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The Influence of Marine Algae on the Mechanical Properties of Concrete.

R.Ramasubramani, Shakthivel.V, Manikandaprabu.S, Ganapathy ramasamy.N

Abstract*: Concrete dependent on Portland cement is most generally utilized construction material on the planet, and its generation pursues a pattern of development. About 15% of the all-out concrete creation contains synthetic admixtures, which are chemicals added to concrete, mortar or grout at the moment of blending to change their properties, either in fresh or solidified state. Algae are photosynthetic amphibian plants that use inorganic supplements, for example, nitrogen and phosphorus. Around 71% of the world is encompassed by sea, the marine green growth naturally known as seaweeds are a differing gathering of photoautotrophic living beings of different shapes (filamentous, lace like, or plate like) that contain pigments, for example, chlorophyll, carotenoids, and xanthophyll's. It controls the substance response of Cement. It maintains a strategic distance from voids and decline porousness of the solid. To study the strength of marine brown algae concrete different percentages (5%, 10% &15%) of algae are added with cement content to determine the Compression strength , Split Tensile strength concrete ,Shrinkage test and Rapid chloride permeability test for M25, M35 & M40grades of concrete. The Slump of the marine algae concrete is increased as the percentage of Wet Marine Brown algae increases and decrease when compared with the conventional concrete and dry marine algae concrete. The concrete compressive strength is decreased with expanding 15 level of the Wet Marine Brown algae replacement to the conventional concrete and dry marine brown algae concrete. The Split Tensile strength was reduced by 15% Wet Marine Brown algae when compared with conventional concrete.

***Keywords* : Compression test, marine brown algae, shrinkage test, spilt tensile.**

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*****Correspondence Author(s)
R. Ramasubramani Assistant Professor Civil Engineering Department SRM Institute of Science and Technology, Chennai, India.
Shakthivel.V .Pursuing B.Tech Civil Engineering at SRM Institute of Science and Technology, Chennai, India
S. Manikanda Prabhu, currently Assistant Professor in Civil Engineering Department at SRM Institute of Science and Technology, Chennai, India
Ganapathy Ramasamy, Assistant Professor in Civil Engineering Department at SRM Institute of Science and Technology, Chennai, India.

I. INTRODUCTION

Algae are photosynthetic amphibian plants that use inorganic supplements, for example, nitrogen and phosphorus. The phaeophyceae or brown algae, are an enormous gathering of the most part marine multicellular algae, including numerous seaweeds. Worldwide there are about 1500– 2000 types of brown algae. A few animal varieties are of adequate business significance, that they have turned out to be subjects of broad research, for example, ascophyllumnudism. Brownish algae contain the fucoxanthin shade present in the algae is in charge of greenish darker shading. Genetic investigations demonstrate their nearest relatives to be the yellow green growth. Brown algae exist in a wide scope of sizes and structures. The littlest individuals from the gathering develop as small, padded tufts of threadlike cells close to a couple of centimetres long. A few species have a phase in their life cycle that comprises of just a couple of cells, making the whole alga tiny. Different gatherings of brown algae develop in a lot bigger sizes. They are utilized as manure, vitality source, nourishment source, shades, contamination control, and in restorative purposes. Concrete dependent on Portland concrete is the most broadly utilized construction material on the planet, and its generation pursues a pattern of development. In 2011, the world creation of Portland concrete achieved 2.8x109tonnes. It is relied upon to increment around 4x109 tonnes in 2050. About 15% of the all-out concrete creation contains synthetic admixtures, which are synthetics added to concrete, mortar or grout at the moment of blending to alter their properties, either in new or solidified. Research is in every case progressively intrigued by the utilization of such items in the concrete mix. This makes the concrete increasingly financial and, in the meantime, there is a decrease of the issue in waste. By examining the properties of algae concrete, the work is important in less contaminated condition and in staying away from the voids in concrete.

II. MARINE ALGAE

About 71% of the world is encompassed by sea. The most significant herbivores in sea are phytoplankton and benthic algae. The marine algae recognizably known as seaweeds are an assorted gathering of photoautotrophic creatures of different shapes (filamentous, lace like, or plate like) that contain shades, for example, chlorophyll, carotenoids, and xanthophylls'.

The growth of marine algae is copious in seaside territory since as the sandy shorelines give great connection focuses in a continually moving and dynamic condition at the sandy shore. The primary sort of vegetation join to the waterfront concrete structure is a filamentous large scale algae. The colonization is because of the consistent scraped spot of the lower locales by the activity of the tide lifting the sand and little stones from around the base of the structure. Various seaweeds can be found in this sort of condition in spite of the fact that there are typically a couple of overwhelming animal groups like Chaetomorpha reception apparatuses. These algae are ordered in the Phylum Chlorophyta. Numerous types of algae become joined to rock and concrete substrates on or close to the sea's surface. As they are appended to a substrate, they can't hurl up on the shoreline by the waves.

III. MARINE BROWN ALGAE CONCRETE

Marine Algae are the one of the nature amicable substance. It controls the compound response of Cement. It maintains a strategic distance from voids and lessening porousness of the concrete. Marine algae are oneself self-consolidating concrete (SCC). Marine algae can decrease the metal balance focus to low levels in metals. The Fig.1 demonstrates the marine brown algae. Fig. 2 demonstrates the gathering of the darker algae. It helps in avoiding the voids of cement. So the different rates of wet and dry marine brown algae concrete (5%, 10%and 15%) were utilized on concrete. The Marine dark coloured algae (5%, 10%and 15%) were used on concrete. The Marine brown algae concrete was added to the cement with different percentages of (5%, 10% and 15%) with different grades of concrete (M25, M35 and M40).Using different types of specimens.

A. Mix Proportions

B. The Mix proportions of conventional concrete for M25, M35 and M40 grade of concrete mixes is shown in Table 1

Table 1 Mix proportions for conventional concrete

S.No	Mix proportions				
	Grade of concrete	*Cement*	*Fine Aggregate*	*Coarse Aggregate*	*Water cement ratio*
1	M25	1	1.93	2.13	0.5
2	M35	1	1.35	2.53	0.45
3	M40	1	1.32	2.57	0.40

IV. EXPERIMENTAL INVESTIGATION

A. General

In order to know the optimum amount of marine brown algae cubes of different dosage of brown algae (5%, 10% and 15% by weight of cement) are casted. The casting of cubes and cylinders are done as per mix proportion and tested for 3, 7 and 28 days.

B. Compression strength test

For testing compressive strength of concrete specimens of 15 cm × 15 cm × 15 cm cube were used. The concrete as per design was poured in the mold. The conventional concrete, wet marine algae concrete and dry marine algae concrete were added with the cement content with different percentages (5%, 10%and 15%). Following 24 hours these moulds were expelled and test samples were placed in water for curing. The top surface of this sample ought to be made even and smooth.

C. Split tensile strength test

This is to determine the tensile strength of concrete.
Cylinders were the test specimens
used to determine the tensile strength. Cylinders of size 100 mm diameters and length 200 mm were used in the present work. The cylinders were cured for 3days7days and 28 days. After 28 days of curing, the beams were tested in a Compression Testing Machine. The conventional concrete wet marine brown algae concrete and dry marine brown algae concrete was added to the cement content with different percentages of (5%, 10% and 15%).

D. Rebound hammer test

At the point when the plunger of rebound hammer was squeezed against the concrete surface, a spring-controlled mass with a steady force was made to hit concrete surface to bounce back. The degree of rebound, which is a proportion of surface hardness, was estimated on a graduated scale. This measured reading is assigned as Rebound Number (rebound index). A concrete with low quality and low firmness will absorb more energy to yield in a lower rebound value. . The various evaluations of cement (M25, M35and M40) for ordinary concrete and wet marine brown algae were characterized to the quality Mpa.

E. Rapid chloride permeability test

As indicated by ASTM C1202 test, water immersed, 50 mm thick, 100 mm diameter concrete specimen and cutting specimens are appeared in this underneath Fig.9 was subjected to a 60 v connected DC voltage for 6 hours utilizing the device and the cell course of action is appeared in Fig.10 In one reservoir is a 3.0% NaC1 arrangement and in the other supply is a 0.3 M NaOH arrangement. The all out charge passed was resolved which later was utilized to rate the concrete as per the criteria included as appeared underneath Table 2. In this regular concrete and 15% level of marine dark coloured algae concrete was utilized for the test.

Table 2 RCPT ratings (per ASTM C1202)

Charge passed (coulombs)	**Chloride Ion penetrability**
<100	Negligible
100-1000	Very Low
1000-2000	Low
2000-4000	Moderate
>4000	High

F. Shrinkage test

At the point when concrete was put; regularly that concrete contains more water than the required to hydrate the cementations materials the mixture contains. This excessed water or water of convenience was for usefulness and situation purposes. The vast majority of the excessed water started to leave the concrete amid position/restoring and made the concrete shrink. In the wake of hardening, concrete started to shrivel as water not devoured by bond hydration left the framework.

This is known as drying shrinkage. Water over that important to hydrate bond is required for legitimate usefulness and completion capacity – the water is designated "water of comfort." all in all, the higher the extra water content, the higher the shrinkage potential. The Shrinkage splits, for example, appeared in the photo underneath are found in poured concrete, are effectively conspicuous, and can be recognized from different sorts of cracks that happen later in the life of a floor slab. The size of the slab 850×540×250 mm diameter15% of wet marine brown algae was having greater strength and the percentage of wet marine brown algae concrete + cement + sand was chosen to conduct shrinkage test. The cross sectional dimensional slab sizes were 850×540×250mm for both wet marine brown algae concrete and conventional concrete.

V. RESULT AND DISCUSSION

A. Specimen tests

As per IS: 456:2009 and IS: 456:2000 the concrete mix design was carried out for concrete grade M25, M35 and M40 the experiments calculated in appendix A.

B. Slump cone test

The table 3 and 4 shows the result to the conventional concrete, wet marine brown algae concrete and dry marine brown algae concrete.

In these wet marine brown algae concretes was more workable on conventional and dry marine brown algae concrete. The results are given below respectively.

Table 3 Slump cone test C.C and wet marine algae concrete

S.No	Grade of concrete	Slump cone valve (mm)	Slump cone valve for wet marine algae concrete (mm)		
			5%	10%	15%
1	M25	91	78	83	87
2	M35	103	90	95	98
3	M40	124	105	110	119

Table 4 Slump cone test C.C and Dry marine algae concrete

S.No	Grade of concrete	Slump cone valve (mm)	Slump cone valve for dry marine algae concrete (mm)		
			5%	10%	15%
1	M25	91	79	81	86
2	M35	103	85	92	95
3	M40	124	90	99	107

C. Compaction factor test

The Tables 5 and 6 shows the compaction factor test values of the mixing of conventional concrete, wet marine brown algae concrete and dry marine brown algae concrete with different percentages (5%, 10% & 15%) for different grades of concrete (M25, M35 &M40).

Table 5 Compaction factor test and Wet marine algae concrete

S.No	Grade of concrete	Compaction factor valve (mm)	Compaction factor valve for dry marine algae concrete (mm)		
			5%	10%	15%
1	M25	0.92	0.89	0.9	0.9
2	M35	0.87	0.79	0.82	0.85
3	M40	0.8	0.77	0.79	0.8

Table 6 Compaction factor test C.C and Dry marine algae concrete

S.No	Grade of concrete	Compaction factor valve (mm)	Compaction factor valve for dry marine algae concrete (mm)		
			5%	10%	15%
1	M25	0.92	0.89	0.9	0.9
2	M35	0.87	0.79	0.82	0.85
3	M40	0.8	0.77	0.79	0.8

D. Compression strength test

The Table7shows the results about the conventional concrete, wet marine brown algae concrete and dry marine brown algae concrete with adding of different percentages (5%, 10% and 15%) to the cement content. Then 15% wet marine brown algae concrete is more than the dry marine algae concrete. The wet marine brown algae concrete increased the 17% of the dry marine brown algae concrete and conventional concrete. The minimum value is 49.32 N/mm2 and maximum value is 55.72 N/mm2. The Fig.1 shows the compression test result for conventional concrete.

Table 7 Conventional concrete for compression test

S.No	Type of concrete	Compression Test (N/mm^2)		
		3 Days	7 Days	28 Days
1	M25	25.04	28.74	33.3
2	M35	26.50	33.12	42.8
3	M40	27.50	34.72	47.48

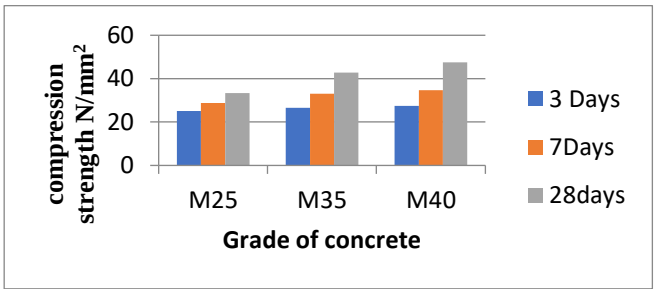

Fig. 1 Conventional concrete on compression test

The Table 8 shows the different percentages of Wet marine brown algae concrete (5%, 10% & 15%).The minimum value of 15% Wet brown algae M25 grade of concrete 31.2 and the maximum value of 15% wet brown algae M420 grade of concrete 55.72.The graphical result shows the Fig.2 for 15% of wet algae concrete gets more strength on conventional concrete and dry algae concrete.

Table 8 Compression Test values of Wet Marine Brown Algae

Type of concrete	3 Days			7 Days			28 Days		
	5%	10%	15%	5%	10%	15%	5%	10%	15%
M25	24.9	25.1	23.01	26.4	28.7	26.7	29.3	30.9	31.2
M35	25.1	26.12	29.71	30.39	33.9	35.14	40.61	41.6	47.92
M40	26.5	28.1	30.79	34.1	35.4	39.71	46.7	49.4	55.72

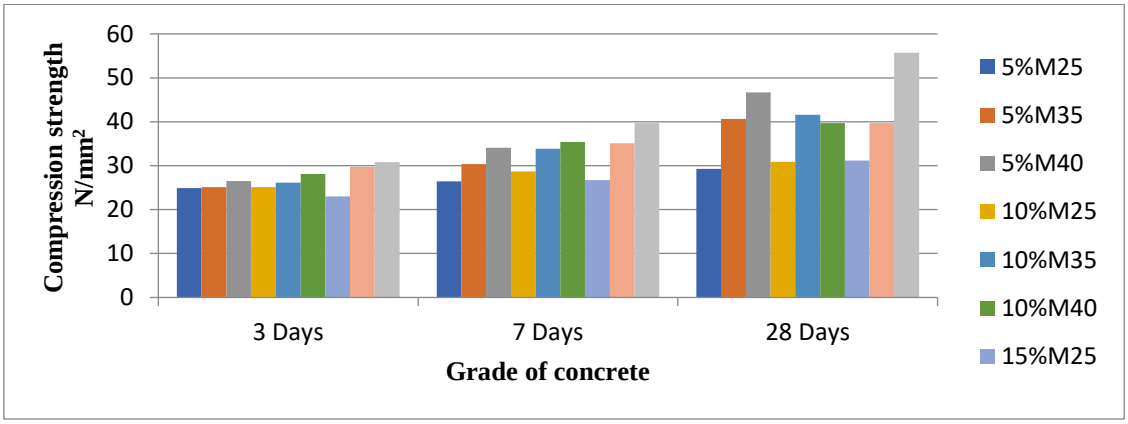

Fig. 2 Compression test for wet marine brown algae concrete

The Table 9 shows the different percentages of Dry marine brown algae concrete (5%, 10% & 15%). The minimum value of 15% Dry brown algae M25 grade of concrete 33.9 and the maximum value of 15% wet brown algae M40 grade of concrete 49.32. The graphical result shows the Fig.3 for 15% of wet algae concrete gets more strength on conventional concrete and dry algae concrete.

Table 9 Compression Test value of Dry Marine Brown Algae

S.NO	Type of concrete	3 Days			7 Days			28 Days		
		5%	10%	15%	5%	10%	15%	5%	10%	15%
1	M25	23.4	24.3	25.04	28.7	29.4	29.6	27.1	30.6	33.9
2	M35	24.1	25.0	26.5	29.8	30.12	33.1	30.8	33.7	42.9
3	M40	25.0	28.3	27.5	34.2	34.9	35.6	47.48	48.9	49.32

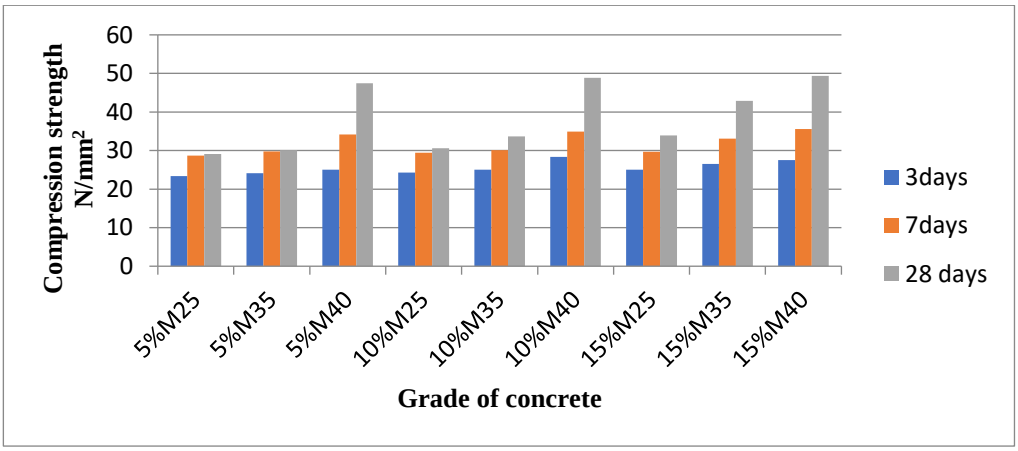

Fig. 3 Compression test for Dry marine brown algae concrete

E. Split tensile strength test

The Table 10 shows the results about the conventional concrete, and the graphical value of the conventional concrete minimum value is 3.39 and maximum value is 5.98. Different grades of concrete (M25, M35 & M40) for testing 3, 7&28 days respectively. The Fig.8 gives the result for conventional concrete.

Table 10 Conventional concrete for Spilt Tensile Test

S.No	Type of concrete	Split Tensile Test (N/mm^2)		
		3 Days	7 Days	28 Days
1	M25	2.31	2.68	3.39
2	M35	3.31	4.01	5.12
3	M40	3.79	4.34	5.98

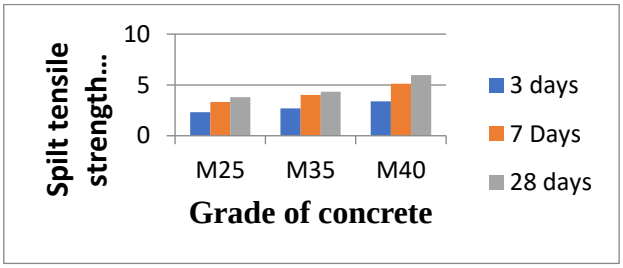

Fig. 4 Spilt tensile test for Conventional concrete

The Table 11 shows the values of different percentages of wet marine brown algae concrete (5%, 10% &15%) on adding with cement content to the different grades on concrete (M25, M35&M40).The minimum and maximum value of wet marine algae concrete is 3.15 and 7.43 respectively. The graphical result shows the Fig.9 for 15% of wet algae concrete get more strength on conventional concrete and dry algae concrete.

The Table 11 shows the values of different percentages of wet marine brown algae concrete (5%, 10% &15%) on adding with cement content to the different grades on concrete (M25, M35&M40).The minimum and maximum value of wet marine algae concrete is 3.15 and 7.43 respectively. The graphical result shows the Fig.9 for 15% of wet algae concrete get more strength on conventional concrete and dry algae concrete.

Table 11 Split tensile test for Wet Marine Brown Algae

S.NO	Type of concrete	3 Days			7 Days			28 Days		
		5%	10%	15%	5%	10%	15%	5%	10%	15%
1	M25	2.3	2.57	2.33	2.58	2.33	2.9	3.1	3.12	3.15
2	M35	3.1	3.57	3.5	3.9	4.5	4.70	3.79	5.12	5.5
3	M40	3.12	3.63	4.43	4.1	4.52	5.5	4.70	5.70	7.43

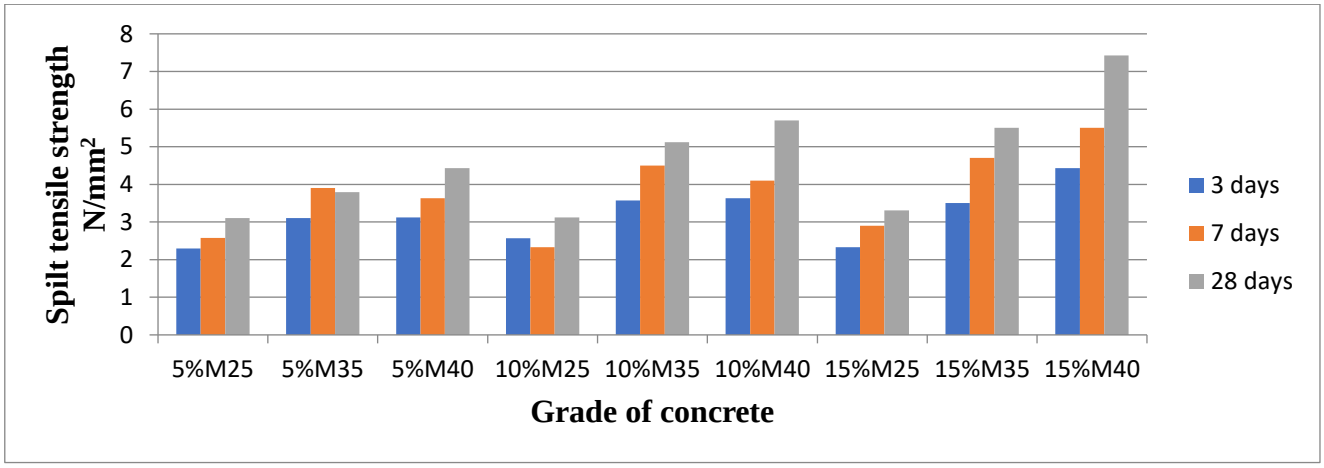

Fig. 5 Spilt tensile test for wet marine brown algae

The Table 12 shows the result of different percentages of wet marine brown algae concrete (5%, 10% &15%) on adding with cement content to the different grades on concrete (M25, M35&M40).Theminimum and maximum value of wet marine algae concrete 4.35 and 6.43 respectively. The graphical result shows the Fig.10 for 15% of wet algae concrete get more strength on conventional concrete and dry algae concrete.

Table 12 Split Tensile test for Dry Marine Brown Algae

S.NO	Type of concrete	3 Days			7 Days			28 Days		
		5%	10%	15%	5%	10%	15%	5%	10%	15%
1	M25	2.35	2.67	2.9	2.58	2.9	3.19	3.1	3.12	4.35
2	M35	3.12	3.57	3.59	3.69	4.15	4.50	4.0	5.16	5.90
3	M40	3.5	3.63	3.63	4.15	4.52	5.25	4.70	4.9	6.43

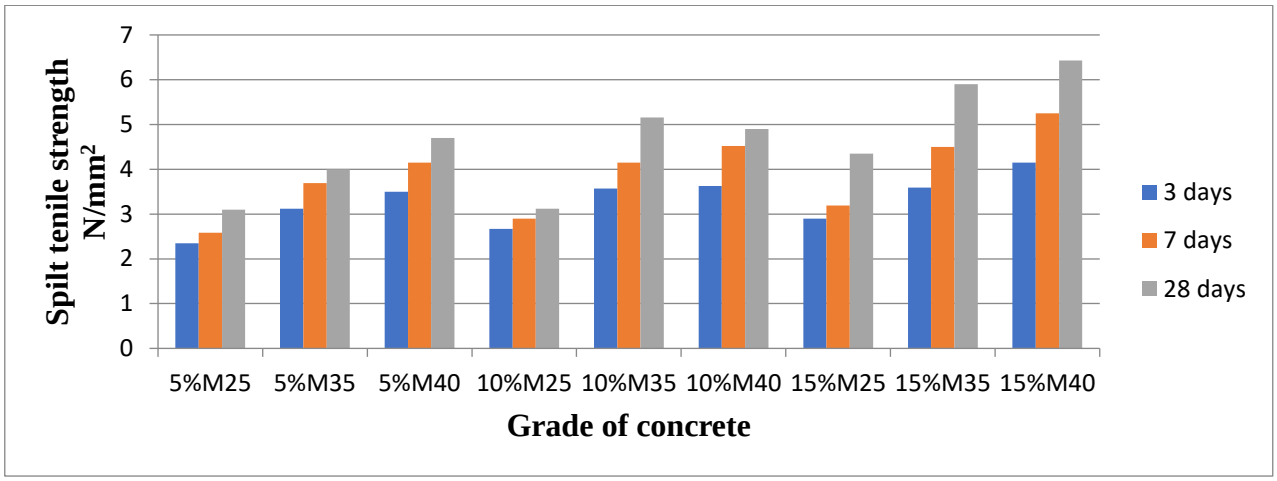

Fig. 6 Spilt tensile test for Dry marine brown algae

The result of strength parameter was such that 15% of algae added M40 grade of concrete had high strength. So with 15% of algae added M40 grade of concrete was taken for further tests such as hardness (rebound hammer), durability (RCPT) and shrinkage test. Since the wet brown marine algae paves a good strength in all parameters such as slump cone (table 3 & 4), compaction (table 5 & 6), compressive strength(table 9and10) and split tensile test(table 11 and 12) the wet brown marine algae was chosen for this study.

F. Rebound Hammer Test

The Table 13 shows the rebound hammer test values for the mixing of marine brown algae concrete for M25, M35 and M40 grades for conventional concrete and 15% of wet marine brown algae for 14 days test.

Table 13 Rebound hammer test for 14 days C.C and 15% of wet algae

Grade of Concrete	Conventional concrete (Kg/cm^2)	Wet marine brown algae concrete (kg/cm^2)
M25	226.5	223.4
M35	374.4	366.3
M40	402	397.4

G. Rapid Chloride Permeability test

The specimens were fit in the chamber with the required brass metal just as elastic oaring. The record time was set to 30 minutes and the log time to 6 hours and 30 minutes. The current of 60V was supplied continuously. The information lumberjack recorded the readings of relating cells at the each record time with its initial readings. Toward the finish of log time, the framework ended subsequent to taking the last reading. Normal current coursing through one cell was determined by at relieving period; 14 days the RCPT was taken for traditional concrete and marine brown algae concrete.

I = 900 × 2 × I Cumulative coulombs.

$I_{CUMMULATIVE} = I_0 + I_{30} + I_{60} + I_{90} + I_{120} + I_{150} + I_{180} + I_{210} + I_{240} + I_{270} + I_{300} + I_{330} + I_{360}$ Eqn------ (1)

Where

I_0= Initial current reading in mA.

I_{30}+I_{60} = Current reading at minutes in mA.

Table 14 **RCPT** forC.C and wet marine brown algae

Grade of concrete	% of wet algae	14 days Chloride Permeability				Chloride permeability as per ASTM C 1202			
M40	0.00	2843	2212	2115	2085	M	M	M	M
M40	15%	2972	2413	2172	2163	M	M	M	M

M: Moderate

Fig. 7 shows the comparison to the conventional concrete and 15 % of wet marine brown algae concrete. So the 15% wet marine brown algae is increased 3.74% on conventional concrete.

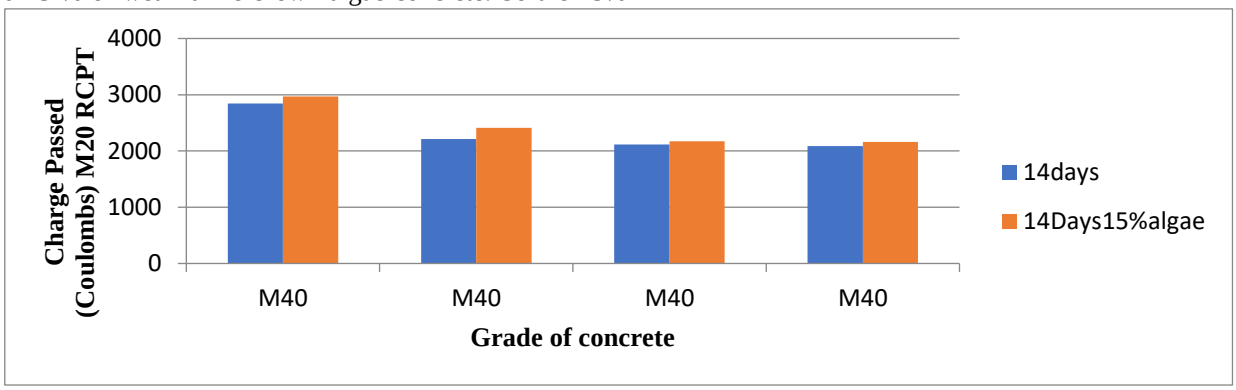

Fig.7 RCPT value for M40 grade at different ages of concrete

H. Shrinkage Test

Fig. 8 and 9 shows the conventional concrete on dry shrinkage test on M40 grade of concrete the slab cross sectional dimensions 840x540x250mm and casting of the slab is 19/2/2015 evening 3:00pm.Initial setting time 3:45 minutes and final setting time 11-12 hours. So the initial and final crack width of conventional concrete is 0.01 and 0.04(length x width = crack area) respectively.

Figs.8 and 9 Initial and final cracks on conventional concrete

Fig. 10 and Fig. 11 shows the 15% wet marine algae concrete on dry shrinkage test at room temperature. Slump cone value is more than the conventional concrete and dry marine concrete. This was why the wet marine algae concrete put on shrinkage test. Casting date 19/02/2015.initial setting time 3:35PM and final setting time 11-12 hours. The initial crack width is 0.02 and final crack width is 0.04

Figs.10 and 11 Initial and final cracks on 15% wet marine brown algae concrete

VI. CONCLUSION

The accompanying ends can be drawn from the test examination completed. The Slump of the concrete was expanded as the level of Wet Marine Brown algae increases and decreases when compared with the conventional concrete and dry marine algae concrete. The Compaction factor was increased as the 15% percentage of Wet Marine Brown algae increases and decreased when compared with the conventional concrete and dry marine brown algae concrete.5%,10%, and 15% of Wet Marine Brown algae and Dry Marine Brown algae come about that the compressive quality was decreased when contrasted and the regular concrete. The compressive strength of the concrete diminished with expanding 15 level of the wet Marine Brown algae replacement to the conventional concrete and dry marine brown algae concrete. The Split Tensile strength at 3, 7&28days was reduced by 15% Wet Marine Brown algae when compared with conventional concrete and dry marine brown algae concrete increased 7.5 % of wet algae concrete. The shrinkage test was increased with the 15 % added of Wet Marine Brown algae increases at the conventional concrete. Chloride permeability of wet marine brown algae concrete showed grater chloride permeability into concrete compared with 15% of wet algae. When the specimen was tested at the curing of 14 days the value was 3.70%. Increased in wet marine brown algae.

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AUTHORS PROFILE

R. Ramasubramani is currently Assistant Professor in Civil Engineering Department at SRM Institute of Science and Technology, Chennai, India. He received his B.E degree in Civil Engineering and M.Tech degree in Structural Engineering.

Shakthivel.V is currently pursuing B.Tech Civil Engineering at SRM Institute of Science and Technology, Chennai, India.

S. Manikanda Prabhu is currently Assistant Professor in Civil Engineering Department at SRM Institute of Science and Technology, Chennai, India. He received his B.E degree in Civil Engineering and M.Sc degree in Construction Project Management.

Ganapathy Ramasamy .N is currently Assistant Professor in Civil Engineering Department at SRM Institute of Science and Technology, Chennai, India. He received his B.E degree in Civil Engineering and M.E degree in Construction Engineering and Management.