



Development of High Quality No Fine Concrete

by

Dr. G. Nandini Devi

Professor, Department of Civil Engineering,
Adhiyamaan College of Engineering, Hosur, Tamilnadu, India.

Email: gdevi80@gmail.com

Development of High Quality No Fine Concrete

Abstract:

Natural sand is being extorted at an increasing rate. Construction industry is looking for an alternative material for sand and research is going on to find new innovative concrete. No fines concrete has been generally used for paving applications, other non-structural application, such as reinforced panels, acoustic, thermal and permeability properties because of its previous nature. In this work, 12.5mm size coarse aggregate is used in place of usually used 20mm size in no fine concrete with various mix ratio of cement and 12.5mm coarse aggregate. Specimens were casted and tested for its mechanical properties. Results are compared with M25 conventional concrete.

Keywords: *Natural sand, No Fine Concrete, Tensile strength, Flexural strength, Innovative concrete, Compressive strength.*

INTRODUCTION

Concrete is the base of all construction activity worldwide and is the second most used material after water, with nearly 3 tonnes used yearly by each person on earth. India uses about 450 million cubic metre of concrete per annum. Natural sand is being extorted at an increasing rate. As a result, prices are being pushed up because of the increasing scarcity of natural sand. In most areas of India, the mining of natural sand has been banned. So construction industry is looking for an alternative material for sand and research is going on to find new innovative concrete without its basic ingredients like cement, sand and coarse aggregate, thus leading to fly ash concrete, geopolymer concrete, recycled waste aggregate etc.

No-fines concrete is generally a crushed rock or gravel of 20 mm single size aggregate coated in a cement slurry with no fine aggregate addition. Very often only single sized coarse aggregate, of size passing through 20 mm retained on 10 mm is used. It has good drainage properties due to its open texture. The ratio of aggregate to cement by volume is generally 6:1 or 10:1 by mass. Because it does not contain any fine aggregate the mix cannot segregate and consequently it can be dropped from a height. Formwork pressures are lower than for normal concrete so shutters can be lighter and pour height lifts greater.

The strength of no-fines concrete is dependent on the water/cement ratio, aggregate-cement ratio and unit weight of concrete. The water/cement ratio for satisfactory consistency will vary between a narrow range of 0.38 and 0.52. The bond strength of no-fines concrete is very low and, therefore, reinforcement is not used in conjunction with no-fines concrete. However, if reinforcement is required to be used in no-fines concrete, it is advisable to smear the reinforcement with cement paste to improve the bond and also to protect it from rusting.

For quality control and quality assurance, unit weight or bulk density is the preferred measurement because some fresh concrete properties, such as slump, are not meaningful for pervious concrete.

SiddharthTalsania et al have analysed the strength and permeability of pervious concrete by replacing cement with various industrial waste materials such as waste glass powder, hypo sludge, ceramic waste and rice husk ash.

1. MATERIALS AND METHODS

1.1. Materials Used and Mix Proportioning

Materials used are cement, coarse aggregate and water. For conventional concrete mix of M25 Grade, proportion as recommended by IS 456:2000 is used i.e. 1:1:2 with water-cement ratio of 0.45. Coromandal king OPC 53 Grade cement, fine aggregate conforming to Zone III, 20mm size coarse aggregate are used. For No Fine Concrete, Coromandal king OPC 53 Grade cement, coarse aggregate of size passing through 20 mm retained on 10 mm are used. Potable tap water available in laboratory with pH value of 7.0 ± 1 and conforming to the requirement of IS 456:2000 was used for mixing, casting the concrete and curing the specimen as well. Cubes, cylinders and prisms were casted, cured using water and tested. Table.1 gives the mix proportion of conventional and No Fine Concrete. Figure.1 and Figure.2 shows the mixing and casting of specimens.

1.2. Testing Of Specimen

The following tests were carried out as per IS: 3495 (Part 1):1992 to find the compressive strength, split tensile strength and flexural strength of specimens.



a). Compressive Strength Test

Compressive strength test on cube specimen of size 150mm was conducted at 7th, 14th and 28th days. CTM (compression testing machine) of capacity 100 tonnes is used. The concrete specimen were placed with flat faces. The compressive strength test was carried out by applying a uniform rate of loading to the concrete specimen by compressive testing machine. The load was applied till failure occurred on the concrete specimen. The maximum load at which the specimen failed was noted. Figure. 3 shows testing of cube specimens.

b). Split Tensile Strength Test

Split tensile strength test on cylinder specimen of size 150mm diameter and 300mm height was conducted at 28th day to measure tensile strength of concrete. Figure.4 shows testing of cylinder specimen for split tensile strength.

c). Flexural Strength Test

Flexural strength was conducted on prism of size 100mmX100mmX500mm at 28th day to measure the flexure strength of concrete. Factors influencing the flexural strength are degree of compaction, porosity, and the aggregate-to-cement (A/C) ratio. Figure. 5 shows the flexural test on prism specimen.

2. RESULTS AND DISCUSSIONS

The cube compressive strength of conventional concrete at 28th day is 37 N/mm². For mix M1, M2 and M3, the cube compressive strength at 28th day is 31.5 N/mm², 27 N/mm² and 14 N/mm² respectively. Table. 2 shows the results of compression test carried out on cube specimens. In all mixes, it is found that about 50% of 28th day strength is reached and about 75% of 28th day strength is reached. Table. 3 gives comparison of compressive strength of different mixes. It is found that mixes M1 and M2 has reached the design strength i.e. 25 N/mm². Figure. 6 shows the comparison of conventional concrete with No fine concrete of different mix ratios.

Split tensile strength of cylinder specimens at 28th day are tabulated in Table. 4 and Figure. 7 shows the split tensile strength of conventional concrete with different mix ratios of No fine concrete. It is observed that no fine concrete has less strength than conventional concrete.

Table. 5 gives flexural test values of No fines concrete at 28 Days curing and Figure. 8 shows the flexural strength of conventional concrete with No fine concrete of different mix ratios. IS 456:2000 recommends the value of $0.7\sqrt{f_{ck}}$ for flexural strength. As observed earlier, here also reduction in strength and is tabulated in Table.5

3. CONCLUSIONS

From experimental investigation, the following conclusions were made:

- Mixes 1:2 and 1:3 of no fine concrete has reached the design strength i.e. 25 N/mm². Mix 1:2 is 16.7 % more than mix 1:3.
- Split tensile strength of mix 1:2 and 1:3 obtained at 28 day is 14% and 36% lesser than the conventional concrete.
- Flexural strength of mix 1:2 and 1:3 obtained at 28 day is 23% and 57% lesser than the conventional concrete.
- Grading of 12.5mm size coarse aggregate is better than normal 20mm size coarse aggregate in No fine concrete. Mix 1:2 is found to have mechanical properties close with conventional concrete.

REFERENCES

- [1] Young Min Joung, B.S., Dr. Zachary C. Grasley, "Evaluation and optimization of pervious concrete with respect to permeability and clogging".
- [2] A.M. Amde and S. Rogge, "Specifications & Development of high quality pervious concrete".
- [3] Vimy Henderson and Robert Loy, "Behaviour and performance of pervious concrete pavement".
- [4] Darshan S. Shah 1, Jayeshkumar Pitroda, J.J.Bhavsar, "Pervious concrete concept for rural road pavement"
- [5] IS 456 (2000) Indian Standard for Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standards, New Delhi. 2002.
- [6] IS 15388: 2003 Indian Standard for Silica Fume Specifications - Code of Practice, Bureau of Indian Standards, New Delhi. 2002.
- [7] IS 10262: 2009 Indian Standard for Guidelines For Concrete Mix Design - Code of Practice, Bureau of Indian Standards, New Delhi. 2002.



Figure 1. Mixing of ingredients



Figure 2. Casting of Specimens



Figure 3. Compression Test of Cube Specimens



Figure 4. Split Tensile Test



Figure. 5 Flexural Test on prism

Table 1. Mix proportion of No Fine Concrete

<i>Mix</i>	<i>Cement</i>	<i>Fine Aggregate</i>	<i>Coarse Aggregate</i>	<i>Water</i>
Conventional concrete	1	1	2	0.45
M1	1	-	2	0.45
M2	1	-	3	0.45
M3	1	-	4	0.45



Table 2. Compressive Strength Results of Cube Specimens

Mix	Day	Trial -1, (kN)	Trial -2, (kN)	Compressive Strength, (N/mm ²)	Percentage of its 28 th day strength
Conventional concrete	7 th	401	410	18.0	48.65%
	14 th	520	558	24.0	64.86%
	28 th	860	820	37.0	100%
M1 - 1:2	7 th	311	333	14.3	45.40%
	14 th	548	559	24.6	78.10%
	28 th	710	692	31.5	100%
M2 - 1:3	7 th	355	365	16.0	59.25%
	14 th	455	480	21.0	77.78%
	28 th	595	613	27.0	100%
M3 - 1:4	7 th	192	203	8.7	62.14%
	14 th	268	231	11.0	78.57%
	28 th	320	305	14.0	100%

Table 3. Comparison of Compressive Strength of different Mix

Mix	28 th Day Compressive Strength, (N/mm ²)	Percentage with respect to conventional concrete
Conventional concrete	37.0	100%
M1 - 1:2	31.5	85.13%
M2 - 1:3	27.0	72.97%
M3 - 1:4	14.0	37.84%

Table 4. Split Tensile Strength of Cylinder Specimens at 28th Day

Mix	Trial-1(kN)	Trial-2 (kN)	Trial-3(kN)	Split Tensile Strength (N/mm ²)	% Difference with Conventional Concrete
Conventional concrete	223	264	278	3.24	-
M1 - 1:2	170	209	214	2.79	86%
M2 - 1:3	153	155	132	2.07	64%
M3 - 1:4	114	121	108	1.613	50%



Table 5. Flexural Test Values of No Fines Concrete at 28 Days Curing

Mix	Trial-1, (kN)	Trial-2, (kN)	Flexural strength, (N/mm ²)	% Difference with Conventional Concrete
Conventional concrete	11.9	12.5	4.88	-
M1 - 1:2	10.5	8.3	3.76	77%
M2 - 1:3	5.38	5.2	2.1	43%
M3 - 1:4	0.3	0.4	1.4	28.7%

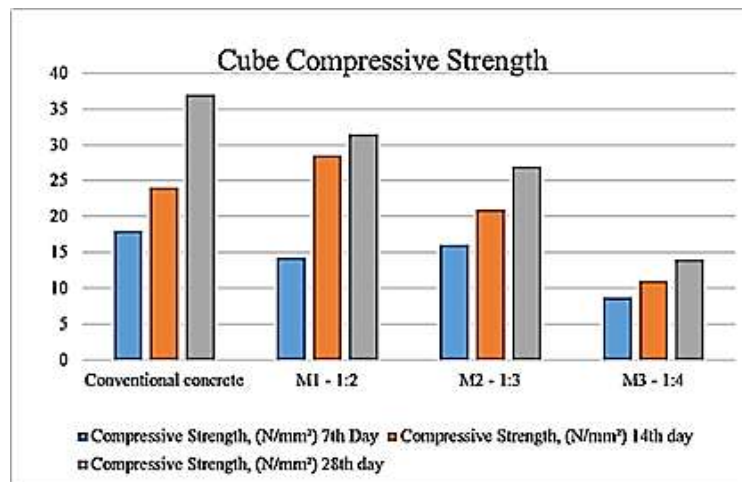


Figure. 6 Comparison of Conventional Concrete with No fine Concrete of Different Mix

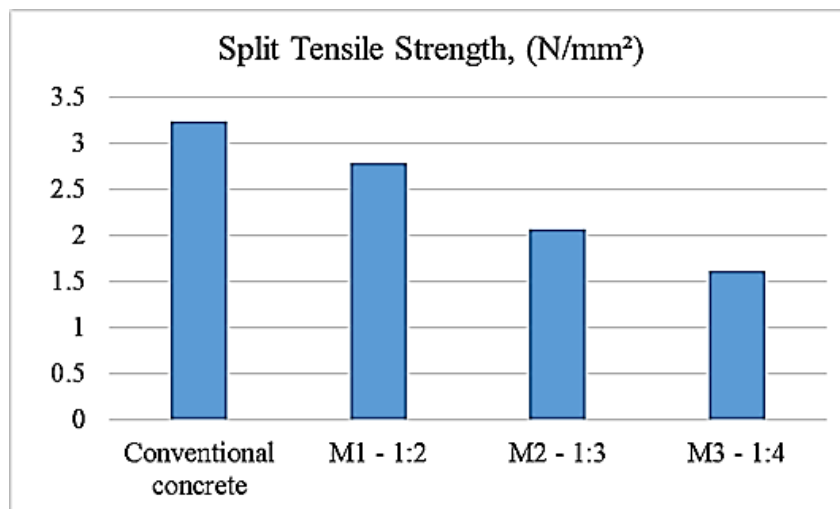


Figure. 7 Split Tensile Strength of Conventional Concrete with Different Mix Ratios of No Fine Concrete

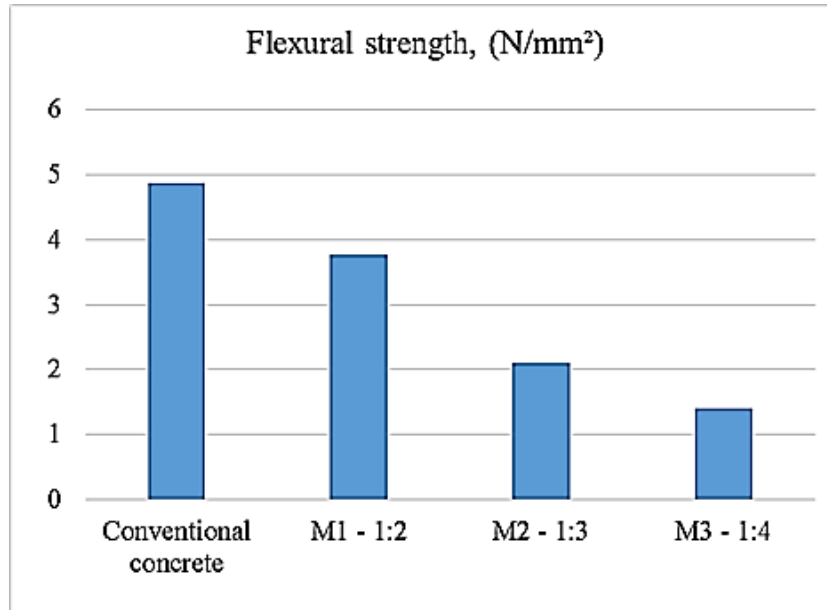


Figure. 8 Flexural strength of Conventional Concrete with No Fine Concrete of different mix ratios