

Comparative Study of Concrete Mixed Design

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ABSTRACT: Concrete mix design is the process of choosing suitable ingredient of concrete and determining their relative quantities with the object of producing as economically as possible concrete of certain minimum properties, notable workability, strength and durability. It should be explained that an exact determination of mix proportions by means of table or computer data is generally not possible. The main objective of the study was to design M25 concrete mix and find the compressive strength using different mix design methods like IS10262-1982, IS 10262-2009, ACI method and DOE method. We conclude that in above four methods minimum cement content used in DOE methods and it gives desire compressive strength of concrete economical way.

The design of concrete mix is not a simple task on account of the widely varying properties of the constituent materials. Mix design is the process of determining the appropriate proportions of cement, fine aggregate, coarse aggregate, water and admixtures if any which will satisfy the requirements of compressive strength, workability and durability. The purpose of designing as can be seen from the above definitions is two-fold. First object is to achieve the stipulated minimum strength and durability. Second object is to make the concrete in the most economical manner. The basic assumption made in mix design is that the compressive strength of workable concrete is, governed by the water cement ratio. Another most convenient relationship applicable to normal concretes is that for a given type, shape, size and grading of aggregates, the amount of water determines its workability. However, there are various other factors which affect the properties of concrete

I. INTRODUCTION

Concrete occupies unique position among the modern construction materials, Concrete is a material used in building construction, consisting of a hard chemistry inert, particulate substance known as aggregate that is bounded by cement and water

The various methods, developed for concrete mix design, are not universal because design mixes are specific to regional climate, local materials, and exposure. The new-generation mix design method should be developed based on the performance criteria. The concrete strength obtained from the designed concrete mix and minimum cement content should not be considered the only parameter for suitability of concrete mix for harsh environment region. The durability and quality parameters in a cost-effective way should be included into the mix design methods for extreme climate. The strength and relative proportion of ingredient should be given consideration for the concrete coherent mix. This paper presents the basic principles and comparative study of some popular concrete mix design methods namely fineness modulus method, ACI mix design method, and DOE method from qualitative and cost-effective point of view. It is clear from the study that the mix design methods need some adjustment in their basic design parameters for quality and cost-effectiveness. The durability indicators, in terms of denseness indicator, i.e., mix density and fine aggregate-to-total aggregate ratio, quality indicator, i.e., total aggregate-to-cement and fine aggregate-to-cement ratio, and other cementing material/mineral admixtures in addition to minimum cement content are suggested for severe environment. It is anticipated that with detailed experimental investigation on various suggested design factors focusing more on local challenges, present study will pave the way for the development of performance-based extreme environment design mix principles.

The process of selecting suitable ingredients of concrete and determining their relative amounts with an objective of producing a concrete of required strength, durability, and workability as economically as possible is termed as concrete

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mix design. Here we are doing concrete mix design of M25 grade by adding various types of admixtures and get more strength as well as it's become economical mix design as far as cost is concern.

II. RELATED WORK

This is the simplest test and that most commonly used in on site testing and it has been referred in ASTM C 184-83 & 430-83 it can Be used in laboratory. Wight correctly 100gm of cement and take on a IS sieve no.9 (90 microns). Break down the air-set lumps in the sample with figer. Continuously sieve the sample giving circular and vertical motio for period of 15 min. Weigh the residue left on the sieve.

Thi weigh shall not excwvd 10% for ordinary cement

III. MATERIALS USED

Cement

SAGAR 53grade cement ordinary Portland cement,PRIYA ppc cement is used for casting the elements. The following test are conducted

- Fineness test
- Standard consistency test
- Initial setting time test
- Final setting time test
- Specific gravity test
- Compressive strength test

Fine aggregate:

In this investigation fine aggregate is a naturally available sand and it is free from dirt, dust and any organic matter. The fine aggregate used for the project was obtained from Krishna river.

The following tests were conducted on the sand:

- i. Sieve analysis.
- ii. Bulking of sand by volume method.
- iii. Specific gravity test.

Coarse aggregate:

In this investigation hard broken granite aggregate is used. The size aggregate is various from 12 mm to 20 mm. The source of aggregates is from gunthapalli village

Applications:

Fly ash is typically introduced into concrete mixes to reduce cement costs, reduce heat of hydration, improve workability, reduce the effects of aggregate reactivity, or attain required long term strength levels, and for ecological reasons. Fly-ash modified concrete can have some specific applications in construction. Ash is often used in the production of high strength concrete because the addition of ash may reduce the water requirement without a loss in workability and because fly ash produces increased strength at late ages that cannot be achieved with additional Portland cement.[Popovics1990b] Fly ash is also often used in the production of roller compacted concrete (RCC). Here, fly ash may be used in two different applications: lean concretes with lower ash contents or rich concretes with high ash content. [ACI 1987c] In RCC, the paste content must be kept high enough to assure compaction; fly ash does this. Because the performances of a given fly ash vary inherently and with different cements, trial mixes are recommended for the prediction of the performance of fly ash concrete mixtures

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IV. PROPOSED METHODOLOGY

Test Methods:

Test and sampling methods for fly ash are outlined in ASTM and RILEM report the methodology for various fly ash tests.

The following fly ash tests are discussed in detail:

- Moisture content,
- Loss on ignition,
- Silicon oxide content,
- Alumina oxide content,
- Calcium oxide content,
- Chloride content,
- Free calcium oxide content,
- Total alkali oxides content,
- Particle density determination (by Pycnometer bottle and Le-Chatlier Flask methods),
- Fineness determination (by dry sieving, wet sieving, Blaine air permeability and laser methods)

The following tests for fly ash cement pastes, mortars, or concretes are outlined:

1. Soundness (expansion test),
2. water requirement (expressed as water content of test specimen divided by water content of control specimen to achieve equal specified consistencies)
3. Preparation and curing of specimens, determination of compressive strength (28 days).

Chemical composition:

The chemical specifications of fly ash require that the minimum for the sum of the oxides (reactive glasses) is 70% for Class F and 50% for Class C ash. However, this definition has been criticized. Alternatively, Class C ash can be defined as that ash having a minimum calcium oxide content of 10% and self cementing capabilities. For both Classes of ash, however, an upper limit of SO₃ content is usually set at 5%. This is because the compound has an effect on setting time and other properties as well as making the concrete more susceptible to sulfate attack. A limit of moisture content (3% max.) is necessary to insure handling characteristics as well as to prevent premature hydration of Class C ashes. For both types of ash, the maximum allowable LOI is 6% although there is speculation that this value should be lower, particularly for air entrained concretes. Similarly, a maximum content for alkalis is set at 1.5% for both classes of ash. The primary physical requirement of both classes of fly ash is that not more than 34% should be retained on the No. 325 (45 μ) sieve by wet sieving. This is an important specification because coarser fly ash fails to react pozzolanically.

The traditional chemical method for determining fly ash reactivity is based on measuring the amount of lime which combines with the ash when mixed with hydrated lime or Portland cement.

Proportioning:

A reasonable concept is to pre estimate the relative amount of fly ash to be used in the mixture, and then follow a proportioning technique similar to that used in proportioning concretes made with Portland cement or blended cement. Methods for the pre estimation of the optimum amount of fly ash are available. [Popovics 1982b] It is possible to design a fly ash concrete of comparable strength to standard concrete at any age. However, factors such as curing condition sensitivity, sensitivity to particular cement, etc., must be considered.

The interaction between fly ash and other admixtures and by-products in concrete must be studied. In general, there are four classes, other than air entraining admixtures, of concrete admixtures that are used along with fly ash: accelerators, retarders, water reducers, and super plasticizers. Results show that all types of accelerators are effective in the presence of fly ash. However, they do not completely compensate for the slow rate of strength gain that results with ash substitution. Similarly, fly ash does not seem to consistently affect the performance of water reducing admixtures or super plasticizers. In the case of super plasticizers however, some test results show that their effectiveness may be

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reduced by the presence of fly ash. The simultaneous use of fly ash and other mineral admixtures was investigated. It was found that fly ash and condensed silica fume or fly ash and ground slag can be used together in concrete. When used with a modest amount of silica fume, the early strength of the fly ash concrete improved considerably. In addition, the later strength also improved dramatically. However, the use of silica fume increases the water requirement of a mix, and this has to be accounted for.

MIXED DESIGN WORKING AND PROCEDURE:

1. Nominal mix – M35

Step-1 : target mean strength

$$\begin{aligned} f_m &= f_{ck} + 1.65 * S \\ &= 35 + 1.65 * 5 \\ &= 43.25 \text{ N/mm}^2 \end{aligned}$$

Step -2 : water cement ratio

$$\text{Water cement ratio} = 0.35$$

Step-3: water content :

$$\text{Max water content} = 186$$

$$\text{For 20mm aggregate} = (25-50\text{mm})$$

$$\text{Workability} = 100\text{mm}$$

$$\text{Water content} = [186 + 6/100 * 186]$$

$$\text{Therefore water content} = 197 \text{ ltrs}$$

Step-4 : calculation of cement content

$$\text{W/c ratio} = 0.35$$

$$\begin{aligned} \text{Cement content} &= \text{water content} / \text{W/c ratio} \\ &= 197 / 0.35 \end{aligned}$$

$$\text{Therefore cement} = 562.85$$

Step -5 : volume of fine aggregate

$$V = [w+c / s_c + 1/p * f_a / s_a] * 1/1000$$

$$0.98 = [197 + 562.85 / 3.40 + 1/0.35 * f_a / 2.75] * 1/100$$

$$\text{Fine aggregate} = 594.301 \text{ kgs}$$

Step – 6 : volume of coarse aggregate

$$C_a = 1 - p * f_a * S_{ca} / S_{fa}$$

$$C.A = 1003.365 \text{ kgs}$$

Therefore mix design

$$\begin{aligned} \text{C: F.A.:C.A} &= 562.85 : 594.301 : 1003.365 \\ &= 562.85 / 562.85 = 1 \end{aligned}$$

$$\text{Cement} = 1$$

$$\text{Fine aggregate} = 594.301 / 562.85 = 1.055$$

$$\text{Coarse aggregate} = 1003.365 / 562.85 = 1.782$$

Therefore mix design be

$$\text{C:F.A:C.A} = 1 : 1.055 : 1.782$$

By some similar changes the mix can be changed for the 20mm aggregate and also for flyash .

2. Nominal mix of M35

Using 10mm coarse aggregate

Step -1 target mean strength :

$$\begin{aligned} F_m &= f_{ck} + 1.65 * s \\ &= 43.25 \end{aligned}$$

Step – 2 : water cement ratio

$$0.40$$

Step -3 : water content

$$\text{Max water content taken} = 186 \text{ ltrs}$$

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Step-4 :cement content

$$\begin{aligned}\text{Cement content} &= \text{water content} / \text{w/c ratio} \\ &= 186/0.4 \\ &= 0.4\end{aligned}$$

$$\text{Therefore cement content} = 465 \text{ kg/m}^3$$

Step -5 :volume of fine aggregate

$$V = [W + C/S_c + 1/P * f_a/S_{fa}] * 1/1000$$

$$0.98 = [186 + 465/3.40 + 1/0.35 * f_a/2.75] * 1/1000$$

$$\text{Therefore Fine aggregate} = 632.580 \text{ kg}$$

Step-6 :volume of C.A

$$C_a = 1 - p/p * f_a * S_{ca}/S_{fa}$$

$$C_a = 1068.005 \text{ kg}$$

$$\text{Cement} = 465/465 = 1$$

$$\text{Fine aggregate} = 1.360$$

$$\text{Coarse aggregate} = 2.296$$

$$\text{Therefore C:F.A:C.A} = 1 : 1.360 : 2.296$$

Similarly mix design using 10% flyash is given below

$$\text{C:F.A:C.A} = 1 : 1.360 : 2.296$$

$$\text{Cement} = 18 * 10/100 = 1.8$$

$$= 18 - 1.8$$

$$\text{CEMENT} = 16.2 \text{ kgs} = 8.1 \text{ kgs}$$

$$\text{FLYASH} = 1.8 \text{ kgs} = 0.9 \text{ kg}$$

$$\text{F.A} = 24.48 \text{ kg} = 12.24 \text{ kg}$$

$$\text{C.A} = 41.328 = 20.664$$

$$\text{Cement} = 9.6 - 0.96$$

$$\text{Cement} = 8.64$$

$$\text{Flyash} = 0.96 \text{ kg}$$

$$\text{F.A} = 13.056 \text{ kg}$$

$$\text{C.A} = 22.0416 \text{ kg}$$

CURING

The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

PRECAUTIONS

The water for curing should be tested every 7 days and the temperature of water must be at 27±2°C.

PROCEDURE

(I) Remove the specimen from water after specified curing time and wipe out excess water from the surface.

(II) Take the dimension of the specimen to the nearest 0.2 mm

(III) Clean the bearing surface of the testing machine

(IV) Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.

(V) Align the specimen centrally on the base plate of the machine.

(VI) Rotate the movable portion gently by hand so that it touches the top surface of the specimen.

(VII) Apply the load gradually without shock and continuously at the rate of 140 kg/cm²/minute till the specimen fails

(VIII) Record the maximum load and note any unusual features in the type of failure.

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V. EXPERIMENTAL RESULTS

Result

Test results on cement

S.NO	TEST NAME	RESULT		
1	sieve test	8 %		
2	standard consistency	29 %		
3	Initial setting time	52 min		
4	Final setting time	480 min		
5	Specific gravity test	3.15		
6	Compressive strength	3 days N/mm ²	7 days N/mm ²	28 days N/mm ²
		22.12	30.12	44.23

Test result on fine aggregate

S.NO	TEST NAME	RESULT
1	Sieve analysis	Zone III
2	Bulking of sand by volume method	12.5%
3	Specific gravity test	2.51
4	Relative density	45% (medium dense)

Test result on coarse aggregate:

S.NO	TEST NAME	RESULT
1	Fineness modulus	7.5
2	Specific gravity	2.83
3	Water absorption	2.1%
4	Crushing strength	22.43%
5	Impact test	28.12%

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Percentage strength of concrete at various ages

Age	Strength per cent
1 day	16 %
3 day	40%
7 day	65%
14 day	90%
28 day	99%

Grade of concrete	Minimum compressive strength N/mm ² at 7 days	Specified characteristics of strength(N/mm ²) at 28 days
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45

VI. CONCLUSIONS

- Fly ash is added at different proportions namely 0%, 10%, 20%, 30% and 40%.
- For 43 grade cement with M30 mix, by adding up to 30% of fly ash to the cement, the strength is increased and by adding 40% of fly ash the strength is decreasing.
- The test results show that on addition of 30% of fly ash to cement it has gained maximum strength at 28 days period but the rate of strength gain compared to ordinary Portland cement concrete OPCC is at slower rate at initial days.
- The compressive strength increased by 27.12%, split tensile strength increased by 20.14% when compare to normal concrete.
- By use of fly ash as admixture, the cost of construction is also considerably reduced.
- Non-biodegradable fly ash is effectively utilized in H.P.C, so it reduces the disposal problem of fly ash.
- It is concluded that when compare to super plasticizer, fly ash gives more desirable properties to concrete and eco friendly.

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REFERENCES

1. Raju N.K.: Design of Concrete Mixes, Fourth edition. CBS Publisher, New Delhi (2007)
2. Nataraja M.C., Dhang N., Gupta A.P.: A simple equation for concrete mix design curves of IS 10262:1982. Indian Concr. J. **73**(2), 111–115 (1999)
3. Nataraja, M.C.; Lelin, D.: Concrete mix proportioning as per IS 10262:2009-comparison with IS: 10262: 1982 and ACI 211.1-91. Indian Concr. J. 64–70 (2010)
4. Zein Al-Abideen H.M.: Environmental impact on concrete practice. Concr. Int. **20**(11), 48–54 (1998)
5. Al-Khaiat H.M.N. Haque: Carbonation of some coastal concrete structures in Kuwait. ACI Mater. J. **94**, 602–607 (1997)
6. Lamond J.F.: Designing for durability. Concr. Int. **19**, 34–36 (1997)

BIOGRAPHY



K.PARAM SINGH was born in 1991 at Gurrapu Thanda Village in Nalagonda district, Telangana. He received his Bachelor of Technology in Civil Engineering from Avanthi Engineering college, Hyderabad in 2013. He is currently a Final year student of Master of technology in Structural Engineering from Gurunanak Institute of Technology. His research interests COMPARITIVE STUDY OF CONCRETE MIXED DESIGN



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Prof. S. Madan Mohan received his Bachelor of Technology degree in Civil Engineering from JNTUCE Hyderabad in 1998. In 2001 he received his Master's Degree in Structural Engineering from University College of Engineering Osmania University, Hyderabad. He Joined Gurunanak Institute of Technology as a faculty where he is a Professor and Head of the Civil Engineering Department with a total experience of 17 years in field of Research, Designing and education.



Dr. S. SREENATHA REDDY Professor & Principal, Guru Nanak Institute of Technology under JNTUH, Hyderabad. Dr. S.SREENATHA REDDY obtained B.Tech, Mechanical Engineering from JNTU, Hyderabad, M.Tech.-Heat power, Refrigeration & Air conditioning from JNTU, Hyderabad and Ph.D. Faculty of Mechanical Engineering from JNTUA. Dr. S.SREENATHA REDDY held various administrative posts and developed the Institution with his projects and developmental activities. Notable among his award i.e National award for best research publication i.e Jawaharlal Nehru memorial prize issued Institution of Engineers on the occasion of Inauguration 27th Indian Engineering Congress at New Delhi. He is a young & dynamic Technical Person worked 14 years in Teaching in Mechanical & Aeronautical field and 3 years in Industry from Thermal Power plants. Dr. S. Sreenatha Reddy is having rich experience in administrative area. Earlier he worked as Principal, Head of both the Aeronautical & Mechanical department, coordinating R&D cell for Aeronautical Research and Development Board (ARDB) projects, TPO & developing courseware and implementing ISO 2001 and NBA Accreditation.