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STUDY ON EFFECT OF METAKAOLIN ON THE FLEXURAL BEHAVIOUR OF STEEL BARS IN MARINE ENVIRONMENT

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ABSTRACT:- *This experimental study focuses on the performance of steel bars in concrete under two point loading in marine environment. M40 grade of concrete is used for the study. Different parameters such as compression strength, split tensile, and flexural strength test were carried out of M40 grade of concrete. Based on the results, reinforced concrete beam are caste. Two specimens are reinforced with steel bars in both longitudinal and transverse direction which is cured under portable water and salt water for 28 days. Load-deflection behavior, failure modes and ultimate load carrying capacity of conventional steel reinforced beams are studied.*

Keywords: flexural strength, failure mode, load carrying capacity

1. Introduction

Flexure failure is commonly encountered in structural elements such as beams and slabs which are transversely loaded and the strength is a measure of tensile strength of OPC concrete. Although the probability of the structures being flexure deficient is low, failures have occurred due to a variety of factors such as errors in design calculations and improper detailing of reinforcement, construction failures or poor construction, changing the function of a structure from a lower service load to a higher service load, seismic and wind action.

Metakaolin is one of the most widely used mineral admixtures these days for HPC mixes. It helps concrete obtain both higher performance and economy. The use of mineral admixtures has been going on for quite some time now. There are a variety of them available and are used for concrete in market. However, what makes Metakaolin different from others is, the fact that it is not an industrial by – product as the others. Instead it is specially produced by high quality Kaolin using state of the art thermal treatment technology yielding a highly reactive amorphous material with Pozzolanic and latent hydraulic reactivity, , ideally suited for cementing applications. This makes the finishing job easier. This nature of Metakaolin also helps in making concrete easier to pump to greater distances, either vertically or horizontally.

Curing is done primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength. However excessive loss of water by evaporation may reduce the amount of retained water below that necessary for development of desired properties Curing is carried out by supplying water to the surface of concrete in a way that ensures that it is kept continuously moist. So, there is a need to explore alternative for potable water in construction industry as billons of water is used for mixing and curing of concrete. Oceans make up 71 percent of the surface of the earth; therefore, a large number of structures are exposed to seawater either directly or indirectly.

Thus, the usage of Saline water is an alternative in construction for mixing or at least for the curing. In this paper, Concrete grades of M-40 design mix with a slump in between 75 to 100 mm were considered.

2. Objective

To study the mechanical properties of M40 grade of concrete by replacing the percentage of metakaolin on cement.

To compare number of cubes, cylinders and prisms cured under salt water and potable water for its mechanical properties.

To study the Load-deflection behavior, crack patterns, failure modes and ultimate flexural capacity of beams cured in portable water and salt water.

3. Test specimen

Series of cubes, cylinders, and prism were caste for testing the mechanical property of M40 grade of concrete with a mix proportion of 1: 1.80: 3.78 using IS 10262 where cement is replaced with metakaolin of 10% and 0.02% of SP is used as admixture.

3.1 Cube

12 cubes of size 150 X 150 X 150mm is caste and that is to be tested for compression strength of concrete of grade of M40.

3.2 Cylinder

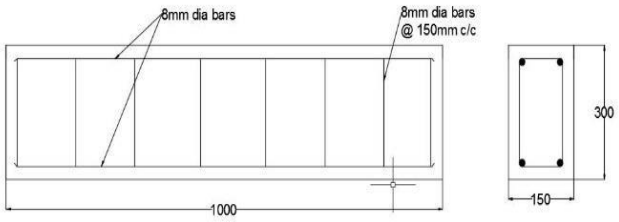
12 cylindrical specimens of diameter 100mm and height 300mm which is caste and cured in portable and salt water for 7 and 28 days for performing splitting tensile strength test of M40 grade of concrete.

3.3 Prism

12 prisms were caste of size 500X100X100mm which is cured in portable and salt water for 7 and 28 days. After curing flexural strength test were performed.

3.4 Flexural member

Flexural member is caste and the size of flexural member is 1000 X 150 X 300mm.



4. Experimental program.

M40 grade of concrete in which cement is replaced with 10% metakaolin is taken for experimental study. M40 concrete mix is arrived and series of cubes, cylinders, and prism were caste and their Mechanical properties is investigated.

4.1Compression strength

Compression test is the most common test on hardened concrete, because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength. Usually testing is done after 7 days and 28 days. Atleast 3 specimens are tested immediately after curing period is over.

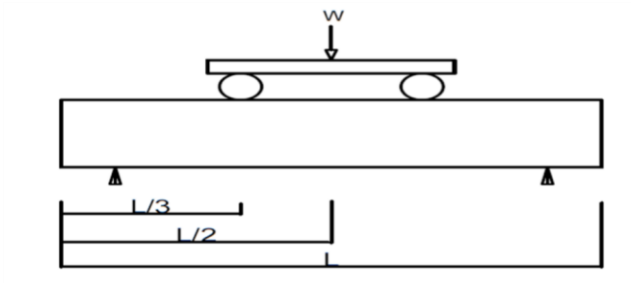
4.2 Split tensile strength

The determination of tensile strength of concrete is essential to estimate the load at which the concrete members may crack. As it is difficult to determine the tensile strength of concrete by conducting a direct tension test, an indirect method, such as Splitting Tension Test is used.

4.3 Flexural strength

The dimension of the prism is 100 x 100 x 500mm, the flexural strength determined normally for 7 and 28 days curing. The specimen is placed in UTM with roller support and single point load is applied until the specimen fails. The broken pieces are taken, the distance between the line of fracture and the nearest support is measured for further calculation.

4.4 Two point loading testing of beam



Beams were tested in UTM by Two-point loading method with an effective span of 800mm. Two Dial gauges were used to measure the deflection. The testing was carried out in 1000kN capacity UTM. Two-point load were applied and displacement of the beam specimen were noted.

5. Result and discussion.

5.1 Compression strength of M40 grade of concrete

Description	7day N/mm^2	28 day N/mm^2
conventional concrete, portable water curing	35.511	39.74
conventional concrete, salt water curing	41.613	51.03
10% metakaolin replacement concrete, portable water curing	43.95	51
10% metakaolin replacement concrete, salt water curing	47.03	50.56

Table 1: compressive strength

From the above table the compression strength of M40 grade of concrete that is cured in portable and salt water is determined. It is found that the compression strength after 28days curing is higher than the compressive strength attained in 7days. 10% MK replaced concrete shows compressive strength more than the targeted compressive strength achieved through calculation for both curing.

5.2 Split tensile strength of M40 concrete grade

Description	7day N/mm^2	28 day N/mm^2
conventional concrete, portable water curing	3.6125	4.127
conventional concrete, salt water curing	3.858	4.89
10% metakaolin replacement concrete, portable water curing	4.012	5.20
10% metakaolin replacement concrete, salt water curing	4.308	4.717

Table 2: split tensile strength

From the above table the split strength of M40 grade of concrete that is cured in portable and salt water is determined. It is found that the split tensile strength after 28days curing is higher than the split tensile strength attained in 7days. 10% MK replaced concrete shows better split tensile strength in saltwater curing after 7 and 28 days.

5.3 Flexural strength of M40 grade of concrete

Description	7day N/mm^2	28 day N/mm^2
conventional concrete, portable water curing	3.440	4.2
conventional concrete, salt water curing	3.60	4.54
10% metakaolin replacement concrete, portable water curing	3.47	4.6
10% metakaolin replacement concrete, salt water curing	3.6	4.98

Table 3: flexural strength

From the above table the flexural strength of M40 grade of concrete that is cured in portable and salt water is determined. It is found that the flexural strength after 28days curing is higher than the flexural strength attained in 7days. 10% MK replaced concrete shows better flexural strength test results in saltwater curing after 7 and 28 days.

5.4 Load deflection values

The following table represent the detail about deflection of flexural member at (L/3) distance from both left and right end which is cured in portable water.

Load	deflection (l/3) 1	deflection (l/3) 2
0	0	0
10	0.02	0
20	0.04	0.03
30	0.44	0.12
40	0.57	0.39
50	0.62	0.48
60	0.67	0.64
70	0.79	0.71
80	1.04	0.86
90	1.33	1.07
100	1.54	1.46

Table 4: Load deflection values of steel reinforcement beam cured in portable water

The following table represent the detail about deflection of flexural member at (L/3) distance from both left and right end which is cured in portable water.

Load	deflection (l/3) 1	deflection (l/3) 2
0	0	0
10	0	0
20	0	0
30	0.18	0.04
40	0.47	0.31
50	0.67	0.73
60	0.97	0.96
70	1.23	1.14
80	1.61	1.44
90	2.12	1.78
100	2.59	2.03

Table 5: Load deflection values of steel reinforcement beam cured in salt water

5.5 Mode of failure of flexural member

The following table gives detail about initial cracking load, ultimate load carrying capacity of beam, type of failure that occurs during loading

specimen	Initial crack loading	Ultimate load	Type of failure
Beam PW	86 kN	203 kN	Shear failure
Beam SW	83 kN	192kN	Flexural failure

Table 6: Test results of beam

Beam PW – steel reinforced beam cured in portable water.

Beam SW – steel reinforced beam cured in salt water.

6. Conclusion:

From the results it is found that, there was an increase in compressive strength, split tensile strength and flexural strength of concrete cubes which were cured with salt water as compared with the concrete cubes cured with fresh water. The beams behaved linearly until cracking and almost linearly between cracking and failure. The experimental result of flexural member were considered comparing the load deflection curve, initial crack loading, and type of failure of beams that is cured under salt water and portable water. In future there will be huge scarcity for fresh water so use of saline water for curing will be an alternative for fresh water.

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