International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 4, Issue 1 (January-February, 2016), PP. 171-175

STRENGTH EVALUATION OF STEEL FIBRE REINFORCED CONCRETE WITH RECYCLED AGGREGATES

Suman Preet Singh [1], Rajwinder Singh Bansal[2]
[1]Civil Engg. Dept. St. Soldier institute of Engg. & Tech., Jalandhar,
[2]Civil Engg. Dept. Ramgarhia Institute of Engg. & Tech., Phagwara, India
[1]construction_Suman@yahoo.com
[2]rajwinder.16272@gmail.com

Abstract—-**This study was conducted to investigate the effects of replacing natural coarse aggregates (CA) with recycled concrete aggregates (RCA) & addition of steel fibres on workability, compressive strength, tensile strength & flexural strength of concrete. Properties were evaluated using different proportion of RCA and Steel fibres. For this, an experimental program was planned in which different concrete mixes were prepared with partial replacement level of 0%, 50% & 100% CA with RCA in binary mixes. The ternary concrete mixes were also prepared by partial replacing CA by 0%, 50% &100% RCA and by adding 0%, 0.5% & 1% of steel fibres as reinforcement. In all, nine RCA mixes were prepared, the water/binder (w/b) ratio was kept constant at 0.4 and the super plasticizer was used at 1% by weight of cement to maintain the workability of concrete. To determine compressive strength of concrete mix, cubes of size 150 mm x 150 mm x 150 mm were prepared and tested after the period of 7 and 28 days of water curing. To determine split tensile strength and flexural strength, for each mix, cylinders of size 100 mm diameter and 200 mm height and beam of 100 mm x 100 mm x 500 mm were casted and tested after 28 and 56 days of curing period.**

Index Terms—**Component, formatting, style, styling, insert.**

I. INTRODUCTION

Concrete is the most common and useful material in the construction industry and has contributed to the advancement of civilizations throughout last century. However, construction activities demand a significant amount of natural materials in order to produce cement and aggregate. Procurement of these natural materials significantly modifies the natural sources and creates major environmental problems. Further more, sustainable waste management is another major issue faced by countries all over the world. In order to minimize the environmental impact and energy consistency of concrete used for construction facilities, reuse of construction and demolition wastes can be a beneficial way which leads to sustainable engineering approaches to concrete mix design. As many developing countries all over the world are recycling and reuse area alternatives to minimize the impact of energy and raw material consumption on the environment, another waste that can be potentially used for concrete production is recycled concrete aggregate obtained via construction & demolition waste.

Sustainable development of the cement and concrete industry requires the utilization of industrial waste components. At present, for a variety of reasons, the concrete construction industry is not sustainable. Firstly, it consumes huge quantities of virgin materials which can remain for next generations. Secondly, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change. Thirdly, many concrete structures suffer from lack of durability which may waste the natural resources. So, finding a solution to substitute a practical recycled product for part of the cement seems to be desirable for sustainable development. The utilization as mineral admixture to partially replace cement could preserve the non-renewable resources required for the production of cement, and could somehow contribute to sustainable construction

The recycled concrete aggregate have some properties like the natural aggregates but the strength is less than the natural aggregates. We can use the industrial by product to some extent, which do not affect the fresh and hardened properties of the concrete and gives the similar result as normal concrete.

A large number of researches have been directed towards the utilization of waste materials. To increase the durability of the concrete made with recycled concrete aggregates, admixture & fibre can be used, the admixture increase the workability of the concrete at same water cement ratio, whereas the fibre increase compressive, tensile & flexural strength of the concrete. The required durability characteristics are more difficult to define than the strength characteristics, specification often use a combination of performance & prescriptive requirements, such as workability, compressive strength, Split tensile strength, flexural strength and water-cement material ratio to achieve a durable concrete. End result may be a high strength concrete, but this only comes as a construction & demolition waste of requiring a durable concrete.

II. CEMENT

Cement is used as binder in concrete, it is very fine and grey in colour. It has tendency of setting independently and binding other materials together. Its initial and final setting time is half an hour and ten hour respectively.

Table 1:Chemical composition of cement (%)

A. Types of Cement

a) Non-hydraulic cement: This cement sets under dry conditions and reacts with carbon CO2 in the atmosphere .But it can be easily affected by violent chemicals after setting.

b) Hydraulic cement: Cement which is obtained using replacement of cement in a mix with Aluminum silicates and pozzolanas, such as fly ash, rice husk etc. is called hydraulic cement. The chemical reaction makes hydrates which are insoluble in water, durable and safe from chemical attack.

B. Some Common Mistakes

III. AGGREGATES

Aggregates are the inert materials such as gravel, sand or coarse aggregates, with can be mixed with water and Portland cement are necessary ingredients of concrete. Aggregates can be of two types

Natural

Manufactured.

Recycled aggregate

Natural aggregates are obtained from rocks through an open quarry. Extracted rock particles are then grinded to usable sizes by mechanical crushing. Manufactured aggregates are the byproduct of natural aggregates and is manufactured in industries. Recycled aggregate is obtained from demolition of old structural concrete.

IV. FINE AGGREGATES

Fine aggregate is ordinary sand which has been washed and sieved to remove the larger particles more than 4.75mm size. The fine and coarse aggregate are kept separately because mixture of fine aggregates is more expensive than coarse aggregates. The cause for using a mixture of fine and coarse aggregate is that by correct proportions to make the concrete free form voids or very few voids are obtained, and it also reduces the quantity of comparatively expensive fine material like cement.

V. COARSE AGGREGATE

Coarse aggregates are bigger in size i.e. above 4.75 mm. In concrete, 10 mm and 20 mm size of aggregates are commonly used. Coarse aggregates also termed as mineral materials such as gravel and crushed stone aggregates which are used with a bitumen or Portland cement to form compound materials such as asphalt concrete and Portland cement concrete respectively. In road construction 20mm and 40mm aggregate are used as base and sub base in both rigid and flexible pavements. Concrete admixtures are primarily used to increase the setting time of concrete and also to ensure the quality of concrete during mixing, transporting, placing, and curing. But use of natural aggregates also leads to high cost of construction. In this research work recycled aggregate was used. As the use of recycled aggregate in concrete mix makes it economical.

VI. RECYCLED CONCRETE AGGREGATES

With the demolition of the old structure, the environmental waste increases. To reduce the environmental waste we can process the old concrete by crushing it to the size required for the mix design, the recycled concrete aggregate have same properties like the natural aggregates but the strength is less and water absorption is more than the natural aggregates. As the sources of natural aggregates are reducing and the cost of aggregates is increasing, we can use the recycled concrete aggregates to make the concrete mix economical. Many researches have been directed towards the utilization of waste materials, which show that the concrete having partial replacement of natural aggregates with recycled aggregates is having less durability than nominal concrete. To increase the durability of concrete made with partial replacement of natural aggregates with recycled aggregates, fibres can be used, as the workability of concrete containing recycled aggregates is less, so to increase the workability admixture can be used.

VII. STEEL FIBRES

For increasing the strength of the recycled concrete I have used corrugated steel fibres which I purchased from STEWOLS INDIA (P) LTD.5-8B, Nagpur. As the workability of concrete decreases with addition of long length fibre, I have used 25 mm length corrugated steel fibreand having 1mm dia in section.

VIII. PROPERTIES OF MATERIALS

Table 1. Characteristics of binding material

S.No	**Characteristics**	**Result obtained**
1	Initial Setting time	110 minutes
2	Final Setting time	270 minutes
3	Fineness	3000 cm^2/g
4	Compressive strength	44.5 MPa(28 Days)
5	Specific gravity	3.15

Table 2. Characteristics of fine aggregates

S.No	**Characteristics**	**Result obtained**
1.	Fineness Modulus	2.57
2.	Specific Gravity	2.7
3.	Bulk density (loose) Kg/m^3	1680

Table 3. Characteristics of course aggregates

S.No.	Characteristics	Result obtained
1.	Fineness Modulus	6.55
2.	Specific Gravity	2.65
3.	Bulk density (loose) Kg/m^3	1260
4.	Water absorption %	2.9

Table 4. Characteristics of recycle coarse aggregates

S.No.	Characteristics	Result obtained
1.	Fineness Modulus	6.41
2.	Specific Gravity	2.45
3.	Bulk density (loose) Kg/m^3	1485
4.	Water absorption	4.3

Table 5. Characteristics of steel fibres

S.No	Properties	Value
1.	Length of Fiber	25mm
2.	Diameter	1 mm
3.	Aspect ratio	25
4.	Shape	Corrugated
5.	Material	Fe-415
6.	Thermal conductivity	High
7.	Specific gravity	7850kg/m^3

Table 6. Characteristics of admixture

S.No	Properties	Value
1.	Color	Light brown liquid
2.	Relative Density	1.08 $\pm$ 0.01 at 25°C
3.	pH	≥6 at 25°C
4.	Chloride ion content	< 0.2%

1. Results

Table 7. Compressive strength Result

Sr.No	Mix ID	COMP. STRENGTH	
		7 days	28 days
1	M 1	30.26	39.57
2	M 2	34.9	45.02
3	M 3	38.02	47.17
4	M 4	31.36	32.37
5	M 5	32.11	36.68
6	M 6	32.93	38.85
7	M 7	24.68	29.98
8	M 8	25.52	31.74
9	M 9	28.77	32.77

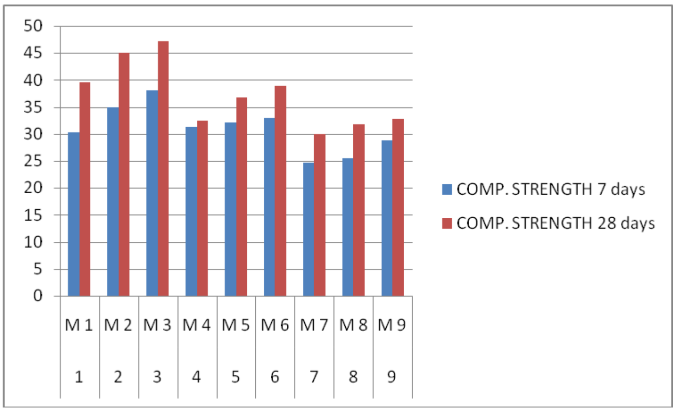


Table 8.

Sr. No.	Mix ID	TENSILE STRENGTH	
		7 days	28 days
1	M 1	4.32	5.48
2	M 2	4.66	6.48
3	M 3	5.42	6.72
4	M 4	3.86	5.41
5	M 5	4.15	5.75
6	M 6	4.76	6.23
7	M 7	2.88	4.27
8	M 8	3.10	3.86
9	M 9	3.43	3.37

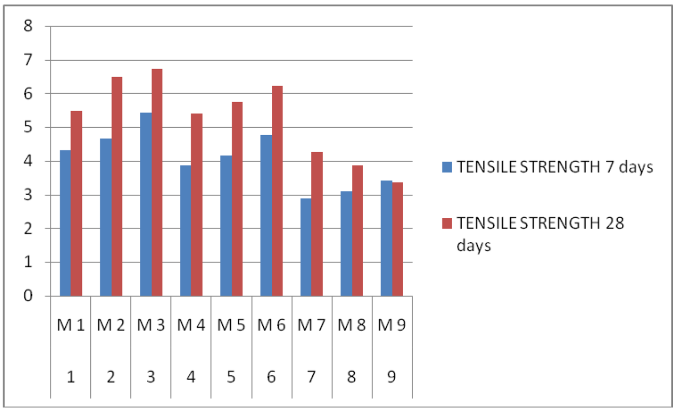
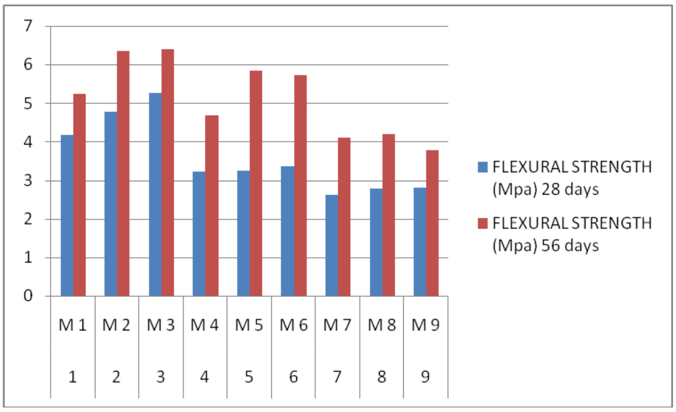


Table 9. Flexural strength result

Sr.No	Mix ID	FLEXURAL STRENGTH (Mpa)	
		28 days	56 days
1	M 1	4.17	5.23
2	M 2	4.78	6.35
3	M 3	5.26	6.40
4	M 4	3.22	4.68
5	M 5	3.25	5.85
6	M 6	3.36	5.73
7	M 7	2.62	4.10
8	M 8	2.78	4.20
9	M 9	2.81	3.78



REFERENCES

1. Ajdukiewicz, A., (2002) "Influence of recycled aggregates on mechanical properties of HS/HPC". cement and concrete composite. Vol-24, pp269-279.
2. Butter, L., (2011) "the effect of recycled concrete aggregates properties on the bond strength between RCA. Concrete & Steel Reinforcement". Cement & concrete research. Vol-41, pp1037-1049.
3. Carneiro, J., (2014) "Compressive Stress- strain Behavior of steel fibre reinforced-recycled aggregate concrete". Cement & concrete composite. Vol-46, pp 65-72.
4. Conrinaldesi, V., (2010) "Mechanical and elastic behavior of concrete made of recycled-concrete coarse aggregates". Construction & building material. Vol-24, pp 1616-1620.
5. Chai, C.W. & Yun, H.P, (2013) "long term deflection & flexural behavior of recycled concrete beam with recycled aggregates". Materials & design. Vol-51, pp 742-750.
6. Dong, J.F., (2013) structural behavior of recycled aggregates filled steel tube". Engineering Structures. Vol-48, pp 532-542.
7. Erdam, S., (2011) "Microstructure linked strength properties and impact response of conventional & recycled concrete reinforced with steel & synthetic macro-fibres". Construction & building materials. Vol-25, pp 4025-4036.
8. Faithifozl, G., (2011) "Stress capacity evaluation of steel reinforced recycled concrete beams". Engineering structures. Vol-33, pp 1025-1033.
9. Gull, I., (2011) "The strength of recycled waste concrete and its application". Journal of construction Engineering & Management. Vol-137, pp 1-5.
10. Gabr, A.P., (2012) "properties of fresh & hardened concrete". Journal of materials in Civil Engg. Vol-24, pp 494-498.
11. Kou, S.C.,& Poon. C.S. (2012) "the durability properties of concrete prepared with coarse recycled aggregates". Construction & building Materials. Vol-29, pp 368-377.
12. Kumar, P., and Dhinakaran, G., (2012) "The effect of admixture recycled aggregate concrete on properties of fresh and hardened concrete". Journal of materials in civil engineering. Vol-24, pp 494-498.
13. Katz, A., (2003) "Properties of concrete made with recycled aggregates from partially hydrated old concrete". Cement and concrete research. Vol-33, pp 703-711.
14. Kim, S., & Yun, H., (2013) "influence of recycled coarse aggregates on the bond behavior of deformed bars in concrete". Engineering structures. Vol-48, pp 133-143.
15. Levy, S. & Helene, P., (2004) "Durability of recycled aggregates concrete a safe way to

sustainable development" Cement and concrete research Vol-34, pp 1975-1980.

16. Malesev, M., (2010) "the compressive stresses depend on the quality of recycled concrete aggregates for all load phases". Cement & concrete composite. Vol-27, pp 1907-1912.
17. Mas, B., (2012) "the influence of the amount of mixed recycled aggregates on the properties of concrete for non-structural use". Construction & building materials. Vol-27,pp 612-622.
18. Manzi, S., (2013) "Short & long term behavior of structural concrete with recycled concrete aggregates". Cement & concrete composites. Vol-37, pp 312-318.
19. Padmini, A.K., (2009) "Influence of parent concrete on the properties of recycled aggregate concrete". Construction & building material. Vol-23, pp 829-836.
20. Rounwana, Z., (2001) "the assessment of the surface prevention properties of recycled aggregates concrete". Cement & concrete composites. Vol-25, pp 223-232.
21. Rathod, H. A.,& Kumar. J. (2013) "Use of RCAs in Civil construction works will reduce environmental pollution & reduce the cost of production of natural resource". Engineering structures. Vol-46, pp 431-438.
22. Saban, K., (1999) "Fatigue behavior of fibre reinforced recycled aggregates base course". Journal of material in civil Engineering. Vol-11, pp 124-130.
23. Santsos, M., (2011) "The strength of concrete building blocks made with recycled demolition aggregate". Construction & building materials. Vol-25, pp 726-735.
24. Sagoe, K.K., (2001) "performance o9f concrete made with commercially produced coarse recycled concrete aggregates". Cement and concrete research. Vol-31, pp 707-712.
25. Younis, K.H., &Pilakautos, (2013) "strength prediction model & material for improving recycled aggregate concrete". Construction & building Material. Vol-49, pp 688-701.