easy Availability of Spares:** Sales is combined with service in today's scenario. It should be ensured that spares are easily available for replacements as and when required. In addition, service and repairs should be prompt. The company's track record in this matter should be considered.

10. **Minimum Wear and Tear:** The components of the batching plant should undergo minimum wear and tear despite constant use. The warranty period and clauses should be carefully scrutinised.

11. **Minimum Energy Consumption:** It is another important factor to look into to minimize running expenses of the batching plant.

12. **Minimum Maintenance Requirements:** The batching plant should be able to withstand rough handling and demand minimum maintenance.

13. Low Consumption of Consumables: In addition to low power consumption, the plant should have low consumption of consumables such as oils to minimise running expenses.

14. Noise Pollution: The plant should make minimum noise during its operation.

15. Miscellaneous Requirements :

a. Delivery schedule of the supplier
b. Erection and commissioning of equipment at site
c. Training to certain operation and maintenance personnel of the buyer
d. Transportation of equipment from the works to the site, or bearing its costs should be sorted out
e. Transit insurance
f. Availability of tool kit
g. Cost of consumables and unskilled labour
h. Foundation Drawing details
i. Plumbing and water supply provisions. (Installation of a pump may be necessary)
j. Electric supply connection and cabling network for various equipment at desired ratings

16. Plant Installation: Whenever orders are placed with a firm for supply and installation of a concrete batching and mixing plant, certain issues over site facilities should be sorted out at the time of placing the order so that no problems arise during the installation period.

Appendix "B"

INFORMATION TO BE SUPPLIED BY THE MANUFACTURER OF CONCRETE BATCHING AND MIXING PLANT

1. Model and type of plant offered
2. Brief description of the plant along with its units
3. Specific features of the plant
4. Capacity of the plant
5. Capacity of DG set required for operation of plant
6. Overall dimensions and weights of different units of the plant for transportation purpose
7. After sales-service facility, nearest to the commissioning site
8. Supply of spare parts catalogue, operation and maintenance manual assured
9. List of fast moving components assured
10. Details of similar model of plants supplied so far, year-wise
11. Provision of training facilities
12. Calibration frequency

Appendix "C"

SAMPLE CALCULATION OF RATE OF USAGE CHARGES OF CONCRETE BATCHING AND MIXING PLANT

Assumptions

(a) Salvage value = 15 per cent of the cost of equipment at site

(b) Storage charges = 1 per cent of total investment to be depreciated, spread over the economic life of the plant

(c) Repair and maintenance charges per hour including replacement of tyres = 150 percent of total investment to be depreciated spread over the economic life

(d) Over head charges @ 5 per cent of the sum of wages per hour + Servicing charges (Manpower and material cost)

1. For Equipments Used Departmentally

1.1 Ownership Charges

(A) Total investment at site of work (This includes tender cost, sales tax, excise/custom and other duties, transport expenses consisting of freight by sea or rail, insurance, loading/ unloading charges, erection and commissioning on receipt)

= Rs. X (say)

(B) Deduct salvage value @ 15 per cent of total investment = 0.15X

(C) Total investment to be depreciated = 0.85X

(D) Economic life of machine in hours = Y hours

(E) Depreciation per hour = Rs. 0.85 X/Y per hour

(F) Storage charges per hour (1 per cent of "C" spread over the economic life)

Total ownership charges = Rs. 0.01x 0.85 X/Y

= Rs. 1.01x0.85 X/Y --------I

1.2 Operation Charges

(G) Repair and maintenance charges per hour (including maintenance and replacement of tyres) is 150 per cent of "C" spread over the economic life = Rs 1.50x0.85 X/Y -------- II

1.3 Overhead Charges

5 per cent of ownership plus operation charges = Rs. 0.05x (I+II)---III

(a) Ownership charges per hour = Rs. I

(b) Operation charges per hour = Rs. II

(c) Overhead charges per hour = Rs. III

Sub-Total

1.4 Running charges

Operating staff/labour wages

Designation	No	Unit wage per month	Total wages per month
i) Operator ii) Helper iii) Cleaner iv) Misc. Expenses			
		Total	

Total wages required for Operating staff and labour per month = Sum of wages per month

(H) Total wages required for Operating staff and labour per hour = Total wages required for Operating staff and labour per month/hours per month

(I) Servicing charges

Servicing charges includes man power cost

Designation	No	Unit wage per month	Total wages per month
(i) Mechanic (ii) Cleaner			
		Total	

Total wages required for servicing staff per month = Rs.

Total wages required for servicing staff per hour = Total wages required for servicing staff per month/hours per month

(J) Servicing charges (Material cost)

Fuel/lubricant	Rate per litre/kg	Consumption (In litre/kg)per month	Expenditure per month
i) Fuel ii) Lubricants iii) Grease iv) Hydraulic oil v) Gear oil vi) Cotton waste			

Total servicing charges (material cost) = Total expenditure per month/Total hours per month

(K) Cost of lubricating oil, fuel consumed per hour

(L) Total running charges per hour = H+I+J+K ---------------------------------------IV

1.5 Over head charges @ 5% of total = 0.05x(L) --------------------------------------V

Hire charges = I+II+III+IV+V

2. For Equipment provided Given to Contractor and Outside Agencies

When the equipment is issued to contractors, interest and insurance charges @ 10 per cent of the average investment per year will be calculated as under and added.

$$= \frac{A}{1500^*} \times \frac{60^{**}}{100} \times \frac{10}{100}$$ * on 5 years life

= Rs.

* 1500 is the life of machine in a year

** 60/100 is due to average investment per year when the life of equipment is taken 5 years and depreciation is assumed to be uniform,

(M) Interest and insurance charges per hour

Therefore the total charges in that case would be as follows:

(i)	Owner-ship charges (E+F+M)	=	I
(ii)	Operational charges	=	II
(iii)	Running charges	=	IV
(iv)	Over-head charges @ 5 per cent of total charges per hour (I+II+IV)	=	V
	Hence hire charges per hour	=	I+II+IV+V

Appendix "D"

SAMPLE CALCULATION TO WORK OUT REQUIREMENT OF CONCRETE BATCHING AND MIXING PLANT

1. Quantity of concrete required say 500000 cum.

2. Time period for completion tenure of the project say 24 months.

   (i) Assume number of working months = 16 months
   (ii) Number of working days per month = 20 days
   (iii) Number of working hours per day (2 shifts) = 10 hours
   (iv) Total working hours of Plant = 16x20x10 = 3200 hours

3. Quantity of concrete required to be produced per Hours = 500000/(3200) = 156.25 cum.

4. Assuming the efficiency of the plant is 80 per cent,

   Quantity of concrete required to be produced per Hour = 156.25/0.80 = 195.31 cum

5. Next available capacity of Concrete Batching and Mixing Plant = 240 cum/hr.

6. Hence, there will be requirement of one number concrete batching and mixing plant of capacity 240 cum/hour for producing concrete of 5,00,000 cum for the project.

7. While working out the requirement of the concrete batching and mixing plant, the aspect of monthly requirement of concrete must also be considered. The plants available with the contractors at a particular site may preferably be of a single make. This would lead to standardization of the plant inventory and reduce variations in the output of the plants (due to likely differences in the plant characteristics and settings).

NAME AND ADDRESS (E-MAIL) OF MANUFACTURERS

Name of the Manufacturers	E-mail	Website (www. -----)	Phone No.
M/s. Schwingstetter India Ltd.	newdelhi@schwingstetterindia.com	www.schwingstetterindia.com	91 44 27156539
M/s. Greaves Cotton Ltd.	rahul.rao@greavescotton.com	www.greavescotton.com	91-22-24397575
M/s. Conmat India Pvt. Ltd.	info@conmatindia.com	www.conmatindia.com	91 265 2647276
M/s. Apollo Infratech Ltd.	opalinfo@vsnl.net	www.apolloinfratech.com	91-2764-232217
M/s. Macons India Pvt. Ltd.	info@macons.co.in	macons.co.in	91-79-25894558
M/s. Vinayak Road Equipment	viral_jolapara@yahoo.co.in	www.vinayakroadequipment com	(+91)-79-25840930
M/s. Maxmech Equipments Pvt. Ltd.	info@maxmechgroup.net	www.maxmechgroup.net	91-79-25841985
M/s. Jayem Manufacturing Co.	jayem.mfgco@yahoo.com	jayemmfgco.net	91-120-4322849
M/s. Aquarious Engineers Pvt. Ltd.	enquiries@aquariusengineers	aquariusengineers.biz	91-20-25445227
M/s Universal Construction Machinery & Equipment Ltd.	marketing@uceindia.com	www.uce.india.com	91-20-25230777
M/s Kaushik Engineering Works	info@kaushikengineeringworks.com	kaushikengineeringworks .com	91-79-22902714
M/s Mecaster	corp@mekaster.asia	www.mekaster.com	011-23354216/18

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' whcih shall be considered as effective and as part of the code/guidelines/manual etc. from the date specified therein)