International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

RESEARCHERID
THOMSON REUTERS

[Jangam *et al.*, 9(5): May, 2020]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN OF HIGH PERFORMANCE CONCRETE UPTO 120 MPA

Ms. Aishwaryadevi S. Jangam.*[1], Prof. Santosh S. Mohite[2], Mr. Bajirao V. Mane[3].

[*1]PG Student, M.E Civil (Structure),Department of Civil Engineering, Annasaheb Dange College of Engineering & Technology, Ashta (Sangli), Maharasgtra, India.

[2]Head of Department, Department of Civil Engineering, Annasaheb Dange College of Engineering & Technology, Ashta (Sangli), Maharasgtra, India.

[3]Assistant Professor, Department of Civil Engineering, Annasaheb Dange College of Engineering & Technology, Ashta (Sangli), Maharasgtra, India

DOI: 10.5281/zenodo.3870451

ABSTRACT

The paper represents the study of design of high performance concrete upto 120 MPa. Now A days, Concrete is widely used for construction work. Due to increasing demand of cement it produces environmental pollution because of emission of CO_2gas. To reduce these problems it will be beneficial to use supplementary cementious material with cement. It will reduce cost as well as environmental problem. The research is done on HPC by using two supplementary cementious materials such as metakaolin & alccofine. Metakaolin is the made up by the china clay. Metakaolin is calcined between 600º & 850ºc. Alccofine is the fine material can be used for replacement of cement. By using these materials, the results showed good compressive strength. Design of grade has used of M60,M80, M100, M120. The replacement of cement viz 10% with metakaolin & 5 % with alccofine has taken for mix design.

KEYWORDS: High Performance concrete, Metakaolin, Alccofine , Grade of Concrete M60, M80, M100, M120, Metakaolin, Alccofine.

1.INTRODUCTION

High Performance of concrete which meets special performance and uniformity requirements that cannot be achieved by conventional constituents and normal mixing, placing and curing. High performance concrete is a concrete high posses high durability and high strength as compared to conventional concrete. High performance concrete is designed for more strong and durability as compared to conventional concrete. High performance concrete mixtures are composed the same materials as conventional concrete. But the proportions are designed different, to provide the strength and durability for the structural requirements of the project. High performance concrete is defined as having a specified compressive strength of 55mpa or greater. The high performance concrete contains one or more cementious materials such as fly ash, metakaolin, alccofine, silica fume & GGBS etc and a superplasticizer.

High Performance Concrete is used in bridges , high rise buildings, under water construction , tunnels for durability and high strength. So are of the properties that may be required include.

1) High Strength
2) High Early Strength
3) High durability and long life in severe environment
4) Toughness and impact resistance.
5) Volume Stability

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

The initial cost of high performance concrete is higher than that of conventional concrete but even it works as to be economical. Beacause the high performance concrete in construction consist the long service life of the structure and this type of structures done less damage when it reduces over all cost.

2. EXPERIMENTAL PROGRAM

2.1 Cement

Ordinary Portland cement (OPC) of 53 grade are used throughout the work. Ordinary Portland cement is most common type of cement around the world. For entire project used Penna OPC53.

2.2 Aggregates

Aggregate in material science, a component of composite material that resists compressive stress. Construction aggregate, material used in construction, including sand, gravel, crushed stones, slag, or recycled crushed concrete

2.2.1Coarse aggregate –

A crushed angular sized aggregate having size 10mm was used.
Specific gravity of aggregate - 2.67
Water Absorption- 0.98%
Size - 10 to 20 mm

2.2.2 Fine aggregate -

river sand was used.
Specific gravity of fine aggregate - 2.78
Water Absorption - 1.06%
Fineness Modulus-2.6

2.3 Metakaolin

Metakaolin is made up of china clay or it is also called as kaolin. The size of metakaolin is less as compared to cement particles. Metakaolin is the production of ceramics. Metakaolin reacts fastly and it also reduces the expansion coefficient compared with the Portland cement because of small particle size and high surface area.Metakaolin is the admixture used as partial replacement of cement in high performance concrete.The chemical formula of metakaolin isAL2O3.2SiO2.2H2O.

Physical Properties
Physical form – Powder
Fineness of metakaolin – 700 to 900 m^2/ kg.
Colour of Metakaolin – White / Grey.
Specific Gravity - 2.5.
Specific Surface – 8 to 15 m^2/ kg.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

CHEMICAL COMPOSITION

Chemical Composition	Percentage (%)
Silica (SiO2)	54.3
Alumina (Al2O3)	38.3
KopFerric Oxide (Fe2O3)	4.28
Calcium Oxide (CaO)	0.39
Magnesium Oxide (Mgo)	0.08
Sodium Oxide (Na2O)	0.12
Potassium oxide (K2O)	0.50

Fig 1 : Metakaolin

2.4 Alccofine 1203: -

Alccofine 1203 is represents ultrafine particle size and low calcium silicate product.As per requirement of concrete performance, Alccofine 1203 provides reduced water demand for a given workability. Alccofine 1203 is a microfine and it is used as admixture for improving the performance of concret without increasing the cost. There are two types of alccofine i.e alccofine 1203 and alccofine 1101 with respect to low calcium silicate and high calcium silicate. Due to high calcium oxide content the performance of alcccofine is very good as compared to other admixtures.

Physical Parameters of Alccofine 1203

Specific Gravity	Bulk Density (kg/m³)	Partical size distribution (µ)		
2.9	600-700	D10	D50	D90
		1-2	4-5	8-9

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Chemical Parameters of Alccofine 1203

CaO	Al2O3	SIO2	Glass content
31-33%	23-25%	33-35%	>90%

Fig 2 : Alccofine

2.5 Superplasticizer

Superplasticizer is also called as high range water reducers. Superplasticizer is a additional material used for the high strength concrete or high performance concrete Masterglenium sky 8654 of BASF was used for mix.

Fig 3 : Superplasticizer (Masterglenium sky 8654)

3. SAMPLE MIX DESIGN OF M60

1. Grade : M60
2. Type of Cemrnt : OPC 53 Grade
3. Maximum size of aggregate : 20mm
4. Maximum water cement ratio : 0.35
5. Workability : 100mm

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

6. Chemical Admixture : Superplasticizer
7. Method of Concrete placing : By hand
8. Degree of Supervision : Good

Test Data for Material

Fineness Modulus of fine aggregate : 2.6
Specific gravity of coarse aggregate : 2.82
Specific gravity of fine aggregate : 2.81
Specific gravity of Cement : 3.15

1) Water binder ratio : 0.32 to 0.38
Let's assume W/B – 0.35

2) Water content :
Water dosage = 160 lit / m^3

3) Binder content
B = 160 / 0.35 = 457.142 kg / m^3
Metakaolin 10 % = 45.714 kg / m^3

Alccofine 5 % = 22.857 kg / m^3

Cement Content = 388.571 kg / m^3

4) Coarse aggregate content
From figure 5.6 for cubic aggregates , it is 1100 kg / m^3
Entrapped air = 2%

5) Superplasticizer
M sol = 457.142 ×0.6/100 = 2.742 kg / m^3
V liq = 2.742 / 0.34 × 1.1 = 8.871
V w = 8.871 ×1.1 × (100-34)/100 = 6.440
V sol = 8.871 – 6.440 = 2.43 kg / m^3

6) Volume of solids
Volume of cement = 388.571 / 3.15 = 123.355
Volume of metakaolin = 45.714 / 2.30 = 19.875
Volume of alccofine = 22.857 / 2.9 = 7.881
Volume of coarse aggregate = 1100 / 2.81 = 391.459
Volume of entrapped air = 2 × 10 = 20 lit / m^3.

7) Total volume
160 + 123.355 + 19.875 + 7.881 + 391.459 + 20 + 2.43 = 725 lit / m^3.

8) Volume of sand
1000 – 725 = 275 lit / m^3.

9) Saturated surface dry of sand
= 275 × 2.66
= 731.5 kg / m^3

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Final Quantities Required For M60 Concrete Are As Follows:
Wt. of water = 160 kg/m3
Wt. of cement = 388.571 kg/m3
Wt. of Metakaolin = 45.714 kg/m3
Wt. of Alccofine = 22.857 kg/m3
Wt. of Coarse aggregate = 1100 kg/m3
Wt. of Fine aggregate = 731.5 kg/m3
Wt. of Super plasticizers = 2.43kg/m3

Final Mix Proportion: (kg/m3)
C : M : A : W : CA : FA : S
388.571 : 45.714 : 22.857 : 160 : 1100 : 731.5 : 2.43

4. MANUFACTURING & CASTING OF HPC

The high performance concrete was mixed in a ribbon mixer of 250kg capacity. All the concrete ingredients was used to weigh & batch must be accurate. In any variation the high performance concrete are very sensitive in their proportions.

4.1 Mixing

The high performance concrete was mixed in a ribbon mixer of 250kg capacity. All the concrete ingredients was used to weigh & batch must be accurate.

Fig 4 : Ribbon Mixer

4.2 Compaction of concrete

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

4.2.1 Table vibrator

This is the special case of formwork vibrator, where the vibrator is clamped to the table.

Fig 5 : Compaction of Concrete

4.2.2 Curing of HPC

Curing is the process of controlling the rate and extent of moisture loss from concrete to ensure an uninterrupted hydration of Portland cement after concrete has been placed and finished in its final position.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Fig 6 : Curing of Concrete

5. INSTRUMENTATION AND TEST SET UP

The test were carried on a compression testing machine of 3000 KN capacity.The cubes and cylinders were tested on compression testing machine.

Fig 7 : Compression Testing Machine

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Mix proportioning for four target compressive strength

Materials	Target Compressive strength in MPa			
	60	80	100	120
Water cement ratio	0.35	0.30	0.25	0.23
Cement,kg/m^3	388.57	439.17	467.50	532.174
Fine aggregate, kg/m^3	731.5	691.63	708.39	630.00
Coarse aggregate, kg/m^3	1100	1100	1100	1085
Water ,kg/m^3	160	155	137.5	144
Metakaolin	45.71	51.66	55	62.60
Alccofine	22.85	25.83	27.5	31.30
High range water reducer Masterglenium 8654 in%	0.4	0.4	0.6	1.00

Test Results of High Performance Concrete

Grade of concrete in MPa	Cube strength in N/mm^2	Split tensile strength in N/mm^2	Flexural Strength in N/mm^2
60(3Day)	23.54	0.6	2.41
60(7Day)	38.60	1.34	3.80
60(28Day)	61.46	2.99	5.96
80(3Day)	39.78	0.64	3.08
80(7Day)	59.01	1.66	4.96
80(28Day)	80.01	3.30	7.87
100(3Day)	39.96	0.83	3.53
100(7Day)	61.61	2.06	5.79
100(28Day)	98.07	3.95	9.10
120(3Day)	55.09	1.02	4.62
120(7Day)	63.38	2.27	7.32
120(28Day)	107.44	4.12	11.18

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Crack Pattern of Cubes, Bems and Cylinders

Fig 8: Crack pattern of Cubes

Fig 10 : Crack Pattern of Cylinders

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Fig 11 : Crack Pattern of Beams

Fig 12 : Crack Pattern of Beams

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

6. CONCLUSION

- In the proposed study,High Performance Concrete from M60 MPa to M120MPa mix design is carried and studied mechanical properties of high performance concrete such as compressive strength, split tesile strength and flexural strength.
- It has been observed that by using cementious materials such as metakaolin and alccofine the results observed good compressive strength of concrete and also it reduces overall cost.
- High performance concrete has more durable and high strength. It is used for high rise buildings, under water constructions, bridges ,dams etc.Hence high performance concrete are more strengthen as compared to conventional concrete.
- It can reduce cost as well as achieve economy and also reduces environmental pollution

7. REFERENCES

[1] Muralinathan P.,Joshua Daniel A, Sivakamasundari S.,Study of high strength concrete using metakaolin atelevated temperatures, SRMIST, Chennai, India,2018,pp.1267-1273.
[2] B.Naresh Goud, K.Nagraj, Characteristics of High Performance Concrete using Metakaolin , Malla Reddy Engineering College, Maissamnaguda, Dullapally Road , Hyderabad , Telangana, India,2017.
[3] Dr. Mahesh Awati, Dr. R.B.Khadiranaikar, Mix Design & Some Mechanical properties of HPC,Tontadarya college of engineering Gadag,2016.
[4] Yogesh R. Suryawanshi, Amar G. Kadam, Experimental study on compressive strength of concrete by using metakaolin, JSPM' ICOER, Pune, Maharashtra , India,2015.
[5] Prof. R.M .Sawant, Dr. Y.M.Ghugal, Recent trend : Use of Metakaolin as admixture a review, Government College of Engineering, Karad , Maharashtra, India, 2015 pp. 8-14.
[6] Fouzia Shaheen , Samiuddin Fazil Mohammed, Effect of Metakaolin & alccofine on strength of concrete, Indian Institute of Technology Guwahati,2015.
[7] Yatin Patel,B.K.Shah, Prof.P.J.Patel, Effect of Alccofine & fly ash addition on the durability of high performance concrete,Ganpat university kherava mehsana gujrat india, 2013.
[8] B.B.Patil, P.D.Kumbhar, Strength & Durability properties of High Performance Concrete incorporating High Reactivity Metakaolin, Rajarambapu Institute of Technology, Rajaramnagar (Sangli), M.S, India, 2012.