Review on Strength Properties of Concrete with Partial Replacing Artificial Sand against Natural Sand and Cost Analysis

Gopal Kumar[1] Jiji M Thomas[2] Pushpendra Kumar Kushwaha[3]
[1]M. Tech Research Scholar [2,3]Assistant Professor
[1,2,3]Department of Civil Engineering
[1,2,3]RKDF College of Engineering Bhopal, India

Abstract— Any Civil Engineering Structure must rest on a Structures are founded with concrete and steel materials mainly. Traditionally, concrete is mixture of cement, sand and aggregate. The most commonly used fine aggregate is natural river sand and coarse aggregate is stone quarry. Scarcity of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative. One such alternative is "Artificial sand" namely if graded by means may also be called as manufactured sand. This paper present Review on natural sand replace by Artificial or Manufacturing sand and cost analysis between manufacturing sand and natural or river sand for M25 and M30 concrete.

Keywords: Natural Sand, Artificial Sand, Concrete

I. INTRODUCTION

A. Literature Reviewed

This chapter is all about the previous work done by so many researchers across the world. Substantial amount of works on this aspect have been carried out by great number of researchers in India and abroad. Some notable contributions in this direction in recent past have been made by scholars are presenting

Sahu A. K, in January 2003 study shows that There is increase in compressive strength modulus of rupture and split strength by replacing natural sand with stone pressure west with 20 and 40 percent as fine aggregate.

H. Donza. O et al (2002) grew High-quality cement with various fine aggregate. The test work is basically concerned about the investigation of mechanical properties like compressive quality, split rigidity and flexural quality of concrete by full substitution of regular sand by manufactured sand as fine aggregate. Tests were done on cubes, cylinders and unreinforced beams to consider the mechanical properties of cement.

Bhatty, J (2006) portrayed the high-volume utilization of fly ash as a raw material in the make of Portland concrete. This approach gives three basic advantages to concrete assembling and nature. To start with, being rich in silica, alumina, and iron, the fly ash can basically replace raw materials in concrete crude encourage, for example, shale and earth, which are generally mined or obtained. Second, the carbon content in fly fiery remains can give a fuel supplement to the vitality concentrated cement manufacturing process.

Reddy (2007) from their trial consider on utilization of rock flow and insulator ceramic scrap in concrete that the rock flow when utilized as fine aggregate expands the modulus of rupture accordingly the flexural quality. From the investigation of green cement have containing quarry dust and marble sludge powder it has been accounted for that the split strength of green cement was 14.62% higher at 7days and 8.66 % higher at 28 days.

Thaniya Kaosol (2010) has made examination on the reuse of concrete waste as crushed stone for hollow concrete masonry units. The principle objective was to expand the estimation of the concrete waste, to make an economical and productive transfer elective for the concrete waste. Endeavours were made to use the concrete waste as crushed stones in the mix blend to make hollow concrete blocks. Different percentages of crusted stones have been attempted (i.e. 0%, 10%, 20%, half and 100%). From the outcomes they discovered concrete waste can used to deliver hallow concrete block masonry units.

Sheetal A. Sahare et al (2015) has been explore an impacts of artificial sand with quarry dust on compressive strength, split strength and flexural strength of various concrete blends when naturall sand is totally supplanted by manufactured sand.

Nithyambigai. G (2015) explored the strength of concrete mix at 28-day and 56-day age containing 0%, 25% and 50 % of fine aggregate by M. Sand and 0%, 25% and 50 % of cementitious materials by fly ash.

Chandrasekar R et al (2017) carried out for utilization of waste foundry sand (WFS) in High strength concrete. The waste foundry sand was replaced in the place of normal sand with four different percentages (10%, 20%, 30%, and 40%). The several tests such as compressive strength, split tensile strength, modulus of elasticity, flexural strength, ultrasonic pulse velocity (UPV), rebound hammer test, are performed for 7 days and 28 days to obtain the behavior the concrete due to foundry sand.

M. Manoj Pravarly and S. Mahesh (2017) concentrated on accomplishing high performance characteristics of concrete by contrasting M80 and M90 grades. The quality, workability and Durability properties for the two evaluations are thought about by varying the percentage of ROBOSAND with natural sand by 0%, 25%, 50%, 75% and 100% together with fly ash remains of 20% substitution in cement.

Nimitha Vijayaraghavan and A S Wayal (2013) concluded from experimental research that the river sand can be fully replaced by manufactured sand.

Prasanna K and Anandh K S (2017) investigates M60 grade concrete with fine aggregate substitution extent 0%, 25%, half, 75% and 100%. The properties, for example, compressive strength, split tensile strength and ultrasonic pulse velocity are determined from cubes and cylinders cast with manufactured sand acquired from kundrathur and river sand taken from Araniar basin.

M. R. Chitlange in 2010 study shows that mixes with artificial sand as fine aggregate gives consistently higher strength than the mixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with cement

than the rounded particles of natural sand resulting in higher strength. The excessive bleeding of concrete is reduced by using artificial sand.

R. Ilangovana1, N. Mahendrana1 and K. Nagamanib2 states that the Physical and chemical properties of quarry rock dust is satisfied the requirements of code provision in properties studies. Natural river sand, if replaced by hundred percent Quarry Rock Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, in terms of compressive and flexural strength studies

Priyanka A. Jadhava and Dilip K. Kulkarni study shows the effect of partial replacement of natural sand by manufactured sand on the compressive strength of cement mortar of proportion 1:2, 1:3 and 1:6 with water cement ration as 0.5 and 0.55 are studied. Results are compared with reference mix of 0% replacement of natural sand by manufactured sand. The compressive strength of cement mortar with 50% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix. The overall strength of mortar linearly increases for 0%, 50% replacement of natural sand by manufactured sand as compared with reference mix (Mix 1). Manufactured sand has a potential to providealternative to natural sand and helps in maintaining the environment as well as economical balance.

Vinayak R. Supekar, Popat D. Kumbhar's study shows the replacement of natural sand by 60% artificial sand results in producing the concrete of satisfactory workability and strength properties. It is also possible to minimize the area of surface cracks of concrete, thus achieving the durable concrete. However, for more than 60% replacement of natural sand by artificial sand causes reduction in compressive strength of concrete mixes with increase in the area of cracks. The replacement of natural sand with artificial sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

Kode V. R. Reported that concrete with stone dust as a fine aggregate yielded 10 % higher compressive strength 24% higher Tensile strength 26% higher Flexural strength over the concrete with natural sand.

Prakash Rao D.S. and Giridhar kumar V. investigated the concrete with stone crusher dust which is available abundantly from crusher unit at low cost, the test conducted pertain to concrete with reverse sand of strength 28.1 mpa and that with granite stone crusher dust of strength 32.8 mpa. Test on strength of concrete and on flexural behaviour of RC beam under 2 point loading sustained about 6 percent more load.

Rajendra P. Mogre, Dr. Dhananjay K. Parbat & Dr. Sudhir P. Bajad study shows there is feasibility of artificial sand in concrete. The replacement of natural sand by artificial sand is feasible for 60% to 80%. It is seen from above studies there is a variation in strength enhancement of concrete made from artificial sand to encourage the use of locally available artificial sand promotes to study to check it suitable optimum percentage replacement in the concrete.

M. Manoj Pravarly and S. Mahesh (2017) concentrated on accomplishing high performance characteristics of concrete by contrasting M80 and M90 grades. The quality, workability and Durability properties for the two evaluations are thought about by varying the percentage of ROBOSAND with natural sand by 0%, 25%, 50%, 75% and 100% together with fly ash remains of 20% substitution in cement. The compressive strength, split tensile strength and flexural strength are thought about for the two grades and results are classified and the optimum percentages are concluded.

Anjali Prajapati et al (2017) studied the effect of performance of HPC using mineral admixture i.e. fly ash and GGBS with M-60 grade of IS cube specimen .We partially replaced Portland cement by weight of binder. Fly ash and GGBS replacement varies from 10% to 30%. We used Conplast SP430-Sulphonated Naphthalene Polymers as a superplasticizer for better workability for high performance concrete. Dosage for superplasticizers is same for all mix proportions. Also, we have replaced fine aggregate in different proportions with foundry sand. We have investigated compressive strength, split tensile strength and flexural strength for all different cases. The HPC mix, grade M60concrete is designed as per Indian standards "Guide for selecting proportions for high strength concrete with Pozzolana Portland cement and other cementitious materials"

B. Literature Surveyed

A study of various articles published between 2003 and 2017 yields contemplates that vary in scope and level of analysis, yet with reliably great outcomes. A review of experimental studies performed by different researchers has been completed to analyse different operational parameters viz. workability, toughness and compressive strength of cement with crushed sand as replacement to the natural sand. The information collected over the course of investigation prompt the accompanying conclusions;

1) The concrete with crushed sand performed better than concrete with natural sand as the quality of concrete mix increased.
2) The flexural strength of concrete with crushed sand was marginally increased on the strength of concrete with natural sand.
3) The workability of concrete manufactured with crushed sand was lesser than that manufactured with natural sand.
4) The round shape and smooth surface texture of natural sand reduces the inter particle friction in the fine aggregate component so that the workability is higher in natural sand. Manufactured sand particles are angular in shape and their rough surface texture improves the internal friction in the mix. Because of that the workability is reduced.
5) Manufactured sand is free from chemical impurities such as sulphates and chlorides which improves the properties of concrete like strength and durability.

II. ECONOMIC COMPARISON

A. Economic Feasibility of Replacement

Concrete is manufactured using production sand; production sand is considered an environmentally friendly alternative to natural sand. The most important natural and cheapest sources of sand are riverbeds and these natural resources are quickly depleted. For various reasons, good sand is not

always immediately available and must be transported from large distances. Transport is an important factor in the price of building sand. Moving construction sand to the market significantly increases the selling price of the market due to the high transport costs.

B. Cost Analysis

1) Cost Analysis of M25 Grade

Material estimation includes costs for water, cement, natural sand, manufacturing sand and coarse aggregate for a particular design mix and transportation cost. According to the mix design calculation we achieved the weight of water, cement, natural sand, manufacturing sand and coarse aggregate for concrete. As the water is largely available in India, its costs can therefore be neglected. Current study shows that replacement of natural sand using manufacturing sand can be made as much as 50% (by weight). Analysis of the cost of concrete with and without manufacturing sand for M25 grade is given below in Table 6.2.

2) Calculation:

Ratio= 1:1.40:3.05
Total= 1+1.40+3.05= 5.45
Vol. of cement= (1/5.45)*1.57=0.28m^3
For 1m^3 of M25 grade concrete requires=395 Kg
No. of cement bags=395/50=8 bags
Vol. of sand= (1.40/7.59)*1.57= 0.4033m^3
For 1m^3 of M25 grade sand requires=0.517*1600=555kg
Vol. of course aggregate concrete= (3.05/5.45)*1.57=0.8786 m^3
For 1m^3 of M25 grade concrete requires=0.517*1600=1210 kg

Concrete Constituent	Quantities per unit vol.
	1:2.35:4.24
Cement	397 Kg (8bags)
Natural Sand	0.4033m^3
Coarse Aggregate	0.8786 m^3

Table 6.1: Quantities per unit volume of concrete constituents for M25

Material	Rate	Conventional Concrete		M25 (Opt. natural sand and manufacturing sand)		% Saving
		Quantity	Cost	Quantity	Cost	
Cement	Rs. 430 per bag (50 kg)	8bag	Rs.3440	8 bag	Rs. 3440	1.19 %
Manufacturing Sand	Rs. 600/m^3	0	0	0..241m^3	Rs. 145.188	
Natural sand	Rs. 900/m^3	0.4033 m^3	Rs. 362.97	0.1623 m^3	Rs. 146.07	
Coarse Aggregate	Rs. 2400/m^3	0.8786m^3	Rs. 2105	0.8786 m^3	Rs. 2105	
Super Plasticizer	Rs. 40/Kg	1.5 Kg	Rs. 61	1.5 Kg	Rs. 61	
			Rs. 5968.39		Rs. 5897.25	

Table 6.2: Cost of material per cubic meter of concrete for M25

From the above table we note that the use of manufacturing sand in concrete saves money up 1.19 % over the conventional cement concrete. This is a significant saving of money. There are good prospects of obtaining a good concrete strength at relatively cheaper cost even while replacing part of the sand with manufacturing sand.

Figure 7.1 shows the comparison of costs between conventional concrete and M25 mixture.

3) Cost Analysis of M30 Grade

Material estimation includes costs for water, cement, natural sand, manufacturing sand and coarse aggregate for a particular design mix and transportation cost. According to the mix design calculation we achieved the weight of water, cement, natural sand, manufacturing sand and coarse aggregate for concrete. As the water is largely available in India, its costs can therefore be neglected. Current study shows that replacement of natural sand using manufacturing sand can be made as much as 50% (by weight). Analysis of the cost of concrete with and without manufacturing sand for M30 grade is given below in Table 7.4.

Ratio= 1:1.32:2.85
Total volume = 1+1.32+2.85= 5.17
Vol. of cement= (1/5.17)*1.57=0.30 m^3
No. of cement bags=405/50= 8 bags
Vol. of sand = (1.32/5.17)*1.57= 0.40 m3
Vol. of concrete = (2.85/5.17)*1.57= 0.8654 m3
For 1m^3 of M25 grade concrete requires= 0.849*1600= 1358.48 kg

Concrete Constituent	Quantities per unit vol.
	1:1.32:2.85
Cement	405 Kg (8bags)
Natural Sand	0.40m^3
Coarse Aggregate	0.865m^3

Table 6.3: Quantities per unit volume of concrete constituents for M30

Material	Rate	Conventional Concrete		M30 (natural sand and manufacturing sand)		% Saving
		Quantity	Cost	Quantity	Cost	
Cement	Rs. 430 per bag (50 kg)	8bags	Rs. 3440	8 bags	Rs. 3440	2.2%
Manufacturing Sand	Rs. 600/m^3	0	0	0.2440 m^3	Rs. 144	
Natural sand	Rs. 900/m^3	0.469 m^3	Rs. 423	0.16 m^3	Rs. 144	
Coarse Aggregate	Rs. 2400/m^3	0.8654 m^3	Rs. 2077	0.865 m^3	Rs. 2077	

Super Plasticizer	Rs. 40/Kg	1.807 Kg	Rs. 72.28	1.807 Kg	Rs. 72.28	
			Rs. 6012		Rs. 5877	

Table 6.4: Cost of material per cubic meter of concrete for M30

From the above table we note that the use of manufacturing sand in concrete saves money up to 2.2 % over the conventional cement concrete. This is a significant saving of money. There are good prospects of obtaining a good concrete strength at relatively cheaper cost even while replacing part of the sand with manufacturing sand.

III. CONCLUSIONS

- It is observed that Artificial Sand can be effectively used as fine aggregate in concrete mix.
- The use of Artificial Sand reduces the consumption of natural river sand as well as cost of construction.
- The use of manufacturing sand in concrete saves money up to 2.2 % over the conventional cement concrete.

REFERENCES

[1] A K Sahu, S Kumar and A K Sachin.,2003 Crushed Stone Waste as Fine Aggregate for Concrete. The Indian Concrete Journal, vol 77, no 1, p 845.
[2] H.Donza,O. Cabrera, E.F. Irassar (2002), " High-strength concrete with different fine aggregate" , Cement and Concrete Research, Vol.32, Issue 11, PP: 1755-1761.
[3] Bhatty, J., Gajda, J., Botha, F., and Bryant, M. (2006), "Utilization of Discarded Fly Ash as a Raw Material in the Production of Portland Cement," Journal of ASTM International, Vol. 3, No. 10, PP: 1-14
[4] Reddy, M.V. and Reddy, C.N.V.S. (2007), "An experimental study of rock flour and insulator ceramic scrap in concrete', Journal of Institute of Engineer, Vol 8, Issue 8, PP: 47-50.
[5] T. Kaosol, "Reuse concrete waste as crushed stone for hollow concrete masonry units," in Proc. The 3rd Technology and Innovation for sustainable development international conference (TISD2010), Faculty of engineering, Khon Kaen University, Thailand, 2010, pp. 176
[6] Nimitha Vijayaraghavan and A S Wayal (2013), "Effects of Manufactured Sand on Compressive Strength and Workability of Concrete", International journal of Structural & Civil Engineering Research, Vol. 2, No. 4, PP: 228-232
[7] Sheetal A. Sahare, Mugdha N. Priyadarshini, Shweta S (2015), "Effect of Artificial Sand on Compressive Strength and Workability of Concrete", International Journal for Science and Advance Research in Technology, Volume 1 Issue 4, 183-188, April 2015.
[8] Nithyambigai. G (2015), "Partial Replacement of Manufactured Sand and Fly Ash in Concrete", International Journal of Emerging Technology and Advanced Engineering, Vol. 5, Issue 6, PP: 166-170
[9] Chandrasekar R, Chilabarasan T, Roshan Thariq Shah A, Visuvasam J (2017), "Development of high strength concrete using waste foundry sand", Journal of Chemical and Pharmaceutical Sciences, Vol. 10, Issue 1, PP: 348-351.
[10] M. Manoj Pravarly, S. Mahesh (2017), "Characteristic of High Performance Concrete by using ROBO Sand and Fly ash", International Journal of Scientific Engineering and Technology Research, Volume 6, Issue 6, PP: 1015–1022.
[11] Prasanna K, Anandh K S, kiruthiga K (2017), "Study on High Performance Concrete with Replacement of Fine Aggregate by Manufactured Sand", International Journal of Civil Engineering and Technology, Volume 8, Issue 8, PP: 1502–1514.
[12] M R Chitlange, 2010, Appraisal of Artificial Sand Concrete, IE(I) Journal Volume 90.
[13] R. Ilangovana1, N. Mahendrana1 and K. Nagamanib2, 2008, Strength And Durability Properties Of Concrete Containing Quarry Rock Dust As Fine Aggregate, ARPN Journal of Engineering and Applied Sciences, vol. 3, no. 5.
[14] R Ilangovan, K Nagamani and P Gopal Swamy, 2007, Recycling of Quarry Waste as an Alternative Material in Concrete Manufacturing, Indian Construction, vol 40, no 2, p 7.
[15] Ilangovan R. and Nagamani K., 2006. Application of quarry Rock dust as fine aggregate in concrete construction. National Journal on construction Management: NICMR. Pune. December. pp. 5-13 Optimum Replacement of Natural Sand with Artificial Sand in Concrete 97
[16] Priyanka A. Jadhav, Dilip K. Kulkarni, fect of replacement of natural sand by manufactured sand on the properties of cement mortar , International Journal of Civil And Structural Engineering Volume 3, No 3, 2013
[17] Vinayak R.Supekar, Popat D.Kumbhar Properties Of Concrete By Replacement Of Natural Sand With Artificial Sand International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 7, September – 2012.
[18] Kode V. R., Murty D.S.R., Swarna Kumar P., " Appraisal of Crushed Stone Dust, as Fine Aggregate in Structural Concrete", Civil engineering & Construction Review, Vol.20, No. 7, july 2007, pp. 52-58.

