EFFECTS OF MANUFACTURED SAND ON STRENGTH CHARACTERISTICS AND WORKABILITY OF FIBER REINFORCED CONCRETE

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ABSTRACT

Concrete is the most widely used composite construction material. Fine aggregate place a very important role for imparting better properties to concrete in its fresh and hardened state. Generally, river sand is used as fine aggregate for construction. Due to the continuous mining of sand from river bed lead to the depletion of river sand and it became scarce material. Also, sand mining from river bed caused a lot of environmental issues. So, as a substitute to river sand in the concrete mix, M-sand (manufactured sand) has been used also with 1% of Galvanized Iron Fibers.

In this present experimental study, a comparative study has been carried out to check the usage of M-sand in the place of river sand. This study involves determination of some major properties of concrete like compressive strength, tensile strength and durability in water made of both the river and m sands.

Based on proposed studies, quality of manufactured sand is inequivalent to natural river sand in many respects, such as cost, strength, availability, presence of impurities and so on. Conclusion has been arrived that M-sand is the best alternative material to natural river sand and could be effectively used in making concrete which provides adequate strength and durability for the concrete.

In the design of concrete structures, concrete is taken into account by taking its compressive strength value. A compressive strength of concrete made of M-sand is observed to be very nearer to the strength of concrete made of natural river sand in the present investigation, thereby 100% replacement of M-sand is reasonable with 1% of G.I. fibers. Replacement of natural river sand by M-sand in this project has been done as 0%,25%,50%,75%,&100%.

The main objectives of our project is to study the different proportions of M-sand with constant fiber reinforced concrete.

I. INTRODUCTION

1.1 GENERAL:

Concrete is the most prominent part in the structural construction, it is the most widely used construction material throughout the globe. Concrete is placed at very next position after water. Construction consisting of cement, fine aggregate, coarse aggregate, water and some admixtures in required proportion for a quick and better results in different conditions.

The construction industries consumed the large quantity of concrete worldwide.Using natural sand conventional concrete is produced from river beds that as fine aggregate in India.The environmental problem is decreasing natural sources so that there is a restriction on sand quarrying resulted in scarcity and so that its cost is

high. There are no normally particles are present in river sand indesired quantity. It is danger to the environment to dig excess amount of sand from river bed. It affects the water level in ground. So alternative material must be found. The easy and cheap way of getting substitute for natural sand is obtained from granite stone quarries, lime stone and crushing stone quarries. This is known the manufactured sand.

By the replacement of natural sand in concrete may attain more or less compressive strength,tensile strength, permeability, modulus of rupture and lower degree of shrinkage as the control concrete. Concrete using various methods of obtaining sand as fully replacement for conventional natural sand. Then result are found better workability and high compressive strength and split tensile strength.

1.2 SIGNIFICANCE:

In structural construction, the usage of natural sand is most prominent material of concrete. Resources having natural sand have no problem in construction industry, but places with the other type of sand is also available as equal to then natural sand. We need to preserve the natural sand material for upcoming generations, it is very important to use other available resources as construction material up to some percent. Because of this reason this study should be carried out to overcome the problem as well as to the benefits of coming generations.

The consumption of concrete in worldwide is estimated at 3 billion tons or half ton for every living human beings. In many places the ratio of concrete consumption to steel consumption exceeds 10 to 1.Why it is the most widely used engineering or structural materials? Cheapest and most readily available material on the job. Cement and aggregates are relatively inexpensive and are more commonly available in most area of the world. About 10000yen/1m3, it is less than 5yen/kg. Cement concrete is much more durable and it can be formed into a variety of forms and sizes.

1.3OBJECTIVES:

1. To provide some details about the use of manufactured sand and galvanized iron fibres.
2. To find the suitability of locally manufactured sand as a natural sand.
3. To be examine the workability, compressive and split tensile strength of concrete with replaced m-sand.
4. To be examine the shear resistance by G.I. fibres.
5. Beneficial and economic value to the local people.

To make explore the usage of locally available materials in structural constructions.

II. LITERATURE REVIEW

2.1 INTRODUCTION:

2.1.1 Previous Study:

The research person Ilangovanaet.al in 2008 studied the feasibility of usage of manufactured sand as hundred percent substitutes for natural sand in concrete. Using design approach of IS, ACI, USBR, RN.No.4 and BRITISH codes for both conventional concrete and M – Sand concrete Mix design has been developed for three grades. Tests were conducted for cubes and cylinders to study the strength of concrete made of manufactured sand and compared with the natural sand concrete. An attempt has also been made to durability

studies on manufactured sand when compared with the natural sand concrete. And it is found that the compressive strength, split tensile strength and durability studies of concrete made of manufactured sand are nearly 10% more than the conventional concrete.

2.1.2 Present study:

In the present investigation we design mix for M25 has been calculated using I.S code 10262-2009 for the conventional concrete and quarry dust concrete. Tests were conducted for cubes and cylinders to study the strength of concrete by using manufactured sand and the results compared with the natural sand concrete. During the present study, 0%, 25%, 50%, 75% and 100% of traditional fine aggregate with replaced with the robo sand. Compressive strength, split tensile strengths and workability were found after 7 and 28 days curing.

Since granite stone is using as coarse aggregate in structural construction, even the other materials available in huge quantity. The common people are not ready to use the other quality materials like lime stone, marble stone, hard granite stone etc in the construction industry as concrete material. We should need to improve some awareness about this type of materials by performing some research on this type of materials. Due to this connection a small research work has been performed on the cube moulds and cylindrical moulds to the compressive strength, split tensile strength and of concrete and workability is carried out on fresh concrete respectively.

2.2 THEORY OF SAND:

Sand is wide range needful material for the construction but this important material must be purchased with all care and vigilance. Any sand which is used in the construction purpose must be clean, free from stones and impurities. It is so important to know what type of sand is beneficial for construction purpose and as sand is also classified into three different forms that make it suitable for specific type of construction.

Sand is classified as: Fine Sand (0.075 to 0.425 mm), Medium Sand (0.425 to 2 mm) and Coarse Sand (2.0 to4.75 mm). Any how the classification of sand further has types of sand in particular and on that basis only they are being incorporated in the construction.

Fig 1: Sample of Natural River Sand

2.3 TYPES OF SAND:

2.3.1 Pit Sand (Coarse sand):

Pit sand is classified under coarse sand which is also called badarpurin common language. The coarse sand procures from deep pits of abundant supply and generally in orange and red colour. The coarse grain is angular, sharp and certainly free from salts which mostly employed in concreting.

2.3.2 River Sand :

River sand is procured from river streams and banks and is fine in quality unlike pit sand. This sand has rounded grains generally and in white-grey colour. River sand has

used in the construction purpose such as plastering.

2.3.3 Sea Sand :

As the name suggest, sea sand is taken from seas shores and it is generally in distinct brown colour with fine circular grains. For the purpose construction of concrete structure sea sand is avoided, and in engineering techniques because it contains salt which tries to absorb moisture from atmosphere and brings dampness. Eventually cement loses its action when mixed with sea sand that is why it is only used for the local purpose instead of structural construction.

There are different standards for the construction purpose which must be checked and considered for the better construction. The requirement is taken according to which sand is chosen should be like:

• For plastering purpose, the overall fine sand used must not be less than 1.5 while silt is preferred to not less than 4 percent.

• For brick work fine sand used must not be less than 1.2 to 1.5 and silt is preferred is 4 percent generally.

• The concreting work requires coarse sand in modulus of 2.5 to 3.5 and with not less than 4 percent silt content.

Anything should be starts from theory, a theoretical analysis will bring a meaningful and good results to understand the any kind of people. Any experimental analysis is meaningless without theoretical analysis. So in any project it is very important to start with a proper theoretical knowledge about the research. Due to considering the above lines samecontent about the rocks like nature of rocks and characteristics of rock as detailed in the following words.

2.4 GENERAL INFORMATION OF AGGREGATE:

Aggregate are the most important constituents in the concrete. They will give body to the concrete, to reduce the effect economy and the shrinkage. Earlier, aggregates are so considered as chemically inert materials but now it was being recognised that some of the aggregates are chemically active also that certain aggregates exhibits bond at the interface of aggregate and paste. But only fact that the aggregate occupies three – quarters of volume of concrete. It indicates that aggregate has considerable importance in properties of concrete.

To know well about the concrete, it is much essential that one should know more about the aggregates which constitutes major volume in concrete. Without the study of the aggregate in deeply, the study of concrete is incomplete. The range and depth of studies that required to be made in respect of aggregate to understand their widely varying effects and influence on the properties of concrete cannot be underrated.

III. OBJECTIVES & SCOPE OF THE STUDY

3.1 INTRODUCTION:

Concrete is the most prominent part in the structural construction, it is the most widely used construction material throughout the globe. In the construction industry natural aggregate is very essential component of concrete. Since from so many days' concrete manufactures in the construction industries have been understand that they should need to use of available sand materials in spite of searching for perfect suitable sand to make an ideal concrete.

We have some types of materials like m-sand as same as properties of natural sand. So in this process we have used crushed hard granite stone in certain proportions with using constant 1% of proportions of fibres. Accordingly, this investigation is on compressive strength and split tensile strength behaviour of m-sand concrete with constant 1% proportions of fibre.

3.2 OBJECTIVES OF PRESENT STUDY:

1. To know the efficiency of m-sand for structural constructions.
2. To study the performance of fibre reinforced concrete.
3. To know the fresh concrete mix properties of m-sand with and without galvanized iron fibres.
4. To study the compressive and split tensile strength properties of m-sand with and without fibres.

For above objectives some experimental work has been planned in following manner. Total 60cubes and 60 cylindersare prepared. In that 6 cubes and 6 cylinders prepared with natural river sand and remaining 54 cubesand 54 cylinders are prepared by the replacement of natural river sand with manufactured sand (M-Sand) proportion of 0%, 25%, 50%, 75%, 100%. Again this same process is repeated with 1% of fibres by the total volume of concrete.

3.3 DETAILS OF MIX PROPORTIONS:

M25 mix concrete

Water content: 186 liters

W/C Ratio	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)
0.48	387.5	727.85	1106.39
Proportion	1	1.87	2.85

3.4 DETAILS OF CUBE SPECIMENS:

Table 1: Details of Different Cube Specimens

S.NO	Mix Proportion	N.S	M.S	Fibres	No. of cubes	Size of cube(m^3)
1.	MS – 0	100%	0%	0%	6	0.15×0.15×0.15
2.	MS – 25	75%	25%	0%	6	
3.	MS – 50	50%	50%	0%	6	
4.	MS – 75	25%	75%	0%	6	
5.	MS – 100	0%	100%	0%	6	
6.	MS – 0 – 1	100%	0%	1%	6	0.15×0.15×0.15
7.	MS – 25 – 1	75%	25%	1%	6	
8.	MS – 50 – 1	50%	50%	1%	6	
9.	MS – 75 – 1	25%	75%	1%	6	
10.	MS – 100 – 1	0%	100%	1%	6	

3.5 DETAILS OF CYLINDER SPECIMENS:

Table 2: Details of Different CylindersSpecimens

S.NO	Nomenclature	N.S	M.S	Fibres	No. of cylinders	Size of cylinder (m^3)
1.	MS – 0	100%	0%	0%	6	0.0053
2.	MS – 25	75%	25%	0%	6	
3.	MS – 50	50%	50%	0%	6	
4.	MS – 75	25%	75%	0%	6	
5.	MS – 100	0%	100%	0%	6	
6.	MS – 0 – 1	100%	0%	1%	6	0.0053
7.	MS – 25 – 1	75%	25%	1%	6	
8.	MS – 50 – 1	50%	50%	1%	6	
9.	MS – 75 – 1	25%	75%	1%	6	
10.	MS – 100 – 1	0%	100%	1%	6	

3.6 PROJECT SCOPE:

The scope of the project was as follows:

- Construct concrete cubes and cylinders by replacing the manufactured sand with natural river sand in constant 1% proportions with galvanized iron fibresby volume.
- Determine and compare the fresh and hardening properties of fibre reinforced concrete by conducting the different test like square cubes for compressive strength test and cylinders for split tensile strength test of concrete mix.
- Analysis of the results and recommendation to further research area.

IV. EXPERIMENTAL INVESTIGATION AND TEST RESULTS

4.1MATERIALS USED:

Few experimental works have been done on following materials to achieve the specified

objectives, which were said in the previous chapters.

4.1.1 Cement:

A.C.C. Ordinary Portland cement of 53 GRADE was used. The physical and chemical properties ofcement is presented in following tables 4.1 & 4.2.

Table 3: physical properties of cement

S.NO	PARTICULARS	RESULTS	BIS SPECIFICATIONS (IS 12269-2013)
1.	Specific Gravity	3.1	-
2.	Normal Consistency	33%	-
3.	Fineness of Cement (m^2/kg)	289	225 min
4.	Setting Time(minutes): a. Initial setting b. Final setting	 125 185	 30 min 600 max0
5.	Sound Ness: Le-chatleir expansion (mm)	 1.0	 10 max

Table 4: chemical properties of cement

S.NO	PARTICULARS	RESULTS	BIS SPECIFICATIONS (IS 12269-2013)
1.	Soluble Silica (%)	19.96	-
2.	Alumina (%)	5.20	-
3.	Iron Oxide (%)	5.65	-
4.	Lime (%)	60.79	-
5.	Magnesia (%)	1.72	Not more than 6.0 %
6.	Insoluble Residue	0.96	Not more than 4.0 %
7.	Sulphur Calculated as SO_3 (%)	2.61	Not more than 3.5 %
8.	Loss On Ignition (%)	1.47	Not more than 4.0 %
9.	Lime Saturation Factor	0.92	In between 0.80 & 1.02
10.	Proportion Of Alumina To Iron Oxide	0.92	Not less than 0.66
11.	Chloride (%)	0.006	Not more than 0.1 %

Fig 3: Sample of A.C.C. cement

4.1.2 FINE AGGREGATE:

a. Natural River Sand:

Generally, Natural river sand available near pit sand, which is passing through 4.75 mm I.S sieve was used. The physical properties and sieve analysis results are listed in the following tables 4.3 and 4.4.

Table 5: Sieve Analysis of Fine Aggregate

S.NO	IS Sieve	Weight Retained	% Weight Retained	Cumulative % Weight Retained	% Of Passing	Standard Zone - ?
1.	4.75 mm	26	2.6	2.6	97.4	90 – 100
2.	2.36 mm	70	7.0	9.6	90.4	75 – 100
3.	1.18 mm	194	19.4	29	71	55 – 90
4.	600 µ	210	21.0	50	50	35 – 59
5.	300 µ	390	39.0	89	11	8 .0 – 30
6.	150 µ	94	9.4	98.4	1.6	0 – 10
7.	75 µ	12	1.2	99.6	0.4	-
8.	Pan	04	0.4	100	Zero	-

Figure 4: sample of fine aggregate

Table 6:Physical Properties of Fine Aggregate

S.NO	PARTICULARS	RESULTS
1.	Specific gravity	2.78
2.	Fineness Modulus	4.7852
3.	Bulk density	16.70 kn/m^3
4.	Bulking of Sand	4% @11cm
5.	Grading of Sand	Zone –2

b.Manufactured Sand (M-Sand):

The size of manufactured sand (M-Sand) is less than 4.75mm.Manufactured sand is the sand manufactured in the stone quarries. It is a substitute for the river sand used in the construction. Manufactured sand or crusher dust obtained from local granite crushers was used as partial replacement of fine aggregate in the present investigation to cast the concrete cubes. The fineness modulus of Manufactured sand is 3.02. The specific

gravity of Manufactured sand is 2.62 respectively.

Fig 5: Sample of M-Sand

Table 7: sieve analysis of manufactured sand

S.NO	IS Sieve	Weight Retained	% Weight Retained	Cumulative % Weight Retained	% cumulative weight	% of finer
1.	4.75 mm	6.0	1.2	6.0	1.2	98.8
2.	2.36 mm	93	18.6	99	19.8	80.2
3.	1.18 mm	124	24.8	223	44.6	55.4
4.	600 µ	44	8.8	267	53.4	46.6
5.	425 µ	61	12.2	328	65.6	34.4
5.	300 µ	108.5	21.7	436.5	87.3	12.7
6.yu	150 µ	44.5	8.9	481	96.2	3.8
7.	75 µ	16	3.2	497	99.4	0.6

4.1.3 Coarse aggregate:

Natural granite aggregate which is available in the local sources has been used. In this study all-in-all size coarse aggregate which passing through the 20 mm IS sieve and retained in the 10 mm IS sieve has been used for the effective utilization and good placing of coarse aggregate. The following tables 4.5 and 4.6 shows the different properties granite aggregate.

Table 8: sieve analysis of Coarse aggregate

S.NO	IS Sieve	Weight Retained	% Weight Retained	Cumulative % Weight Retained	% Of Passing
1.	63	-	-	-	100
2.	63 – 50	-	-	-	100
3.	50 – 40	-	-	-	100
4.	40 – 31.5	-	-	-	100
5.	31.5 – 25	-	-	-	100
6.	25 – 20	304	6.08	6.08	93.92
7.	20 – 16	3020	60.4	66.48	33.52
8.	16 – 12.5	1476	29.52	96	4
9.	12.5 – 10	180	3.6	99.6	0.4
10.	= 10	20	0.4	100	Zero
Fineness modules = 3.7					

Table 9: properties of Coarse aggregate

S.NO	PARTICULARS	RESULTS
1.	Specific Gravity	2.59
2.	Fineness Modules	3.70
3.	Flakiness Index	18.50 %
4.	Elongation Index	23.7 0%
5.	Crushing Value	15.82%
6.	Impact Value	6.9%
7.	Water Absorption	0.4 %

Figure 6: sample of coarse aggregate

4.1.5 Water:

The water used in this experimental investigation is locally available potable water.

4.2 CASTING:

4.2.1 Cleaning of the moulds:

To start with the experimental work, for each percentage replacement of sand content considered, six cube moulds of size 150x150x150mm, six standard cylindrical moulds of 150mm diameter and 300mm length are taken and these moulds are cleaned without any dust particles and are brushed with machine oil on all inner faces and notch plates of DCN moulds to facilitate easy removal of the notch plates and demoulding of the specimens. Especially inner surface of the cylindrical mould should be smooth and levelled for easy demoulding.

Figure 7: cleaned cylinders

4.2.2 Mixing of the ingredients:

The M25 concrete mix has been designed using ISI method (IS:10262-1982)[80] for zeropercent replacement of natural sand. The mix proportion obtained is 1:1.87:2.85 with water cement ratio of 0.48. Keeping the mass of the coarse aggregates constant, the fine aggregate has been replaced by manufactured sand in percentages of 0, 25, 50, 75 and 100 by mass with constant 1% proportions of galvanized iron or steel fibres. For each percentage replacement of fine aggregate considered, the materials are mixed in the standard way. That is, at first the fine aggregates and cement are weighed according to their proportion in the concrete mix. Then these materials are mixed thoroughly in dry condition, then this mixture is spread uniformly over the weighed quantity of coarse aggregate and thoroughly mixed in dry condition. Then the measured quantity of water with water cement ratio of 0.48 is added to this dry mix and then mixed thoroughly. For each percentage replacement of fine aggregate considered, to have a consistent workability of the mix, a slump of 100+10 mm is maintained.

Figure 8: Mixed concrete

4.2.3 Casting of specimens:

The materials which required for casting were weighed as per the mix design kept a side for room temperature. Mix all the ingredients in a proper way thoroughly till to get uniform concrete mix. After with this well mixed fresh concrete mix used to workability test for ten minutes with any wasting of concrete mix. Then filled to the all required specimens in three layers by giving 25 blows to each layer. These moulds were removed after 24 hours and these specimens were exposed to the water continuously for 28 days in curing tank. After 28days' specimens were taken out from the water and allowed to the surface dry under shade for few hours.

Figure 9: casted cubes and cylinders.

V. TEST RESULTS AND DISCUSSION

5.1 INTRODUCTION:

Mainly in this chapter we focused on the experimental results obtained from each test and analysis of the test results. the experimental tests were carried out to obtain the mechanical properties and

behaviour of concrete with m-sand, while also compared to the fibre reinforced concrete. the comparisons of mechanical properties and behaviour include the workability, compressive strength, split tensile strength. with this discussions and results obtained from the experimental tests, it is very clearly to know the effect of m-sand as fine aggregate and steel fibres for structural construction works.

5.2 WORKABILITY OF CONCRETE MIX:

5.2.1 Slump cone test:

Table 10: Slump cone values recorded for each mix batch

S.NO	Percentage mix	Slump value with 0% fibres (cm)	Slump value with 1% fibres (cm)	Slump value with 2% fibres (cm)
2.	M-Sand – 25%	2.6	2.4	2.39
3.	M-Sand – 50%	2.2	2.3	2.28
4.	M-Sand – 75%	2.1	1.8	1.75
5.	M-Sand– 100%	1.5	1.2	1.1

Table 5.2.1 above shows the slump height recorded during the test for all mix batches. Figure 5.2 below shows a graphical representation of slump height for concrete containing no fibres and concrete containing different amounts of fibres. The above tabular diagram 5.1 shows a gradual increase in the slump height while we replace the natural sand with manufacturing sand and the addition of 1% galvanized fibres is also increases the slump value. A small graphical picture of percentage replacement v/s slump has shown in the following figure 5.1

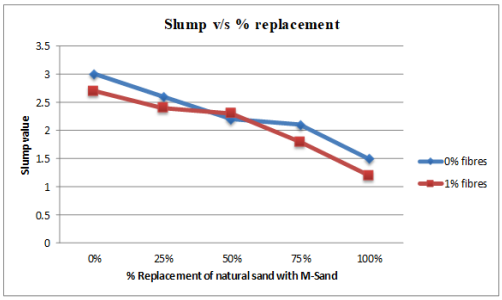

Figure 10: % Replacement v/s slump value

5.2.2 Compaction factor test:

Table 11: Compaction factor values recorded for each mix batch

S.NO	Nomenclature	C.F value with 0% fibres	C.F value with 1% fibres
1.	M-Sand – 0%	0.937	0.91
2.	M-Sand – 25%	0.927	0.87
3.	M-Sand – 50%	0.924	0.86
4.	M-Sand – 75%	0.919	0.86
5.	M-Sand – 100%	0.909	0.84

Compaction factor test indicates decreasing trend when percentage replacement of M-Sand and Fibres increased. Figure 5.2 shows a graphical representation of compaction factor value for concrete containing percentages of Manufactured Sandand percentages of Manufactured Sand along with fibre. The above tabular diagram 5.2 shows a gradual increase in the compaction factor while we replace the natural sand with manufacturing sand and the addition of 1% galvanized fibres is also increases the compaction factor value.

5.3Discussions

Use of manufactured sand in structural construction.

The usage of manufacturing sand (Robo Sand) in present structural construction works can be observed in the following figures 5.3 & 5.4 the concrete with normal sand shows the compressive strength value as 29.1 N/mm2 . The replaced concrete mix batches with 25, 50, 75, 100 levels showed

the compressive strength values as 30.29, 36.14,37.03& 38.12 N/mm2. It seems that even 100% replaced mix batch increased by 40.25% and the addition of fibres also improves the compressive strength by 48.78% even if we replace natural sand with Manufacturing Sand. With these observations we can replace natural sand with manufacturing sand up to75% only. The author wishes to enhance the strength for manufacturing sand is advisable to incorporate the fibres to concrete. The present research work gives an indication to extend the research work in this era.

VI. CONCLUSION

The effect of percentage of replacement of river sand by manufactured sand on strength and workability were evaluated and compared with the reference mix of 0% replacement of river sand by manufactured sand.

1.Thecompressive strength of concrete mix increased when the replacement of natural sand with manufacturing sand increases gradually up to 100% by 40.25% and the addition of galvanized fibres increases the compressive strength by 48.78%.

2.The split tensile strength value ofconcrete mix increased when the replacement of natural sand with manufacturing sand increases gradually up to 100% by 47.71% and by the addition of galvanized fibres that increases the split tensile strength by 62.43%.

3. Workability of concrete mix decreased with replacement of natural sand with manufacturing sand. But up to some extent even replaced concrete mix batches got optimum results. At the same time after 75% replacement of natural sand the workability of concrete mix decreases gradually.

4. By considering all the above parameters like slump cone value, compaction factor value, compressive strength value & split tensile strength value it is recommended that is better to limit the replacement of natural sand with manufacturing sand up to 75% only for better fresh and hardened concrete.

5.The Flexural strength or bending strength is increasing gradually when manufactured sand replacement increases.

6. Failure pattern of cube moulds and cylindrical moulds is almost similar for both natural sand and manufacturing sand.

7. This whole study is mainly to make awareness about the resources like manufacturing sand and galvanized iron fibres to use in the present structural construction works.

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