

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2018

Experimental Investigation on Prestressed Concrete Beam Using M-Sand

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ABSTRACT: Sand is one of the main constituents of concrete making about 42 % of volume of concrete used in construction industry. Natural sand is mainly excavated from river beds and contains high percentages of inorganic materials, chlorides, sulphates, silt and clay that adversely affect the strength and durability of concrete reducing the life of structure. Such an alternative is "Manufactured sand". Production generally involves crushing, screening and possibly washing. In this paper, natural river sand is replaced by M-sand by various proportions such as 0%, 50%, etc. For these various replacement percentages, a suitable proportion is selected for a particular grade of concrete to get optimum strength. Construction of structures using prestressed members. Prestressing of structures is gaining popularity because of its better stability, serviceability, economy, aesthetic appearance and structural efficiency. The main aim is to achieve structure with greater strength and economic.

KEYWORDS: Fine aggregate, Coarse aggregate, post-tensioned concrete, M-Sand.

I. INTRODUCTION

Conventionally concrete is a mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river sand. Scarcity of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufacturers to look for suitable alternative fine aggregate. One such alternative is Manufactured sand. Though manufactured sand has been in use in concrete manufacturing in India, the percentage of its contribution is still very negligible. In many parts of India, good natural river sand is not available and this makes manufacturing of good quality of concrete very difficult. A well processed manufactured sand as partial or full replacement to river sand is the need of the hour as a long term solution in Indian concrete industry until other suitable alternative fine aggregate are developed. Since the introduction of post-tensioning to buildings, a great deal of experience has been gained as to which type of building has floors most suited to this method of construction. Many Engineers and Builders can identify at a glance whether the advantages of post-tensioning can be utilized in any particular situation. Current architecture in India continues to place emphasis on the necessity of providing large uninterrupted floor space, flexibility of internal layout, versatility of use and freedom of movement. All of these are facilitated by the use of post-tensioning in the construction of concrete floor slabs, giving large clear spans, fewer columns and supports, and reduced floor thickness.

II. MATERIALS AND METHODS

Cement:

Cement is a binder that sets and hardens and can bind other materials together. Ordinary Portland Cement (OPC) 53 grade is used. The most common cement used is ordinary Portland cement. Out of the total production, ordinary Portland cement accounts for about 80 to 90 percent.

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Fine aggregate:

The specific gravity of fine aggregate was 2.64. The sand particles should also pack to give minimum void ratio, higher voids content leads to requirement of more mixing water. In the present study the sand conforms to zone II as per the Indian standards. The fine aggregate belongs to grading zone II.

Coarse aggregate:

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.77. The coarse aggregate is having dust particles and so it could be cleaned well by washing and removing the dust particles. The sieve analysis of fine and coarse aggregates is confirmed to IS10262.

Manufactured Sand

The fine aggregates or sand used is usually obtained from natural sources specially river beds or river banks. Now-a-days due to constant sand mining the natural sand is depleting at an alarming rate. Sand dragging from river beds has led to several environmental issues. Due to various environmental issues Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. There is an urgent need to find an alternative to river sand. The only long term replacement for sand is manufactured sand. The cheapest and easiest alternative to natural sand is manufacturing sand by crushing rocks/stones in desired size and grade by suitable method. Sand produced by such means is known as manufactured/ crusher/artificial sand.

Stages Of Post-Tensioning

In post-tensioning systems, the ducts for the tendons (or strands) are placed along with the reinforcement before the casting of concrete. The tendons are placed in the ducts after the casting of concrete. The duct prevents contact between concrete and the tendons during the tensioning operation. In un-bonded post-tensioning, as the name suggests, the ducts are never grouted and the tendon is held in tension solely by the end anchorages. The following sketch shows a schematic representation of a grouted post-tensioned member. The profile of the duct depends on the support conditions.

Devices

The essential devices for post-tensioning are as follows.

- 1) Casting bed
- 2) Mould/Shuttering
- 3) Ducts
- 4) Anchoring devices
- 5) Jacks
- 6) Couplers (optional)
- 7) Grouting equipment (optional).

Anchoring Devices

In post-tensioned members the anchoring devices transfer the prestress to the concrete. The devices are based on the following principles of anchoring the tendons.

- 1) Wedge action
- 2) Direct bearing
- 3) Looping the wires

Wedge Action

The anchoring device based on wedge action consists of an anchorage block and wedges. The strands are held by frictional grip of the wedges in the anchorage block. Some examples of systems based on the wedge-action are Freyssinet, Gifford-Udall, Anderson and Magnel-Blaton anchorages. The following figures show some patented anchoring devices.

Direct Bearing

The rivet or bolt heads or button heads formed at the end of the wires directly bear against a block. The B.B.R.V post-tensioning system and the Prescon system are based on this principle.

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Looping The Wires

The Baur-Leonhardt system, Leoba system and also the Dwidag single-bar anchorage system, work on this principle where the wires are looped around the concrete. The wires are looped to make a bulb. The following photo shows the anchorage by looping of the wires in a post-tensioned slab.

Ducts

Bonded post-tensioning has *prestressing* tendons permanently bonded to the surrounding *concrete* by the in situ grouting of their encapsulating *ducting* following tendon tensioning

Jacks

The working of a jack and measuring the load were discussed in Section 1.3, Pretensioning Systems and Devices . The following figure shows an extruded sketch of the anchoring devices.

Strands

Tendons may consist of single wires, multi-wire *strands* or threaded bars, and are most commonly made from high-tensile steels, carbon fiber or arm.

Couplers

The couplers are used to connect strands or bars. They are located at the junction of the members, for example at or near columns in post-tensioned slabs, on piers in post-tensioned bridge decks.

The couplers are tested to transmit the full capacity of the strands or bars. A few types of couplers are shown.

Grouting

Grouting can be defined as the filling of duct, with a material that provides an anticorrosive alkaline environment to the prestressing steel and also a strong bond between the tendon and the surrounding grout.

Mix design

The mix design of M35 grade concrete is calculated using IS 456-2000 and IS 10262-2009. The material required as per design are given in Table: 1

Materials	W/C ratio	Cement	Fine aggregate	Coarse aggregate
Ratio	0.5	1	1.5	2.9

Table: 1 Material required as per is method of design

Compressive Test:

Type Of Mix	Load At Failure	Compressive Strength(N/Mm ²)	Mean (N/Mm ²)
0% M sand	769 N	34.17	34.64
	790 N	35.11	
25%Msand	744 N	33.06	33.86
	780 N	34.66	
50%Msand	820 N	36.44	37.15
	852 N	37.86	

Table 2: Compressive Strength for 28days

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Fig 1: a) Cubes b) Compressive test

Preparation of specimen

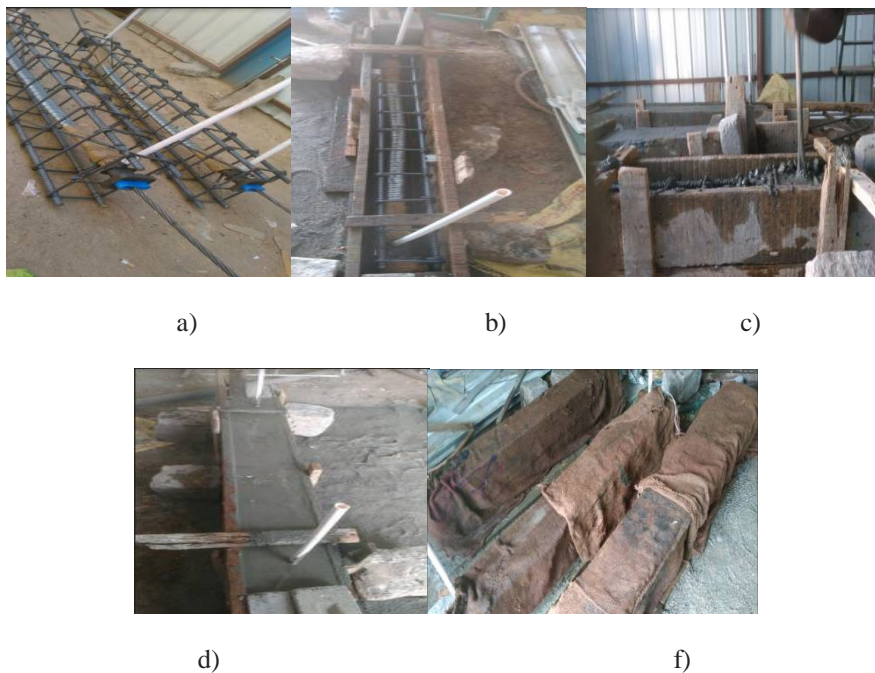


Fig. 2. (a) reinforcing beam (b) shuttering beam(c) compaction (d) Concreting beam (e) Curing beam

SPECIMEN DETAILS:

The following table shows the details of the specimens prepared for casting process.

S.NO	SPECIMENS	M Sand replacement %	TOTAL NO
1	POSTTENSION CONCRETE BEAM	0%	1no
2	POSTTENSION CONCRETE BEAM	50%	2no

TABLE: 3specimen details

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III. FLEXURAL STRENGTH FOR RCC BEAM

All beams (100mm x 150mm in cross section and 1600mm in length) were tested as simply supported beams under three point loading over an effective span of 1400mm. The load shall be applied at a rate of loading of 400kg/min for the 15 cm specimens and at a rate of 180kg/min for the 10cm specimens. The loads were applied at a distance of 533mm on either side of the mid span of the beams of 1600mm length. The loads were monitored through a high accuracy load cell with a load sensitive of 0.1 tonnes. For this case, mid span deflection was measured using dial gauges of least count 0.01mm. The parameters such as initial cracking load, ultimate load and the deflected shape of the specimens were noted.

Determine the modulus of rupture (F_b) = $3Pl / 2bd^2$

Where

- p = maximum load
- L = length of the specimen in mm
- b = breath of the specimen
- d = depth of the specimen.

Tensioning on beam :

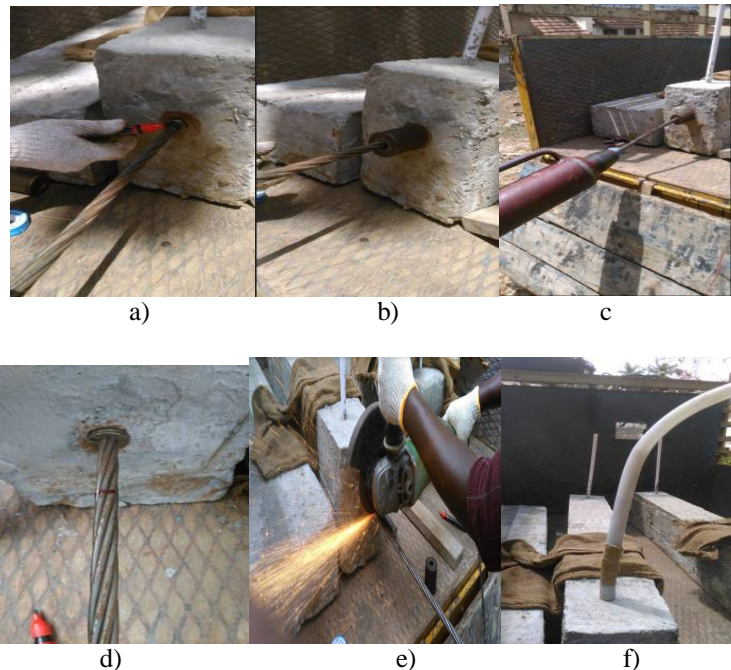


Fig. 3 (a) Before tension (b) Inserting barrel (c) Tensioning on beam (d) after tension (e) cutting excess (f)Grouting

IV. EXPERIMENTAL RESULTS

The following table shows the details of the flexural strength specimens.

S.NO	SPECIMEN	LOAD (kN)	FLEXURAL STRENGTH(N/mm ²)
1	POSTTENSION CONCRETE BEAM USING 0% M-SAND	76	47.29
2	POSTTENSION CONCRETE BEAM USING 50% M-SAND	80	49.77

Table :4Flexural Strength

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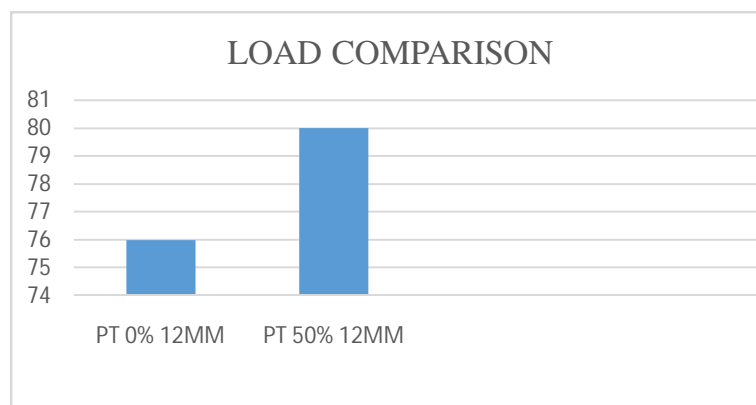
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Fig: 4Initial crack formation

LOAD COMPARISON:

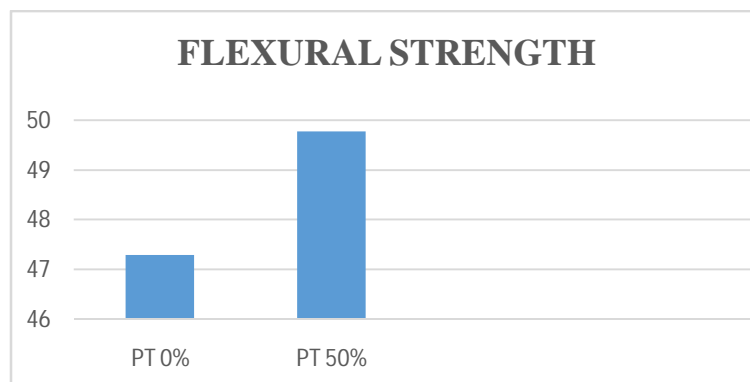
The following graph table shows the details of the load comparison for specimens.



LOAD COMPARISON

FLEXURAL STRENGTH:

The following graph shows the details of flexural strength of specimens.



FLEXURAL STRENGTH

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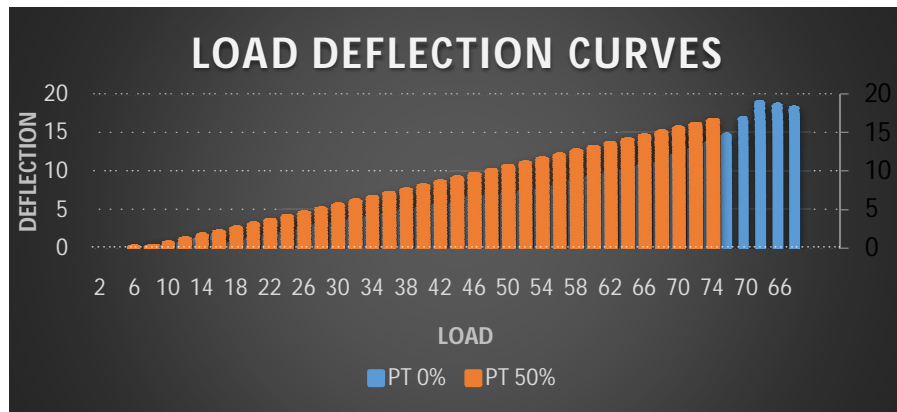
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LOAD DEFLECTION CURVE

The following graph shows the details of load deflection of specimens



LOAD DEFLECTION CURVE

V. CONCLUSION

From the present investigation and limited observations reported, the use of M-sand exhibited excellent performance due to efficient micro filling ability and pozzolanic activity. It was observed that the increase in early strength by the addition of 50 % of M-sand and decrease in 0% of M-sand. Therefore, the results of this study provide a strong recommendation for the combined use of M-sand in concrete manufacturing. M-sand qualifies itself as suitable substitute for river sand. Thus, it can be concluded that the replacement of natural sand with M-sand, as partial replacement in concrete is possible. However, it is advisable to carry out trial casting with M-sand proposed to be used, in order to arrive at the water content and mix proportion to suit the required workability levels and strength requirement. Also it is advisable to remove excess fines of size up to 150 microns by washing.

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