Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 9, pp. 20420-20424, September, 2017

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

COMPRESSIVE STRENGTH OF MARBLE STONE WASTE AGGREGATE CONCRETE WITH CRIMPLED STEEL FIBRES

Venkata Ramana N*

Department of Civil Engineering, University B.D.T College of Engineering, Davangere, Karnataka, India

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0891

ARTICLE INFO

Article History:

Received 18th June, 2017
Received in revised form 10th July, 2017
Accepted 06th August, 2017
Published online 28th September, 2017

Key Words:

Compressive strength, Crimpled steel fibres, Natural Aggregate (NA), Marble stone waste aggregate (MSWA), Regression Models

ABSTRACT

This article presents the compressive strength behaviour of crimpled steel fibre reinforced marble stone waste aggregate concrete. The Natural Aggregate (NA) is replaced by marble stone waste aggregate (MSWA) in the proportion of 25, 50, 75 and 100%. Crimpled steel fibres are added to the marble stone waste aggregate Concrete (MSWAC) by 1 and 2% volume of specimen and with different lengths of 12.5,30 and 50mm respectively. Control specimens are cast with natural aggregate and tested for comparison of MSWAC specimens. The results showed that as the % of marble stone waste aggregate content increases in the mix the strengths are decreased. With incorporation of steel fibres, the strengths are enhanced. There is a rise in the strengths with respect to use of long length and higher volume fraction of fibres. For obtained experimental results Regression Models (RM) are developed to predict the compressive strengths with known parameters of percentage of MSWA and volume fraction of fibres for three different lengths of fibres.

Copyright © Venkata Ramana N, 2017, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Concrete is the most important construction material in the civil engineering arena. During the design of a structural element, we processed the mix design by knowing the basic properties of constitution materials of coarse aggregate, fine aggregate, cement and water. Many works has been taken place to evaluate the mechanical properties of concrete in the past. From those studies it is well known that, the concrete is strong in compression and having low strength in flexural tension. To enhance the low strength properties, fibre technology was adopted and with usage of different type fibres in the concrete the low strength properties of conventional concrete were enhanced to different levels. Now days the availability of coarse and fine aggregates is scaring the society due to limited availability of natural sources. Hence the researcher in the concrete area, focusing the use of other available second grade materials for concrete, in this connection marble stone waste aggregate is using as an alternative materials for coarse aggregate. The present experimental work has been focused on marble stone waste aggregate Concrete (MSWAC) with incorporation of crimpled steel fibres along with different lengths or aspect ratios. Herein the recent past research works are furnishing as literature review.

Bahar Demirel (2010) studied the effect of using waste marble dust on strength characteristics of concrete. It was observed that the replacement of fine aggregate with Waste marble dust yielded enhancing effect on compressive strength utilization of the marble waste dust reducing the environmental pollution.M. Devi (2014) conducted the experimental study on effect of polypropylene fibres on mechanical properties of concrete with Fly ash blended quarry dust (FABC). The FABC with polypropylene fibre can be effectively utilized economically in construction is shown in the results. Er. Amritpal Kaur & Er. Rajwinder Singh Bansal (2015) studied the effect of partial replacement of cement with metakaolin and marble powder on strength characteristics of concrete and compared with conventional concrete. Investigation yielded better strengths for concrete made with metalkaolin and marble powder. The optimum strengths were achieved at 9% MK and 10% MP and also good durability was achieved. K. Chiranjeevi Reddy *et.al* (2015) conducted a study on granite fines as filler material. It is observed that substitution of 7.5% of granite by weight resulted an increase in compressive strength compared to conventional concrete. Further, when locally available granite is a good partial substitution for concrete to improves mechanical properties and reduces overall cost of concrete. Jashandeep Singh and Er. R S Bansal (2015) studied the behaviour of

Corresponding author:* **Venkata Ramana N
Civil Engineering Department, University B.D.T College of Engineering, Davangere, Karnataka, India

concrete, having partial replacement of cement with waste marble powder. The result of investigation indicates that the replacement of 12% of cement with waste marble powder attains maximum compressive and tensile strength. The optimum percentage for replacement of marble powder with cement is almost 12% cement and it also minimizes the cost for construction with usage of marble powder which is freely available. Siddharth Sen and R Naga Vinothini (2015) studied the effects of addition of polypropylene fibers and granite powder on properties of concrete. The mechanical properties increased with age and thus the use of granite powder reduces the wastage disposal from granite industry. N. Venkata Ramana *et.al* (2016) conducted experimental investigation on performance of Fibre reinforced stone waste aggregate concrete. From the results, it is observed that 50% replacement of natural aggregate by Black marble stone waste aggregate is desirable. Regression models were developed to estimate bearing strength of concrete and compared with IS 456-2000 code provision. Saranya Valivarthi and M Durga Rao (2016) presented experimental work on green concrete made with wastes. The fiber reinforced green concrete showed good strength enhancement by using marble sludge and stone dust for M-30 grade concrete. Rizwan Qadir and Fahad Perviaz (2016) presented the applications of coconut fiber and marble waste in construction and concluded that marble waste increases the compressive strength of concrete. G. Rajesh and E. Arunakanthi (2016) studied the fresh and hardened concrete properties of fiber reinforced concrete. An attempt was made to study the suitability of Bethamcharla waste stone aggregate in concrete works. Aquib sultan Mir and O P Mittal (2016) studied the effects of marble dust and steel fibers on steel fibers reinforced concrete. An immense increase in strengths in rigid pavement concretes was shown in results. Rajendra.D *et.al* (2017) conducted experimental work on partial replacement of coarse aggregate with waste cuddapah stone and PPC fly ash based cement. The results of fresh and hardened concrete properties were compared with conventional concrete and showed increase in strength of concrete. Subba Reddy singam and Sashidhar Chundapalle (2017) conducted experimental investigation on utilization of marble waste in concrete. Here, NA was replaced with black stone marble waste and fibres were added. Better workability was achieved compared to natural coarse aggregate. Anisha S *et.al* (2017) conducted investigation on steel fibre reinforced concrete made with partial replacement of cement and addition of fibres. The replacement of marble powder and adding of steel fibre improved the compressive and split tensile strengths were compared with conventional concrete.

Krishan Kumar and Sumesh Jain (2017), discussed the properties of concrete, made with marble powder as substitute material for sand. Based on the feasibility interpretation it is observed that replacing up to 45% marble powder and 0.8% of steel fibres in concrete is appropriate in conformance with the requirement. Ashwani (2017) conducted experimental study on flexural strength, compressive strength and tensile strength of concrete replacement with marble dust and added steel fibres. It is observed that the maximum increase in flexure strength, compressive strength and tensile strength is observed for 0% marble dust & 1% steel fibres. It is an eco friendly approach to replace the cement with marble dust and it is a solution to disposal of marble dust.

From literature it is observed that, a little work has been focused on crimpled fibres with combination of MSWA. So the author had planned to evaluate compressive strength (CS) of crimpled fibre, Marble stone waste aggregate concrete and also to establish the relation between the compressive strength, volume fraction of fibre and % of MSWA. To find CS total 105 of MSWAC cubes were cast with different lengths of fibres (12.5, 30 and 50mm) and 1% and 2% volume fraction of fibres. Total five different mixes are designed as per IS code. The details of the experimental work and results are discussed below.

Materials Used

1. Cement**:** Ordinary Portland cement-43 grade was used. The specific gravity of cement was found as 3.12 and it satisfies the requirements of IS: 12269-1987 specifications.
2. Sand: Locally available sand collected from river bed was used as fine aggregate. The sand used was having fineness modulus 2.95 and confirmed to grading zone-III as per IS: 383-1970 specification.
3. Coarse aggregates: The crushed stone aggregates were collected from the local quarry. The coarse aggregates used in the experimentation were 20mm and down size aggregate and it was tested as per IS: 383-1970 and 2386-1963 (I, II and III) specifications. The specific gravity was observed as 2.65. The used aggregate can be used in the figure 1.

Natural aggregate

Marble stone waste aggregate

Figure 1 Used Aggregates

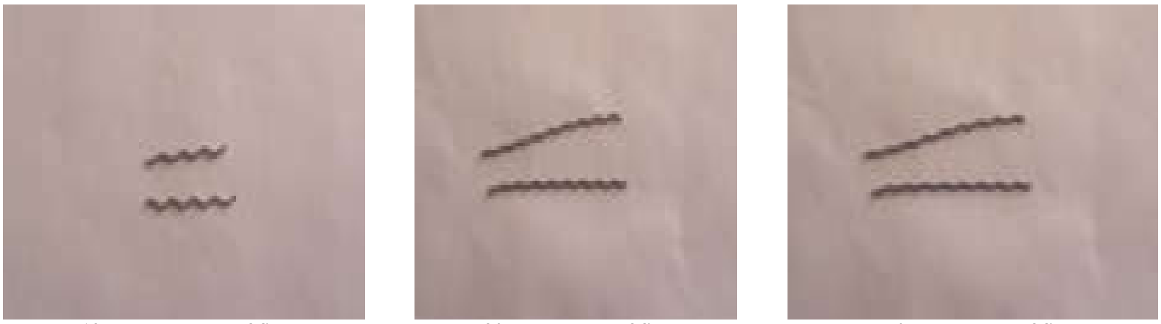
4. Marble stone waste aggregate (MSWA): 20mm size marble stone waste aggregate is obtained by crushing

marble waste generated from polishing industry was used as coarse aggregate in the present investigation. The average specific gravity was found as 2.50. (The MSWA can observe in figure 1).

5. Water: Ordinary potable water, free from organic content, turbidity and salts was used for mixing and for curing throughout the investigation.
6. Crimpled Steel Fibres: The crimpled fibres are obtained from the company Jeetmull Jaichandlall (M) Pvt. Ltd, Chennai and the properties are presented in Table 1 and in figure 2. The specified properties are obtained from the suppliers.

Table 1 Properties of Crimpled Steel fibres

Type of fibre	Length	Diameter	Aspect Ratio
Crimpled Steel fibre	12.50	0.25	50
	30.00	0.50	60
	50.00	1.00	50



12.5 mm Length of fibre **30mm Length of fibre** **50mm Length of fibre**

Figure 2 Crimpled steel fibres

Experimentation

Total five concrete mixes are planed with five replacement ratios of natural aggregate with marble stone waste aggregate (0, 25, 50, 75 and 100%). For this experimental work total 105 cubes were planned and the cubes were cast in steel moulds with inner dimensions of 150 x 150 x 150mm.The cement, sand, coarse aggregate and crimped steel fibres were mixed thoroughly manually. The mix proportion was adopted for all mixes as 1:1.63:3.12 and water cement ratio was arrived as 0.5. (This was designed for M20 grade concrete) During mixing of concrete initially 25% of water required is added and mixed thoroughly till to obtain uniform mix. After that, the balance of 75% of water was added and mixed thoroughly with a view to obtain design mix. Care has to be taken in mixing to avoid balling effect. For all test specimens, moulds were kept on table vibrator and the concrete was poured into the moulds in three layers and compaction was provided with tamping rod, in addition to this table vibrator was also provided.The moulds were removed after twenty four hours and the specimens were deployed to curing pond. After curing the specimens in water for a period of 28 days the specimens were taken out and allow drying under shade.

Compression test on cubes is conducted with 2000kN capacity of compression testing machine. The machine has a least count of 1kN. The cube was placed in the compression-testing machine and the load on the cube is applied at a constant rate till to failure of the specimen and the corresponding load is noted as ultimate load. Then cube compressive strength of the concrete mix is then computed by using standard formula and the obtained values are presented in the next section.

TEST RESULTS AND DISCUSSION

Compressive Strength

The obtained 28 days cube compressive strength results for various mixes are presented in Table 2. From the results, it is noticed that, the compressive strengths for the Marble stone waste aggregate (MSWA) concrete are decreasing as the % of MSWA content increases in the mix. For MSWAC without fibres, the compressive strength is varying from 17 to 27 MPa. The higher value is possessing for low MSWA content of mix. This may due to presence of more Marble stone waste aggregate content in the mix and it forms weak surfaces for the cement mortar due to smooth texture over marble stone waste aggregate. The existing surfaces does not provide good bond with cement mortar.

During the application of compression load the interface surface showed multiple cracks and it led to fail earlier to Natural aggregate concrete load. By the incorporation of crimpled steel fibres, the strengths of MSWAC are increased when compared with zero fibre mixes and this is happened for 1 and 2% volume fraction of fibres. The reference mix MSWA0 was designed for 20MPa, many mixes with addition of fibres showed more than the 20MPa (except for the mix of MSWA100 along with fibre length of 12.5mm), this inferences, and addition of fibres to the mixes can be increases the compressive strengths. Whenever the designer wants to enhance the MSWAC strengths, the addition of fibres suggestible to the mixes and the dosage of fibre for the mixes is also one of the important parameter for attainment of strength. From the present experimental study it is noticed that as the dosage increases for the mixes the cube compressive strengths are increasing, so form the results 2% fibre volume fraction can be taken as optimum. The different lengths of crimpled steel fibres are added to the MSWA, for the same volume fraction of fibres, the compressive strengths increasing as the length of fibre increases. This is all ready proven from the fibre composition mechanism (rule of mixtures). From the present work it is noticed that 50mm length of fibre mix shown higher values than the other lengths of fibre (12.5 and 30mm) mixes. The increase in strength is due to bond between fibre and matrix. From the above discussions it concluded that, the 50mm length of fibre with 2% volume fraction is optimum for MSWAC.

Table 2 Compressive Strength for various mixes

Mix Designation	0% volume fraction of fibre	Compressive strength (N/mm^2)					
		1% volume fraction of fibre			2% volume fraction of fibre		
		Length of fibre			Length of fibre		
		12.5 mm	30 mm	50 mm	12.5 mm	30 mm	50 mm
MSWA 0 or NA or Reference mix	27.85	33.33	34.51	39.11	35.55	38.07	41.33
MSWA 25	24.00	27.67	32.36	35.77	32.31	35.25	38.77
MSWA 50	20.74	25.88	31.22	32.92	30.55	32.33	36.26
MSWA 75	20.00	20.22	25.03	28.92	24.31	29.48	33.88
MSWA 100	17.03	16.33	21.11	25.03	19.53	25.59	31.52

Relation between Compressive Strength, % MSWA and % fibres

Compressive strength is utmost important property for estimating the many strengths of concrete such as flexure, shear, young's modulus, torsion etc. The IS 456-2000 and other codes are provided as, many mechanical properties are related with compressive strength, either directly or indirectly. So the author of the article has focused to estimate the cube compressive strength of MSWAC with different volume fraction of fibres for three lengths of fibres (12.5, 30 and 50mm). The study was limited to with 1 and 2% volume fraction of fibres, because there is a difficulty beyond of two percentage of volume of fraction of fibre as it imparts the mixing problem and balling effect is existing. Few trials are made with 3% of fibres, for this, the above said problem was noticed; hence the study is limited with 2% volume fraction of fibres. To attain the required strength of concrete mix there is a stipulated procedure was provided by the various codes (IS, ACI, Euro, FIB etc) for different design mixes. With the help of already existing codes the mix design was adopted with the Marble stone waste aggregate concrete. But so far there is no code existing to estimate the strength of MSWA concrete with incorporation of steel fibres. At present few regression models are deduced to estimate cube compressive strength of MSWAC. The deduced formulas validity is limited because, herein the experimental work is conducted with three number of cube samples for each mix. However to validate the proposed equations, there is a need to conduct the work with more number of samples. The proposed equations strike the researchers or academicians, to think and modelled the alternative equations for betterment of the results.

$f_{ck}=3.557(\%F) - 0.143(\%MSWA)+28.86$ ----------------for 12.5mm fibres
(R square=0.916, Standard Deviation =1.9641)
$f_{ck}=4.31(\%F) - 0.142(\%MSWA)+30.36$ ----------------for 30.00mm fibres
(R square=0.783, Standard Deviation =3.60)
$f_{ck}=6.814(\%F) - 0.106(\%MSWA)+29.00$ ----------------for 50.00mm fibres
(R square=0.875, Standard Deviation =2.848)
In the above equations
f_{ck}= 28 days cube compressive strength in MPa
F=Crimpled Steel fibers in %
MSWA= Marble stone waste aggregate Content in %
Comparison between the test results and that predicted by proposed equations are presented in Table.3 and 4.The Ratio between Exp/RM is about 0.87 to 1.10. From this it noticed that, the proposed equations have good agreement with the experimental results.

Table 3 Regression Model performance for Compressive strength [1% steel fibers]

Mix Designation	0% volume fraction of fibre	Compressive strength (N/mm^2)								
		1% volume fraction of fibre								
		Length of fibre								
		12.5 mm			30mm			50 mm		
		Exp	RM	RM/ Exp	Exp	RM	RM/ Exp	Exp	RM	RM/ Exp
MSWA 25	24.00	27.67	28.68	1.03	32.36	31.12	0.96	35.77	33.16	0.92
MSWA 50	20.74	25.88	25.10	0.96	31.22	27.57	0.88	32.92	30.51	0.92
MSWA 75	20.00	20.22	21.53	1.06	25.03	24.02	0.95	28.92	27.64	0.95
MSWA 100	17.03	16.33	17.97	1.10	21.11	20.47	0.96	25.03	25.21	1.00

Table 4 Regression Model performance for Compressive strength [2% steel fibers]

Mix Designation	0% volume fraction of fibre	Compressive strength (N/mm^2)								
		2% volume fraction of fibre								
		Length of fibre								
		12.50 mm			30.00mm			50.00 mm		
		Exp	RM	RM/ Exp	Exp	RM	RM/ Exp	Exp	RM	RM/ Exp
MSWA 25	24.00	32.31	32.25	0.99	35.25	35.43	1.00	38.77	39.97	1.03
MSWA 50	20.74	30.55	28.68	0.87	32.33	31.88	0.98	36.26	37.32	1.02
MSWA 75	20.00	24.31	25.10	1.03	29.48	28.33	0.96	33.88	34.67	1.05
MSWA 100	17.03	19.53	21.53	1.10	25.59	28.33	1.10	31.52	32.02	1.05

CONCLUSIONS

The following conclusions are drawn from the present experimental work.

1. The compressive strengths are decreases as the MSWA content increase in the conventional concrete mix.
2. Addition of crimpled fibres is effective for Marble stone waste aggregate concrete in increase of compressive strengths.
3. Among three lengths of fibres (12.5, 30 and 50 mm) the 50mm length fibre shown higher compressive strengths.
4. Crimple steel fibre volume with 1% volume fraction can be used effectively, up to 75% replacement MSWAC without affecting design strength of mix.
5. The Maximum permissible limit for Marble stone waste aggregate content with 2% fibre volume is 100%.
6. The provided regression models in this article are satisfactorily performed with the experimental results.

References

Anisha.S, Manimala.K, Marilakshmi.M, Muthumariammal.S, 2017, Experimental Investigation Of Steel Fibre Reinforced Concrete With Partial Replacement Of Cement By Using Marble Powder, SSRG *International Journal of Civil Engineering*, special Issue, pp 35-41.

Ashwani, 2017, Effect of Steel Fibres on Strength of Concrete with Partially Replaced Marble Dust, *International Journal of Science and Research,* Vol.6, pp 118-122.

Aquib sultan Mir and O P Mittal, 2016, Review Paper on A Study on Strength Properties of Rigid Pavement Concrete with Use of Steel Fibres and Marble Dust, *International Journal of Advanced Research in Education & Technology*, Vol. 3, pp 222-225.

Bahar Demirel, 2010, The effect of the using waste marble dust as fine sand on the mechanical properties of the concrete, *International Journal of the Physical Sciences*, Vol. 5(9), pp 1372-1380.

Er. Amritpal Kaur and Er. Rajwinder Singh Bansal, 2015, Strength and Durability Properties of Concrete with Partial Replacement of Cement with Metakaolin and Marble Dust, *International Journal of Engineering Research & Technology*, Vol. 4, pp 1302-1305.

G. Rajesh and E. Arunakanthi,2016,Behaviour Of Bethamchrla Waste Stone on Mechanical and Workability Properties of Fibre Reinforced Concrete, *International Journal of Scientific & Engineering Research,* Vol.7, pp 185-191.

Jashandeep singh, Er. R S Bansal, 2015, Partial Replacement Of Cement With Waste Marble Powder With M25 Grade, *International Journal of Technical Research and Applications*, Vol.3, pp 202-205.

K.Chiranjeevi reddy, Y.Yaswanth Kumar, P.Poornima,2015, Experimental Study on Concrete with Waste Granite Powder as an Admixture, *International Journal of Engineering Research and Applications*, Vol. 5, pp.87-93.

Krishan Kumar, Sumesh Jain, 2017, Combined Effect of Marble Dust and Steel Fibre on the Mechanical Properties of High Strength Concretes, *International Journal of Trend in Scientific Research and Development*, Vol. 1(4), pp 384-388.

M. Devi, 2014, Significance of Fibres in Enhancing Strength and Corrosion Resistance of Fly Ash Blended Quarry Dust Concrete, International conference on Biological, *Civil and Environmental Engineering* (BCEE-2014), pp 57-61.

N. Venkata Ramana, G Reddy babu, U.Raghu Babu, 2016, Bearing Strength of Steel Fibre Reinforced Black Marble Stone Waste Aggregate Concrete, Materials Today: Proceedings XX (2016), pp 1-10.

Rajendra.D , H. Gokulram, B. Karthik, 2017, Effect of Strength Properties on Concrete by Partial Replacement of Coarse Aggregate with Waste Cuddapah Stones, *International Journal of Engineering Research & Technology*, Vol. 6, pp 433-436.

Rizwan Qadir and Fahad Perviaz, 2016, Effect of Coconut Fibre and Marble waste on properties of Concrete, *International Journal of Scientific & Engineering Research,* Vol.7, pp 518-534.

Saranya Valivarthi and M Durga Rao, 2016, Experimental Study on Fibre Reinforced Green Concrete for M-30 Grade, *IOSR Journal of Mechanical and Civil Engineering*, Vol.13, pp 01-06.

Siddharth Sen and R Naga Vinothini, 2015, Experimental Study on Effects of Polypropylene Fiber and Granite Powder in Concrete, *International Journal & Magazine of Engineering, Technology, Management and Research*, Vol 2, pp 145-148.

Subba Reddy singam and Sashidhar Chundapalle,2017, A Study of Compressive Strength on Black Stone Marble Waste Aggregate Concrete, *International Journal of Emerging Trends in Engineering and Development,* Vol.3,pp102-111.

How to cite this article:

Venkata Ramana N.2017, Compressive Strength of Marble Stone Waste Aggregate Concrete With Crimpled Steel Fibres. *Int J Recent Sci Res.* 8(9), pp. 20420-20424. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0891

****