BEHAVIOUR OF BETHAMCHRLA WASTE STONE ON MECHANICAL AND WORKABILITY PROPERTIES OF FIBRE REINFORCED CONCRETE

G. Rajesh and Dr. E.Arunakanthi,

Structural Engineering, JNTUA College of Engineering, Anantapuramu.

Asso.Professor of Civil Engineering, JNTUA College of Engineering, Anantapuramu.

ABSTRACT

Bethamcherla waste stone is basically marble stone. It is naturally split table A small place Bethamcherla in Kurnool district of Andhra Pradesh has been gifted by nature with huge quantity of Bethamcherla stone. Quarries producing natural stone, Bethamcherla stone, lime stone etc., Generates large quantity of solid waste. This waste is in the form of over lying burden, interbedded burden, production waste generation during cutting for different required form of sizing, splitting at quarry floor. Besides many environmental problems especially from large generation of waste and its disposal continue to be biggest factor for the municipal authorities that will determine the future development of Bethamcherla waste stone like other natural stone.

For M20 grade of concrete, the natural coarse aggregate (N.C.A.) is replaced with the Bethamcherla waste stone aggregate (0%, 25%, 50%, 75%, 100%) with incorporation of steel fibres (galvanized) in different proportions for (0%, 1% & 2% by volume) all mix batches. Here an attempt is made to find the usage or suitability of Bethamcherla Waste Stone Aggregate in concrete works by conducting some workability tests (compaction factor, Slump and Vee – Bee) and some strength tests like compressive strength and impact strength.

Key Words: Marble stone, galvanized fibres, Workbility .

1. INTRODUCTION

Concrete is the highly 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. Concrete consisting of cement, fine aggregate, coarse aggregate, water and some admixtures in required proportion for a quick and better results in different conditions. In the construction industry natural aggregate is very essential component of concrete. Natural aggregate is getting expensive due to scarcity. All over the world consumption of natural aggregate as coarse aggregate in concrete production is very high and several developing countries have encouraged some demand in the supply of natural aggregate in order to meet the increasing needs of infrastructural development in recent years.

In the present years, the growth in the structural construction and the consequent increase in consumption have lead to fast decline in available natural resources on the other hand, a high volume of production has generated a considerable amount of course material which have adverse impact on the environment. The construction industries are to be one of the most potential consumers of mineral recourses, thus generating a great amount of solid waste as a by-product stones. India offers large varieties of a natural stone viz; Sand stone, Granite, Slates, Basalt, Marbles, Quartzite, Bethamcherla marble stones in large varieties of colours, shapes and sizes.In this study, the scope of the research will be concentrated on the use of Bethamcherla waste stone (Marble stone) as aggregate material with incorporation of steel fibres.

2. BACK GROUND INFORMATION OF THE STUDY

Naturally granite material is commonly used as a construction material. Though IS 383:1970 code tells that the use of marble stone and other stones for structural construction works, but it is very rare in reality. In this regard a ray of light was focused on the incorporation of this waste stone construction works. In current time the generation of Bethamcherla stone aggregate is discussed in detail. A small place of area Bethamcherla in Kurnool (DIST) of Andhra Pradesh. The local people is extracting the stone and converting in to finished products, which are useful for the purpose of flooring the houses. These are made in required shape for flooring purpose. During the process, same waste is generating and this is dumping in all around the factories and beside of roads due to the lack of dumping area. This waste disposal is very big problem for the municipality authorities. After looking all this conditions it leads to usage the waste form of stone in the construction industry. In this process it was decided to utilize the waste as coarse aggregate after that it made into a required size (12mm – 20mm) of aggregate. Then with that aggregate, an experimental work planned on Beams (150mm x 150mm x 600mm) mould elements to know the behaviour of impact strength.

3. SCOPE AND OBJECT

Main aim of the study is to know the involvement of Bethamcherla waste stone in construction works. In this study importantly it is concentrated on the some basic properties Bethamcherla waste stone, to know the suitability of the Bethamcherla waste stone in construction works by conducting some workability tests and some mechanical properties tests. To make explore the usage of local accessible materials to the surrounding people.

4. PROPERTIES OF MATERIAL INVOLVED

4.1. Cement

Cement is widely used bonding material in construction works. In the current study Ordinary Portland of 53 Grade cement was used. Physical and chemical properties of ordinary Portland cement are listed in the following table – 1 & 2 respectively.

Table 1 Physical Properties of Cement

S. No	Particulars	Results
1.	Specific gravity	3.10
2.	Normal consistency	33 %
3.	Fineness of cement (m^2/kg)	287
4.	Initial setting time(minutes)	80
5.	Final setting time (minutes)	190

Table 2 Chemical Properties of Cement

S. No	Particulars	Results
1.	Soluble Silica (%)	19.96
2.	Alumina (%)	5.20
3.	Iron Oxide (%)	5.65
4.	Lime (%)	60.79
5.	Magnesia (%)	1.72
6.	Insoluble Residue	0.96
7.	Sulphur Calculated as SO_3 (%)	2.61
8.	Loss On Ignition (%)	1.47
9.	Lime Saturation Factor	0.92
10.	Proportion Of Alumina To Iron Oxide	0.92
11.	Tri Calcium Aluminate	4.25
12.	Chloride (%)	0.006

4.2. Fine Aggregate

Generally near available river sand, which is passing through 4.75 mm I.S sieve was used. The physical properties of the fine aggregate are listed in the following tables – 3.

Table 3 Properties of fine aggregate

S. NO	Particulars	Results
1.	Specific gravity	2.73
2.	Fineness modulus	4.80
3.	Bulk density	15.90 KN/m^3
4.	Bulking of sand	21.10 %
5.	Grading of sand	Zone - TWO

4.3 Coarse aggregate

Natural aggregate (NA) 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 table – 4 shows the different properties granite aggregate.

Table 4 Properties of coarse aggregate

S.NO	Particulars	Results
1.	Specific gravity	2.60
2.	Fineness modules	3.70
3.	Flakiness index	18.50 %
4.	Elongation index	23.70 %
5.	Crushing value	19.42 %
6.	Impact value	17.80 %
7.	Water absorption	0.50 %

4.4 Bethamcherla Waste stone aggregate

The raw material of waste stone was used, which is obtained from the tiles industries. Whenever we make tiles for flooring purpose a lot of waste came from the industries. This waste is not allowed to use in concrete as it, because of stone size. So we need to make it in to graded aggregate from to use in concrete. To convert the stone in to a required graded size we should shift this waste in the crusher units. In this study all-in-all size graded 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 aggregate. Natural granite stone was replaced in different proportions like 0%, 25%, 50%, 75%, 100%. Some of the physical and chemical properties marble stone aggregate were listed in the following tables – 5, 6.

Table 5 Physical properties of bethamcherla waste stone

S.NO	Particulars	Results
1.	Specific gravity	2.55
2.	Fineness modules	5.80
3.	Flakiness index	15.64 %
4.	Elongation index	22.76 %
5.	Crushing value	22.67 %
6.	Impact value	18.73 %
7.	Water absorption	0.20 %

Table 6 Chemical properties of bethamcherla waste stone

S.NO	**Particulars**	**Results**
1.	Silica (Sio_2)	9.8 %
2.	Calcium Oxide (Cao)	29.62 %
3.	Calcium Carbonate ($Caco_3$)	52.87 %
4.	Magnesium Dioxide (Mgo)	16.22 %
5.	Magnesium Dioxide ($Mgco_2$)	33.92 %
6.	Alumina (Al_2O_3)	1.38 %
7.	Ferric Oxide (Fe_2O_3)	1.42 %
8.	Loss on ignition (LOI)	40.56 %

Figure 1 Sample of bethamcherla waste stone

4.5 Water

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

4.6 Fibres

Galvanized iron fibres of aspect ratio 30 have been used in the experimental tests. Cross sectional dimensions of this typical Galvanized steel fibre of diameter of 1.0 mm wire was cut

ISSN 2229-5518

into required size of 3 mm. Steel fibres were produced in steel sheet form, through the process of cutting steel sheets. These Galvanized Iron fibres are commercially available and are generally used for electrical work. These fibres are commercially available in market. Some properties of galvanized steel fibres have been listed in the following table – 7.

Table – 7 Properties of Galvanized iron fibres

S.NO	Particulars	Results
1.	Density of fibres (kg/m^3)	7850
2.	Diameter (mm)	1.00
3.	Modulus of elasticity (Gpa)	200
4.	Tensile strength	1.0–3.0
5.	Ultimate strength (Mpa)	395
6.	Failure strain (%)	3.0–4.0


Figure – 2 Sample of Galvanized iron fibres

5. M$_{20}$ GRADE CONCRETE

5.1 Mixing of ingredients

The M$_{20}$ Grade concrete mix has been designed using ISI method (IS: 10262 – 2000) for zero percent replacement of coarse aggregate (NGA). The mix proportion obtained is 1:1.93:3 with water cement ratio of 0.5. Keeping the mass of the fine aggregates and cement constant, the granite aggregate has been replaced by crushed BWSA in percentages of 0, 25, 50, 75 and 100 by mass with different proportions of steel fibres. For each percentage replacement of coarse 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 0.5 is added to this dry mix and then mixed thoroughly. For each percentage replacement of coarse aggregate considered, to have a consistent workability of the mix, a slump of 100+10 mm is maintained.


Figure – 3 Sample of mixing ingredients

Table – 8 Mix proportion

W/C Ratio	Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)
0.5	372	719.96	1118.73
Proportion	1	1.93	3

5.2 Casting of specimens

All 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 twenty five blows to the each layer. These moulds were removed after twenty four hours and these specimens were exposed to the water continuously for twenty eight days in curing tank. After twenty eight days specimens were taken out from the water and allowed to the surface dry under shade for few hours.

6. WORKABILITY TEST AND RESULTS

6.1 Slump test

Slump test is the most commonly used method of measuring consistency concrete. Generally the slump test ‘does not measure the workability of concrete’, it is useful to obtain the difference in the consistency of fresh concrete and detecting variations in the uniformity of concrete mix from batch to batch. The water content in

ISSN 2229-5518

concrete is the most familiar reason, as other factors such as particle shape and grading of aggregate may varies the slump. The apparatus of slump test is simple, portable and suitable for laboratory and on-site testing. After the concrete was fully mixed, the fresh concrete was undertaken for use in the slump test. The following table – 9 shows the slump value observed of each mix.

Table – 9 Slump value observed of each mix

S.NO	Nomenclature	Slump value with 0% fibres	Slump value with 1% fibres	Slump value with 2% fibres
1.	GA – 0	49	38	30
2.	BMS – 25	61	43	34
3.	BMS – 50	77	54	39
4.	BMS – 75	90	65	50
5.	BMS – 100	115	99	70

6.2 Compaction factor value

The compaction factor test is primarily use in the laboratory conditions but now a day it is using even in the field conditions. It presents a better measurement of workability of concrete than slump test and this test suited better for controlling the production of low slump concrete mixes. This method of workability test describes that the degree of fresh concrete mix will compact by itself when allowed it to fall freely by its force of gravity and without any other external compact influence. The following table – 10 shows the compaction factor value observed of each mix.

Table – 10 Compaction factor value observed of each mix

S.NO	Nomenclature	Compaction factor value with 0% fibres	Compaction factor value with 1% fibres	Compaction factor value with 2% fibres
1.	GA – 0	0.848	0.832	0.819
2.	BMS – 25	0.873	0.846	0.828
3.	BMS – 50	0.909	0.868	0.836
4.	BMS – 75	0.957	0.898	0.850
5.	BMS – 100	0.985	0.945	0.926

6.3 Vee – Bee test values

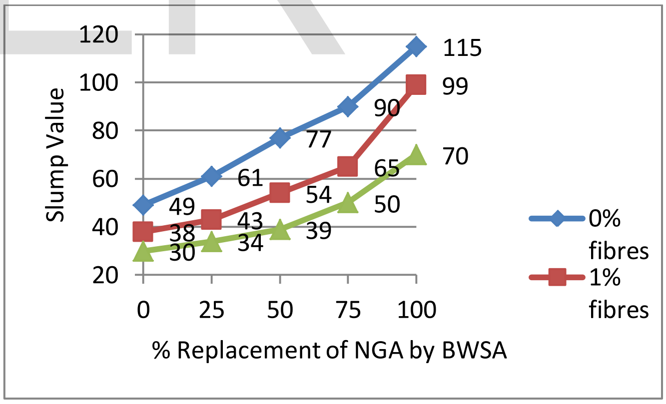
This is very common laboratory test to measure indirectly the workability of fresh concrete at a very low workability. Another form, the VEBE test is basically a mechanical version of slump test for a fresh concrete with low workability. It determines the consistency of the concrete by measuring the time taken for the concrete to collapse in the round mould under the action of vibration. This test measures the workload which is required to compact the freshly mix concrete. The following table – 11 shows the Vee – Bee value observed of each mix.

Table – 11 Vee – Bee value observed of each mix (sec)

S.NO	Nomenclature	Vee - Bee value with 0% fibres	Vee - Bee value with 1% fibres	Vee - Bee value with 2% fibres
1.	GA – 0	5.07	5.4	6.7
2.	BMS – 25	4.3	4.9	5.6
3.	BMS – 50	4	4.56	5.1
4.	BMS – 75	3.17	3.7	3.98
5.	BMS – 100	2.9	3.1	3.5

7.GRAPHICAL ANALYSIS

7.1 Slump values



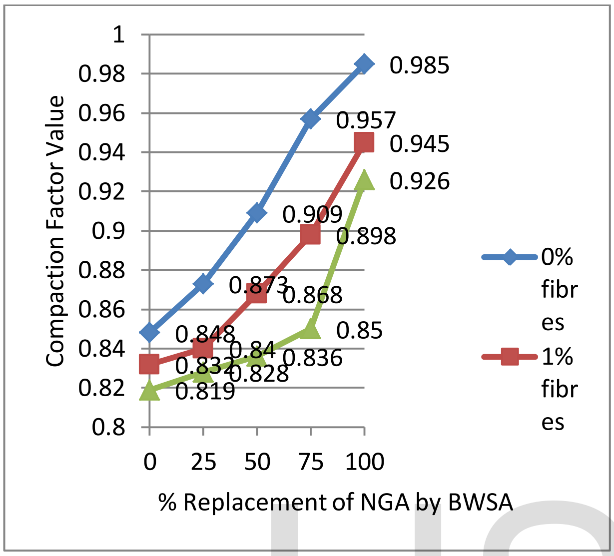
Graph no.1: % Replacement vs Slump value

The slump test indicates increasing trend when percentage replacement of granite stone with Bethamcherla waste stone increased. Figure – 6 above shows a graphical representation of slump value for concrete containing no fibres and concrete containing different amounts of fibres. The experimental results showed that the slump value of the fibre reinforced concrete has a decreasing trend when fibres volume dosage rate

ISSN 2229-5518

increases. The below figure indicates that workability of concrete mix increases as the dosage of fibres rate increases.

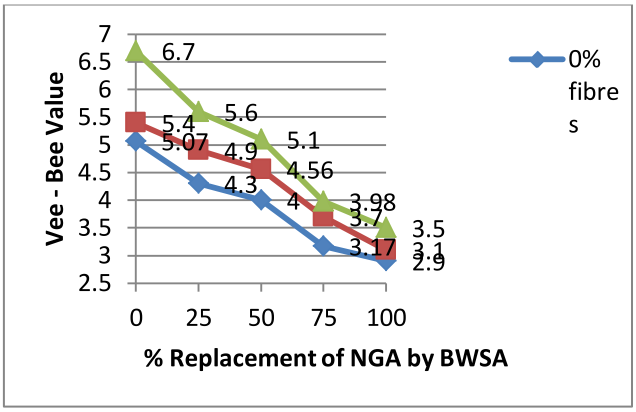
7.2 Compaction factor value



Graph no:2 % Replacement vs Compaction factor value

As like as the slump test compaction factor test indicates increasing trend when percentage replacement of Granite aggregate with Bethamcherla waste stone increased. Figure – 7 above shows a graphical representation of compaction factor value for concrete containing no fibres and concrete containing different amounts of fibres. The experimental results showed that the compaction factor value of the fibre reinforced concrete has a decreasing trend when fibres volume dosage rate increases. The below figure indicates that workability of concrete mix increases as the dosage of fibres rate increases.

7.3 Vee – Bee time



Graph no:3 % Replacement vs Vee – Bee time

The experimental results showed that the Vee – Bee test time of the fibre reinforced concrete has increasing trend when fibres volume dosage rate increases. But the replacement of Granite aggregate with Bethamcherla waste stone aggregate increases Vee – Bee time decreased. There is no much difference in the Vee – Bee time of concrete mix when we add 0% and 1% fibres as we can see in figure – 8 in the above. But there is huge variation when we add 2% fibres. So the above figure shows that the addition of fibre to the concrete will lead to the decrease of workability of a concrete mix.

8. CONCLUSIONS

- Workability properties of concrete mix batches decreased with replacement of natural aggregate with BETHAMCHERLA WASTE STONE AGGREGATE. But up to some extent even replaced concrete mix batches got optimum (good) results. Addition of fibres improved the over workability properties of mix even it replaced with BWS.
- By considering all the above workability parameters like slump test, compaction factor and Vee-Bee. It recommended that it is better to limit the replacement level of "BWSA 50%" only for better quality of concrete.
- This whole study is mainly to make awareness about the resources like Bethamcherla waste stone aggregate to use in the present structural construction works.

- Fibrous reinforced concrete beams have two type of observations like first crack and ultimate crack (second crack) but where has plane concrete we observe ultimate crack only.

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