https://dx.doi.org/10.22161/ijaers.75.46 ISSN: 2349-6495(P) | 2456-1908(O)

Impact behaviour of partially replaced Sea Shell (Cockle Calm) as Manufacturing Sand in Concrete

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Abstract— *The main objective of this research goal is to investigate the impact behavior of cockle calm as fine aggregate in concrete under drop weight impact test. In this study,cockle calm is used in the ratio of 0%, 10%, 20% and 30% in the weight of fine aggregate in concrete matrix. Water Cement ratio was 0.42 for compressive test and drop weight impact test. Four slabs were casted in the dimension of 500mmX500mmX50mm and 6mm diametersteel bars were used with 90mm center to center spacing. The Impact testing machine was self-fabricated. The test results indicate the failure pattern of the slab by visible observation of First crack and final crack occur in the slab. The cracks length, width, depth were observed in every blows.*

Keywords— Cockle calm, Drop weight Hammer, First Crack, Final Crack, Impact test.

I. INTRODUCTION

Now a day, the research on control the crack on concrete are plays a main role in research. Cracks on concrete have a several reasons such as temperature, elongation, durability, bonding etc. [10], [2]. An overview of some of these research areas includes the applicability of mollusc shell ash-blended cement for concrete production, and partial or full application of periwinkle, cockle, and oyster shells as coarse aggregates in constructed concrete facilities. The use of shell in lime production for sustainable masonry applications is one major application for affordable housing. It is evident that the natural resources consistently deplete while the demand for concrete constituent materials still re-mains increasingly high. In this study, the impact resistance of cockle calm as fine aggregate in concrete. It will be helpful to extenduse of sea shells and further clarifies the nature of impact behavior of sea shells.

II. EXPERIMENTAL CAMPAIGN

2.1 Material Used and Properties of the material:

OPC 53 grade cement, fine aggregate size of below 2.36mm, coarse aggregate were used. Cement had specific gravity 3.56; Fine aggregate had specific gravity 2.6, fineness modulus 2.2 and water absorption 2.2%. Course aggregate had specific gravity 2.59, water absorption 2.1%. Super Plasticizer was Polycarboxylate Ether 0.1% of weight of cement was used which is ordered from TECHNY CHEMY, in Tiruchirapalli, Tamil Nadu.Cockle Calmadded in the ratio of 0%, 10%, 20% & 30% by the weight of fine aggregate. Water cement ratio is 0.42.

2.2Mix Design and Fabrication of Concrete

For compressive strength 150x150x150mm specimen was used. Impact test for slab specimen size of 0.5x0.5x0.05m with 90mm center to center spacing and provide 6mm diameter of bars in main reinforcement and distribution reinforcement as shown in Figure1. The mix design done as per Indian Standards IS10262:2009.

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Fig.1: Reinforcement Details for Slab

Table 1: Mix Design

Materials	Quantity (kg/m^3)
Cement	492
Fine Aggregate	780
Coarse Aggregate	992

2.4 Impact Test

The drop weight impact machine was self-fabricated with the height of 1m and drop hammer weight (steel ball) was 4.5kg. The slab is placed in the base plate. The slab is subjected to simply supported, the four sides are not clipped. The drop weight hammer was permitted for free fall on the concrete slab at center point on the slab. Number of blow was noted and observes the first crack and final crack in the specimen and also measures the crack length, width and depth for every blow to calculate the crack resistance of the concrete.

Fig.2: Self-Fabricated Impact Instrument

III. RESULT AND DISCUSSION

3.1 Compressive Strength of the concrete:

Aftercasting the concrete, the specimens are in rest for 24hrs, and thenproceedto 28 days of curing to attain strength. M0 represents 0% Cockle Calm in the concrete matrix, M10 represents 10% Cockle Calmwas added by the weight of Fine

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Aggregate. Similarly, M20 and M30 represent 20% and 30% of Cockle Calmadded by the weight of fine aggregate in the concrete matrix. M0, M10, M20 and M30 had the compressive strength of 36.2N/mm^2, 42.47N/mm^2, 44.5N/mm^2 and 39.9N/mm^2. Compare to the M20, other mix ratio was lower strength. M20 mix was the higher compressive Strength.

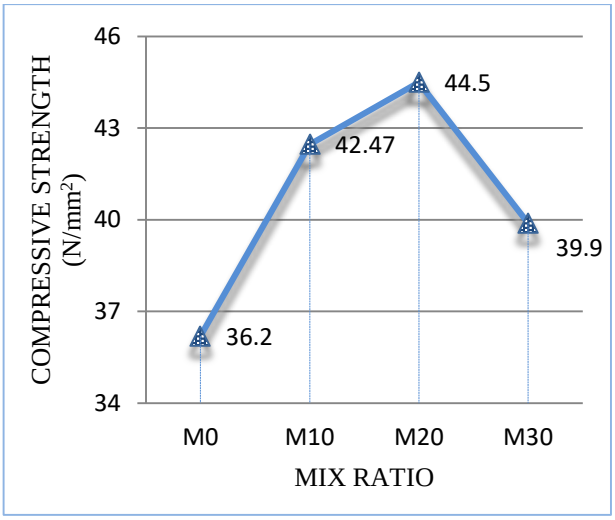

Fig.3: Compressive Strength (N/mm^2) after 28days of curing

3.2 Impact test on Slab and Crack resistance:

The drop weight hammer is free fall from 1000mm height as shown in figure 2. The slabs are simply supported at the ends. The impact energy is calculated by statically [2], [4]. The first crack and final cracksare observed visually.From the experimental surveillance, M0 concrete gives low impact energy than others; also have minimum crack with minimum blows and length of the crack also long, wider than other concrete matrix. M10 concrete matrix have higher impact energy ratio with six number of crack and also resists more blows. M10 has more cracks compare to other concrete matrix but impact resistance is high. M20 resist more cracks butblows are minimum compare to M10 concrete.M30 resist more cracks and minimum number of crack and crack length, width of cracks also minimum compare to other matrix but has minimum blows compared to M10 and M20. Impact energy formula,

Impact Energy U = mxgxHxN -------- (1)

m = Mass of the drop weight hammer (kg),

g = Acceleration due to gravity (m/s^2)

H= height of free fall of steel ball (m)

N= Number of blows for First and Final Crack

The ultimate crack resistance concrete Ru,

Calculation,

Impact Energy U= 4.5x9.81x1x6 = 264.87 N-m

Ultimate crack resistance,

$$Ru = \frac{U}{Lc\ x\ dc\ x\ wc} \quad \text{------- (2)}$$

U = Impact Energy of First Crack N-mm

Lc = Maximum length of Crack, mm

dc = Depth of the crack, mm

wc = Maximum width of the crack, mm

$$Ru = \frac{264870}{500x\ 50\ x\ 1} = 10.59 N/mm^2$$

The crack resistance of the concrete matrix Cr,

$$Cr = \frac{Ru}{fcu} \quad \text{------ (3)}$$

Ru =ultimate crack resistance concrete (N/mm^2)

fcu = Compressive strength of concrete (N/mm^2)

$Cr = \frac{10.59}{36.2}$= 0.29 (No Unit)

3.3 Failure Pattern:

M0 had low impact resistance and crack resistance ratio. M0 has two crack and failure in minimum blow compare to other ratio slab. M10 has many numbers of cracks and give maximum impact Energy.M10 given many crack to indicate the failure. M10 and M20 hadonly 8 & 10cracks but, failure is quickly happened in M10 compare to M20. M30 had developed only three cracks but failure in 21st blow and has resist minimum blow, failure is happened suddenly with minimum number of crack.

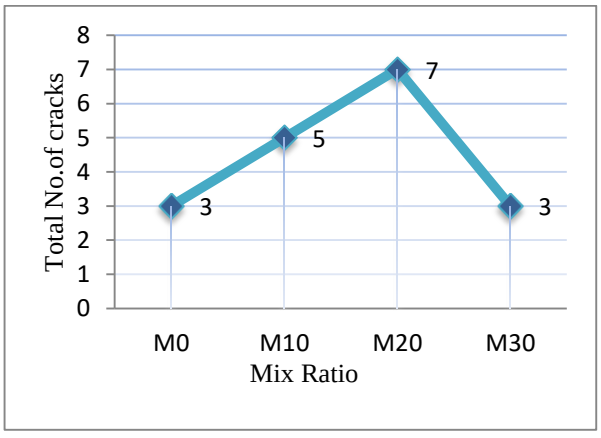

Fig.4: Total no.of cracks in slab up to ultimate failure

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3.3.4 Maximum crack length details:

M0 has only 6 cracks, in that the maximum crack length is 500mmand width is1mm.Compare to other the concrete matrix M0 has max. Crack length and width. M10has 240mm but it has high impact energy.M20and M30 had only 500and 250 mm lengths but it had sudden failure M30.M20 indicate the failure but M0and M30 are not indicate the failure before they fail.

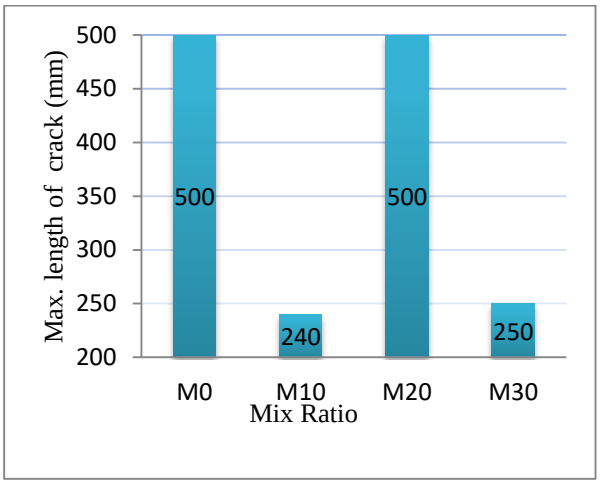

Fig.5: Maximum length of crack on slab up to ultimate failure

Table 2: Impact Energy, Ultimate Crack Resistance, Crack Resistance Ratio Detail

Ratio	***No. of Blows***		***EI statics, N-m***		***No. of cracks up to Final blows***	***Max. crack depth (dc),mm***	***Max. crack length (lc),mm***	***Max. crack width (wc),mm***	***Ultimate crack Resistance (Ru), N/mm²***	***Crack Resistance Ratio (Cr)***
	First Crack	*Final Crack*	*First Crack*	*Final Crack*						
M0	*6*	*22*	*264.8*	*971.19*	*3*	*50*	*500*	*1*	*10.59*	*0.29*
M10	*8*	*34*	*353.1*	*1500.93*	*5*	*50*	*240*	*0.5*	*58.86*	*1.39*
M20	*10*	*36*	*441.4*	*1589.22*	*7*	*50*	*500*	*0.5*	*35.32*	*0.79*
M30	*7*	*21*	*309.0*	*927.045*	*3*	*50*	*250*	*0.25*	*98.88*	*2.47*

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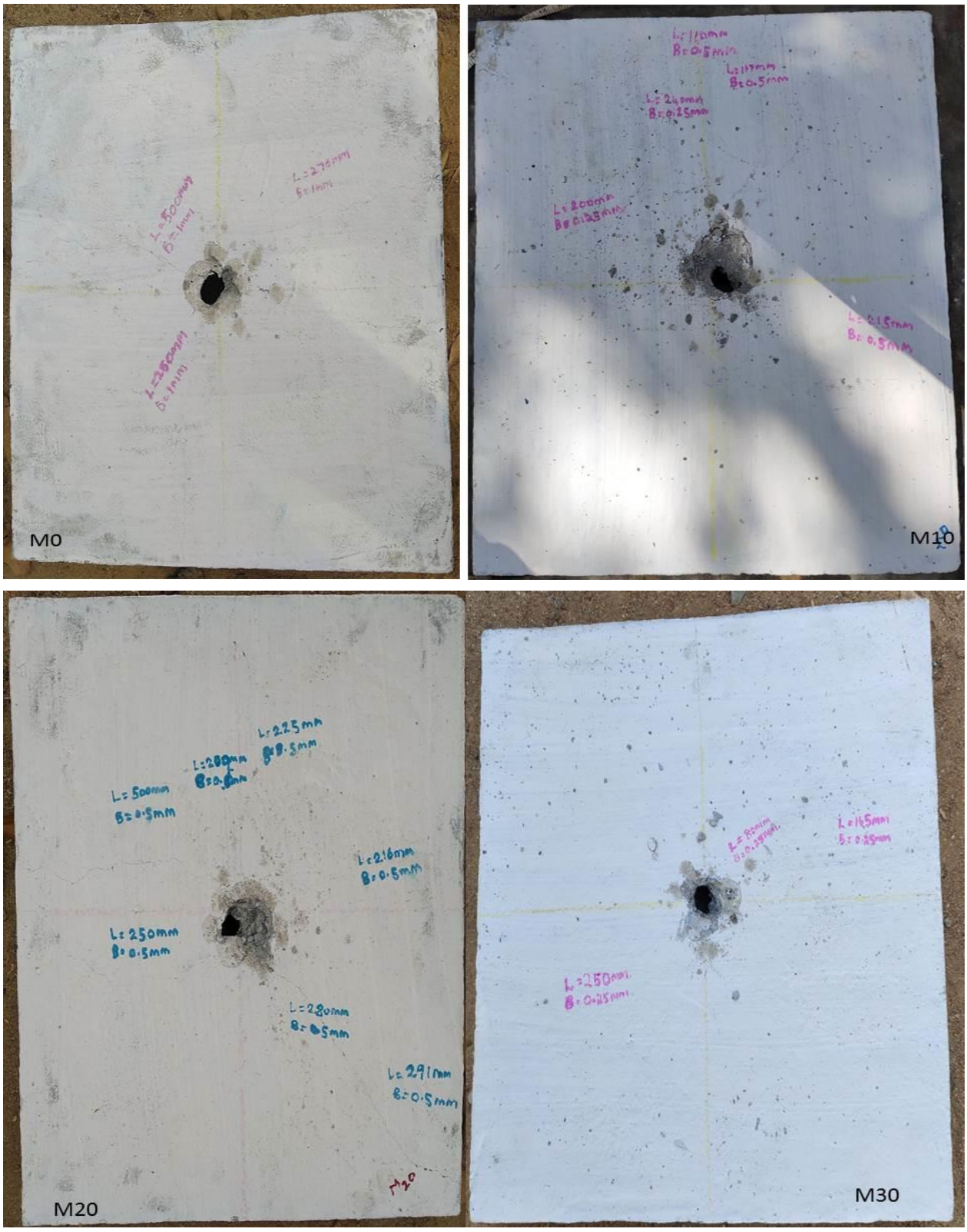

Fig.6: Impact Failure Pattern of Slab with Crack Details

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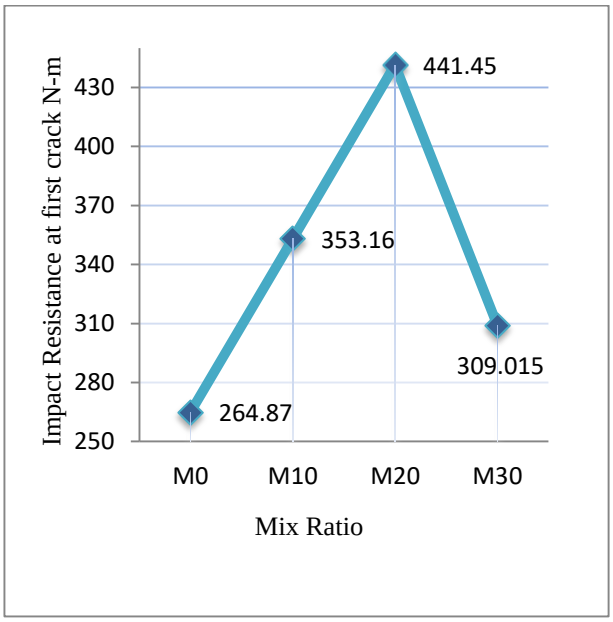

Fig.7: Impact Resistance at first crack in N-m

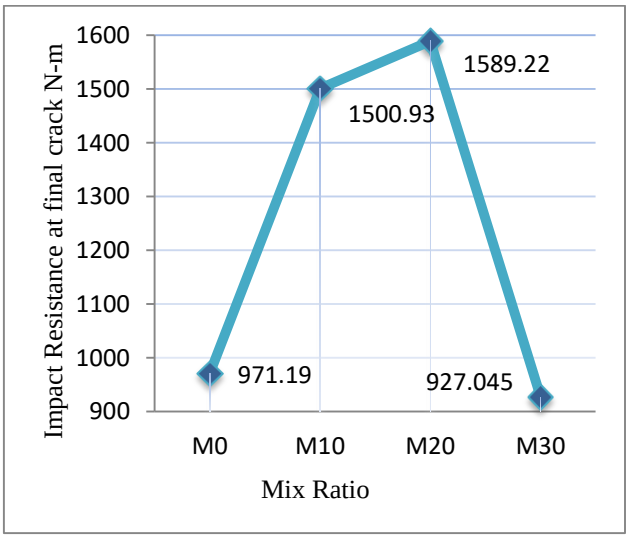

Fig.8: Impact Resistance at final crack in N-m

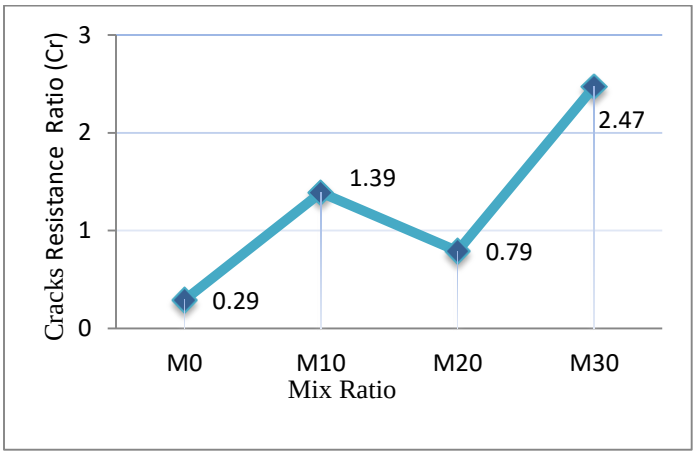

Fig.9: Crack Resistance Ratio (Cr)

IV. CONCLUSION

Based on the experimental test results,conclusions are drawn as follows:

a) As the result suggest,M0 gives maximum crack length compare to other sea shell concrete matrix but M20 resist maximum impact energy compare to other concrete matrix.
b) M20 indicate thefailure by forming a number of cracks in slab but other only for two or four hair line cracks and failure suddenly.
c) M10 has maximum crack resistance but impact energy is low compare to M20 .
d) All the calm shell concrete plays good compare to conventional concrete. M20 has the maximum impact resistance and indicate the failure before ultimate failure by number of visible cracks.

ACKNOWLEDGEMENTS

We would like to thank family members, friends and Staff members of Civil Engineering Department, IndraGanesan College of Engineering, Tiruchirapalli, and Tamil Nadu.

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