iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: VII Month of publication: July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45898

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

Used Engine Coolant as an Admixture in Concrete

Shameem Farooq[1], Prof. Navdeep Singh[2]
[1, 2]CT University Punjab

Abstract: Civil Engineering has always been a field of innovations. Civil Engineers have always worked towards bringing useful outcomes. They have always tried to bring in scientific inventions and discoveries for their benefit. But the sudden explosion of scientific technology has seen some disadvantages as well. The worst hit victim of all nuisance created by the Science and Technology has been the Earth. The pollution created by technologies has started to deteriorate our mother earth. So it has been felt that there is an urgent need of some innovations which would reduce the pollution. The pollution has left our water contaminated and there is an evident scarcity of water in the world. This is to be understood here that water is the most important material when it comes to the construction of civil engineering projects. Thus the scarcity has already hit the construction field and it is surely going to have some very long lasting impacts on the construction in future. Thus we need some alternative to water. There has already been a lot of research on the development of an alternative to water. However, very little has been achieved by now. I decided to take things a little further by introducing a waste product as an alternative to water. I used Engine Coolant as an alternative to water and studied the impact it will have on the constructions. This usage will reduce the waste on earth as well. As of now it is impossible to replace entire water with Engine coolants but we can still study its impact on concrete and its feasibility in constructions. This study is completely based on the impact of Engine Coolant in concrete. The study has been carried out to create an alternative to water and reduce the waste materials in this world. This paper presents a study on properties of concrete like workability, compressive, tensile and flexural strength for both normal and the accelerated curing for M30 concrete mix at 7 & 28 days for (0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 2%, 3%, 4% & 100%) partial replacement of water by used engine coolant in concrete. All the tests for finding different properties of concrete and its mix design were done using the Indian standard guidelines.

Keywords: Used Engine Coolant, admixture, Concrete, Environment, Waste, Compressive Strength, Tensile Strength, Flexural Strength, Slump Value, Curing.

I. INTRODUCTION

Concrete is considered as one of the most important construction materials among all other construction materials, which is manufactured at site. It is the 2nd largest used material after water, with 3 tonnes being used per person per year. Thus there is the least doubt that concrete will remain in use for the years to come. As the demand increases for this fundamental building material, studies will be carried out continuously to optimize the chemical and physical properties so that concrete remains environment friendly and at the same time affordable. One cannot even think of building a structure which is strong, durable and capable enough to resist earthquake shocks. Concoction of Water, fine and course aggregates along with cement after amalgamating them collectively into a solid stone is described as concrete. Once these elements are assorted jointly they outline a liquefied mass, being fresh and impressionable, it can be sorted into any yearned form. Properties like strength, density, chemical and thermal resistance in unsullied and hardened state are managed by consequent materials through which concrete is formed. Since these ingredients vary in quantity, the properties do not remain same. In order to make sure that freshly obtained concrete is workable and after hardening it is capable enough to withstand the weather conditions, the constituents should be correctly mixed. Concrete while defying breakdowns produces consistency together with domestic hostility. These are associated to water cement ratio. The eventual strength is build up by w/c ratio and its appropriate mixing. In manufacture of concrete aggregates consists of 60-70% of total volume and they should be selected according to function of product. Water is in between 15-20%. Being strong in compression and weak in tension, concrete is required to be reinforced by materials having higher tensile strength to overcome the weakness. Concrete is reinforced with steel and different fibres in order to make it strong in tension and desired results have been obtained. In modern world the use of RC construction stems from the wide availability of its ingredients-concrete as well as reinforcing steel. So far as production of concrete is concerned it does not require any expensive manufacturing mills expect for the production of cement and steel bars. Despite this need for sophistication, a large number of single-family houses and low-rise residential buildings in whole world have been and are being constructed by using reinforced concrete without any assistance of engineering. In earthquake prone areas, such buildings are death traps. In concrete it has found that incorporation of fibre also improve several properties such as cracking resistance, tensile strength, ductility and fatigue resistance.

Different types of fibres like steel, nylon, asbestos etc. were used in the past. From all of these asbestos fibres from different waste used in concrete is successful, its exposure is detrimental to the human beings health, wastes fibres improve flexural strength and toughness. Increased density and corrosion damage are the limitations of steel fibres.

Present world is witnessing that the construction is very challenging and difficult in civil engineering structures. In the field of concrete technology efforts are being made to develop such materials which have special characteristics. All over the world researchers are trying to develop high performance concretes by using fibres and admixtures in concrete with proportions. Fibre reinforced concrete (FRC) is a new construction material which develop through various research and development work during last two decades. In concrete incorporation of fibre has found to improve various properties such as cracking resistance, impact and wear resistance ductility and fatigue resistance. These days several waste products are being used to achieve the desire results because modern routine, together with the improvement in technology has only added to the quantity and type of waste being endangered, leading to a waste disposal crisis. For years, scientists and researchers have been searching for possible solutions to environmental concerns of waste production and pollution. Many have found that replacing raw materials with recycled materials reduces our dependency on raw materials in the construction industry. Large quantities of this waste cannot be eliminated. However, the environmental impact can be reduced by making more sustainable use of this waste. The aim is to reduce, re use, or recycle waste, the latter being the preferred option of waste disposal. This study is aimed at understanding the feasibility of used engine coolant as replacement of water in concrete.

A. *Materials*

The materials used in the study were cement, fine aggregates (sand), course aggregate, Water, Used engine Coolant. Tests on these materials were conducted as per Indian Standard (IS) guidelines to determine different properties which are explained as follows

1) *Cement:* Ordinary Portland cement (Ultra tech) was used. OPC was preferred over PPC due fast setting, high early strength and being environment friendly. All important properties of cement like standard consistency, initial and final setting time, specific gravity were determined according to IS guidelines. Table 1 shows properties of cement

.

S.no.	Description	Values obtained	Requirements as per IS-1489, 1991
1	Standard consistency	35%	
2	Initial setting time, min	45 min	>30 min
3	Final setting time, min	350 min	<10 hrs
4	Specific gravity	3.14	3.0-3.15

2) *Aggregate:* Concrete aggregate usually consists of natural sand and gravel, crushed rock, or mixtures of these materials. Natural sand and gravels are by far the most common and are used whenever they are of satisfactory quality and can be obtained economically in sufficient quantity. Crushed rock is widely used for coarse aggregate and occasionally for sand when suitable materials from natural deposits are not economically available.

3) *Fine Aggregate:* Natural river sand size 4.75mm and below confirming to zone 3 of IS 383-1970 is being used as the fine aggregate. Certain tests have been conducted.

Properties	Fine aggregate
Specific gravity	2.7
Moisture content	25%

4) *Coarse Aggregate:* Natural crushed stone with size less than 20mm is being used as coarse aggregate. Table 3.2 gives the values of certain tests conducted on the coarse aggregates.

Properties	Coarse aggregate
Specific gravity	2.68
Water absorption	1.11%
Free surface moisture	1.976
Water content	1.4%

Table3.2: properties of coarse aggregate

5) *Water:* Potable water was being used in this investigation for both mixing and curing. The amount of water in concrete controls many fresh and hardened properties of concrete including workability, compressive strength, permeability, water tightness, durability and weathering, drying shrinkage and potential for cracking. For these reasons, limiting and controlling the amount of water in concrete in important for more constructability and service life. Ordinary portable water with ph less than 6 is used in this investigation both for mixing and curing.
6) *Used Engine Coolant:* Engine coolants are generally used to extract the excess heat and need to be replaced after some specific period. Coolant which is the waste now can be used in the concrete so as to mitigate the disposal problems and to get benefited using the antifreeze and anticorrosive properties. Green glycol based coolant was used during the whole procedure which was obtained from a local car workshop.

II. METHODOLOGY/EXPERIMENTAL PROGRAM

Machine mixing was done. Slump test was carried on fresh concrete. While as compressive strength, tensile strength and flexural strengths were carried out on the hardened concrete for normal and accelerated curing. These tests were carried to determine the mechanical properties of concrete at 7 & 28 days for compressive, tensile, flexural strengths.

Weight batching being superior to volume batching was used in the whole experimental setup. M-30 concrete mix was used with coarse aggregates of size 20mm.Mix design was carried out as per Indian Standard IS guidelines. After mix design it was found that the final Mix proportions were 1:0.963:2.276 (Cement: Fine aggregates: Course Aggregates), W/C ratio was 0.37. Electrically operated concrete mixer was used for mixing of concrete.

A. Testing of Specimen

Slump tests were being conducted on the fresh concrete so as to check its workability. Compaction factor tests were being conducted to check the compaction factor for various concrete mix. Compressive strength tests, tensile strength tests & flexural strength tests were being carried out on the hardened concrete after the curing for 7 & 28 days.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

III. EXPERIMENTAL PROGRAM

The properties of unreinforced concrete which includes Workability, Compressive Strength, Tensile Strength, and Flexural Strength were all determined by following the Indian Standard guidelines. The Mix design of Concrete was also done by following the Indian Standard guidelines.

A. *Workability*

Slump test was conducted to check the workability of the concrete with and without replacement at 0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 2%, 3%, 4% & 100% following the IS Standards.

B. *Compressive Strength*

A total of 6 cubes each of size (150x150x150) mm were casted for M30 at 7 & 28 days for various percentages (0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 2%, 3%, 4% & 100%) by partial replacement of water by coolant. Both normal curing and the accelerated curing procedures were followed. CTM was used for determining the compressive strength of concrete in accordance with the IS Standards.

C. *Tensile Strength*

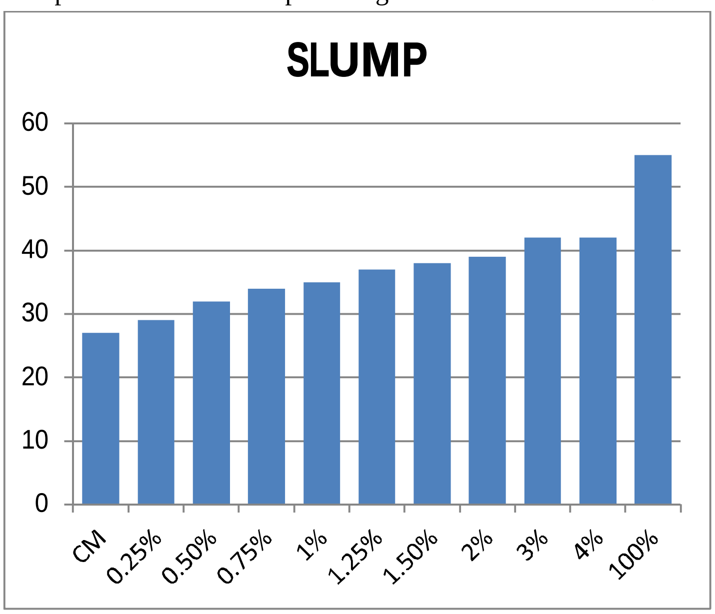
6 cylindrical specimens were casted with 150mm dia & 300mm height each for 7 and 28 days. Standard split tensile test conforming to IS Codes was used for the cylinders with varying percentages of coolant (0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 2%, 3% & 4%).

D. *Flexural Strength*

6 beams each of size (100x100x500)mm were casted at 0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 2%, 3% & 4% for 7 & 28 days respectively. FTM in accordance with IS Standards was used to determine the flexural strength of concrete.

IV. RESULTS & DISCUSSIONS

Workability of concrete is defined as the capability to work alongside concrete. Concrete is said to be workable if it can be taken care of without isolation and loss of uniformity. Slump Value was obtained to check the workability of concrete. The slump value of M30 concrete grade having mix of 1:0.963:2.276 (Cement: Fine aggregates: Course Aggregates), with W/C ratio of 0.37 was found to be 28 mm for control mix. While, 29.5mm for 0.25% UC, 31.534mm for 0.5%UC, 33mm for 0.75%UC, 34mm for 1%UC, 35.8mm for 1.25%UC, 37.3mm for 1.5%UC, 39mm for 2%UC, 43mm for3%UC and 44mm for 4%UC and 54mm for 100% replacement. Figure 1 shows the slump values for different percentages of coolant in concrete.



Slump results

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

1) *Compressive Strength, split tensile Strength and Flexural Strength of Concrete:* The compressive, split tensile and flexural strength were all determined by using M30 mix of 1:0.963:2.276 (Cement: Fine aggregates: Course Aggregates), W/C ratio 0.37. Compressive strength is the ability of a material to bear up loads having tendency to decrease size of material. A total of 6 cube moulds of concrete were tested to determine the load at which failure will occur. The compressive strength was determined corresponding to average of failure loads of three specimens.

V. COMPRESSIVE STRENGTH

	7 DAYS	*28 DAYS*	Average
Control mix	21.090 N/mm2	33.530 N/mm2	27.310 N/mm2
0.25% used coolant	20.980 N/mm2	27.430 N/mm2	24.205 N/mm2
0.5% UC	20.040 N/mm2	26.730 N/mm2	23.385 N/mm2
0.75% UC	19.872 N/mm2	26.496 N/mm2	23.184 N/mm2
1% UC	19.500 N/mm2	26.460 N/mm2	22.980 N/mm2
1.25% UC	19.490 N/mm2	26.300 N/mm2	22.895 N/mm2
1.50% UC	18.510 N/mm2	25.010 N/mm2	21.760 N/mm2
2% UC	18.570 N/mm2	24.160 N/mm2	21.365 N/mm2
3% UC	17.330 N/mm2	23.210 N/mm2	20.270 N/mm2
4% UC	17.240 N/mm2	22.500 N/mm2	19.870 N/mm2
100% UC	2.384 N/mm2	14.723 N/mm2	8.553 N/mm2

Table 4.3: compressive strength results

The effect of different percentages of used coolant on compressive strength of concrete is presented in table 4.3. The compressive strength of concrete goes on decreasing with an increase in the percentage of used coolant in the concrete mix at 7 and 28 days for normal curing. The best comparable results after replacement were at 1.25% for 7 & 28 days as after this, the water starts decreasing and the quantity of coolant alone doesn't form the best paste with cement. For 1.25% of used coolant the average decrease in compressive strength is 21.56% of the conventional concrete.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

A. Tensile Strength

	7days	28days	Average
Control Mix	2.286 N/mm^2	3.372 N/mm^2	2.829 N/mm^2
0.25%used coolant	2.246 N/mm^2	2.680 N/mm^2	2.463 N/mm^2
0.5% UC	2.088 N/mm^2	2.613 N/mm^2	2.350 N/mm^2
0.75% UC	1.970 N/mm^2	2.580 N/mm^2	2.275 N/mm^2
1% UC	1.976 N/mm^2	2.525 N/mm^2	2.250 N/mm^2
1.25% UC	1.860 N/mm^2	2.500 N/mm^2	2.180 N/mm^2
1.5% UC	1.817 N/mm^2	2.450 N/mm^2	2.133 N/mm^2
2% UC	1.805 N/mm^2	2.486 N/mm^2	2.145 N/mm^2
3% UC	1.767 N/mm^2	2.310 N/mm^2	2.038 N/mm^2
4% UC	1.673 N/mm^2	2.280 N/mm^2	1.976 N/mm^2

Table 4.5: Tensile strength results

A similar decreasing trend was observed while calculating the split tensile strength of the cylindrical concrete specimens. Since, the tensile strength is 10% of the compressive strength so decrease in compressive strength is directly related to decrease in tensile strength. The optimum percentage for the replacement is same as that for compressive strength which is 1.25% of the weight of water.

B. Flexural strength:

	7days	28days	Average
Control Mix	2.140 N/mm^2	3.230 N/mm^2	2.685 N/mm^2
0.25%used coolant	3.210 N/mm^2	3.541 N/mm^2	3.375 N/mm^2
0.5% UC	3.126 N/mm^2	3.500 N/mm^2	3.313 N/mm^2
0.75% UC	3.103 N/mm^2	3.473 N/mm^2	3.288 N/mm^2
1% UC	3.090 N/mm^2	3.420 N/mm^2	3.255 N/mm^2
1.25% UC	3.070 N/mm^2	3.336 N/mm^2	3.203 N/mm^2
1.5% UC	3.011 N/mm^2	3.250 N/mm^2	3.132 N/mm^2
2% UC	3.008 N/mm^2	3.150 N/mm^2	3.079 N/mm^2
3% UC	2.830 N/mm^2	2.990 N/mm^2	2.910 N/mm^2
4% UC	2.640 N/mm^2	2.870 N/mm^2	2.755 N/mm^2

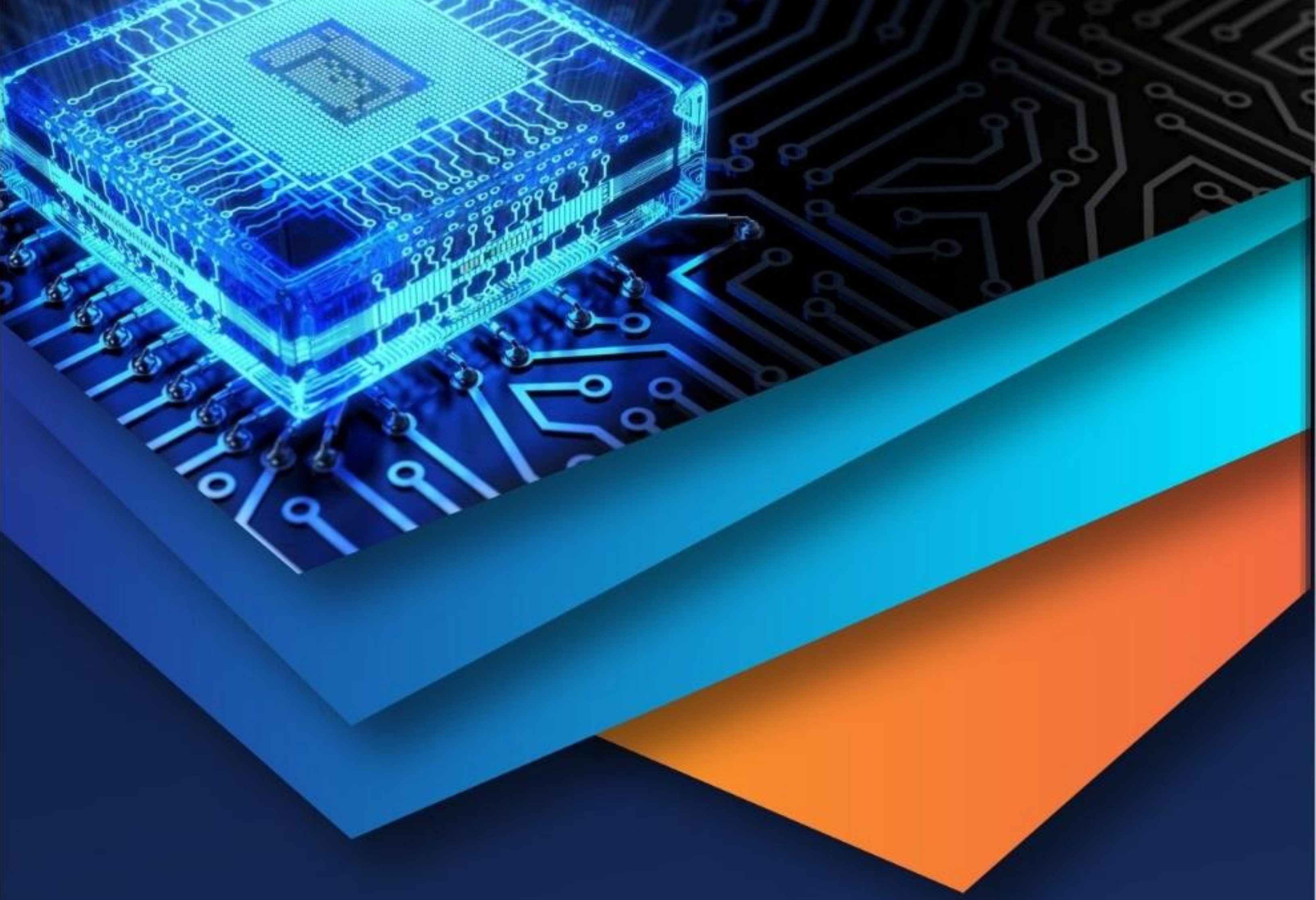
The results show that with the increase in the percentage of the used coolant the flexural strength also decreased because of the direct relation between the compressive and the flexural strengths (flexural strength=0.75√fck). The optimum percentage which gives the comparable results was kept as 1.25%.

VI. CONCLUSION

1) The workability of the used coolant replaced concrete has been found to increase with an increase in the concentration of used coolant in the concrete mix.
2) The addition of the used coolant to the concrete showed the comparable results upto certain percentages (1.25%) for the compressive, tensile and flexural strengths.
3) The accelerated curing showed even more increase in the strengths when compared to the normal curing. (1.849% increase in compressive strength than normal curing at 1.25% replacement)
4) The addition of low concentration of the used coolant can be adventitious for both concrete and to the environment as the waste will be no longer exposed to the environment hence protecting the land and the ground water which otherwise was affected for aprox. 200 years.
5) Comparative study revealed that the coolant alone cannot form the best paste with the cement hence, the optimum percentage which can be added to the concrete will be 1.25% of the used coolant which exhibited the strength of 26.3 N/mm^2 for normal curing and 34.15 N/mm^2 for accelerated curing. (1.849% increase in strength). The studies suggest that the accelerated curing helps in the completion of the hydration reaction between the cement, water and coolant which otherwise was halted by normal curing.

REFERENCES

[1] Neville, A. M. and Brooks, J.J. (1990). Concrete Technology (2nd ed.). Harlow, UK: Longman Scientific & Technical.
[2] Nagesh, M. (2012). Concrete Technology. Ramanagara, India: Government Engineering College.
[3] Owens, G. (2009). Fultons concrete technology (9th ed.). Midrand: Cement & Concrete Institute.
[4] Custódio, J. (2015). Structural Adhesives. In Materials for Construction and Civil Engineering (pp. 717-771). Springer International Publishing
[5] Hensher, D. A. (2016). Fiber-reinforced-plastic (FRP) reinforcement for concrete structures: properties and applications (Vol. 42).Elsevier
[6] Zollo, R. F. (1997). Fiber-reinforced concrete: an overview after 30 years of development. Cement and Concrete Composites,19(2), 107-122
[7] L'hermite, R. (1977). Use of bonding techniques for reinforcing concrete and masonry structures. Materials and Structures, 10(2),85-89.
[8] Varastehpour, H., & Hamelin, P. (1997). Strengthening of concrete beams using fiber-reinforced platics. Materials and Structures,30(3), 160-166
[9] Qi, C., Weiss, J., & Olek, J. (2003). Characterization of plastic shrinkage cracking in fiber reinforced concrete using image analysis and a modified Weibull function. Materials and Structures, 36(6), 386-395
[10] Wang, Y., Zureick, A. H., Cho, B. S., & Scott, D. E. (1994). Properties of fibre reinforced concrete using recycled fibres fromcarpet industrial waste. Journal of materials science, 29(16), 4191-4199.
[11] De Brito, J., & Saikia, N. (2013). Use of Industrial Waste as Aggregate: Properties of Concrete in Recycled Aggregate inConcrete (pp. 115-228). Springer London [46] Standard, I. (1991). IS-1489.,1991. ―Portland- Pozzolana cement-Specification‖, Bureau of Indian Standards, Manak Bhawan, 9.
[12] Standard, I. (1988). IS-4031-1988. ―.Methods Of Physical Tests For. Hydraulic Cement‖, Bureau of Indian Standards, ManakBhawan, 9.
[13] Standard, I. (1970). IS-383-1970. ―.Specification for Coarse and Fine Aggregates From Natural Sources For Concrete.‖, Bureau of Indian Standards, Manak Bhawan, 9.
[14] Standard, I. (1980). IS-2720-1980. ―.Methods of Test for Soils. Part III Determination. of Speclflc Gravity.‖, Bureau Of Indian Standards, Manak Bhawan, 9.
[15] Standard, I. (2000). IS-456. 2000. Plain and Reinforced Concrete-Code of Practice‖, Bureau of Indian Standards, ManakBhawan,9.
[16] Standard, I. (1974). (IS 7320-1974). Specification for concrete slump test apparatus‖, Bureau of Indian Standards, Manak Bhawan, 9
[17] Standard, I. (1959). IS-516. 1959. Method of Tests for Strength of Concrete‖, Bureau of Indian Standards, Manak Bhawan, 9.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)