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Behavioral Study of Flexible Concrete Sheet

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Abstract: Concrete is most extensively used material in today's rapidly growing world. In various structures, the concrete section has used to carry different types of loads. Many times concrete poses difficulty in its usage and application and hence a new material called flexible concrete sheet has developed. The paper covers the major aspect of the behavioral study of flexible concrete sheet. Flexible concrete sheet is the composite member having three layers in which bottom layer is impermeable layer, intermediate layer is a 3-D fiber matrix and top layer is permeable cotton layer. The middle layer has filled with a settable material, whichcan be cured. The settable material used here is cement mortar. This paper also emphases on the benefits of the flexible concrete sheet in various different applications. The paper also includes the financial study and cost comparison of flexible concrete sheet with the conventional concrete material.

Keywords: Concrete Sheet, Concrete, Cement, 3-D fiber matrix

INTRODUCTION

The cement concrete is the most commonly used material in the world in the field of construction industry. Concrete is composed of cement, sand, aggregate, water and admixtures. Now-a-days, concrete is widely used various fields in different conditions. Concrete can be molded in to any shape until it is wet. The concrete has many advantages like those that it is economical, can be easily made on site, and many more. Despite of these benefits the concrete has a great drawback that it is not flexible. This drawback leads us to the development of new material called as flexible concrete sheet.

In construction field there is often need of flexible material that can be easily casted on site as well as in factory. Now a days, the composite material are being increasingly used because of their specific strength, flexibility, stiffness and this can be altered easily by changing fiber orientation and some or other property. Thus, the behavioral study of composite flexible concrete sheet is important. Concrete sheet is upcoming revolution in the field of civil engineering.

Flexible concrete sheet is 3-D fiber matrix containing dry concrete mix. An impermeable canvas sheet has used as the bottom layer to prevent the entry of water and hydrophilic fibrous material to help in hydration. The matrix has filled with cement mortar. The adhesion between all layers has made by using Fevicol. The figure below shows the flexible concrete sheet section.

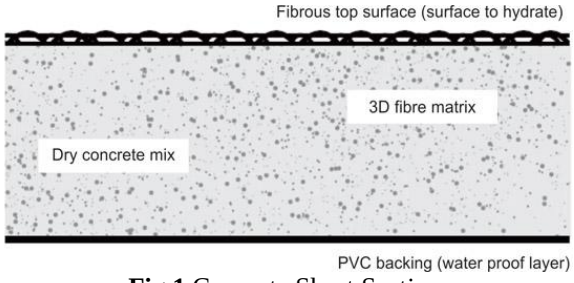

Fig 1 Concrete Sheet Section

REVIEW OF LITERATURE

The flexible concrete sheet is new innovative material and therefore not much work has done on it. The present material gets stiffness and hardness within 24 hours. The present literature review has classified into two parts

- Behavioral study
- Study of applications

The behavioral study of concrete sheet is essential because of its wide range of applications. Since the material is new and still in innovation stage no research work is available for the research work. The present work is carried out taking the reference of work of the Milliken Infrastructural Solutions. Milliken Infrastructural Solutions manufactured a material called Geo-synthetic Cementitious Composite Mat (GCCM).GCCM Concrete Cloth is a three-dimensional flexible cement impregnated fabric that hardens after hydration. GCCM

Concrete Cloth is an easy to use material with high degree of flexibility. It can be rapidly unrolled to form a ditch or channel lining.

V. Vedha Narayanan published a paper, which aimed at study of different properties and application of concrete cloth in different fields.VaseemAkhtar and AmitTyagi issued a paper on "Studying the Utility of Concrete Canvas". The material with three different thicknesses is use for the research work.Prof. K.Srinivas and Prof.Ravindrastudied the material closely to study the various specifications of the material manufactured by the British Company.

A review of the literature shows that a lot of work has done on the usefulness of flexible concrete material.The present study mainly aims at filling some of the voids that exist in the proper understanding of the behavior of the Concrete Sheet.

THEORY AND FORMULATION

Flexible concrete sheet is a combination of cement and 3-D space matrix. The following diagram shows the cross sectional view of the flexible concrete sheet.

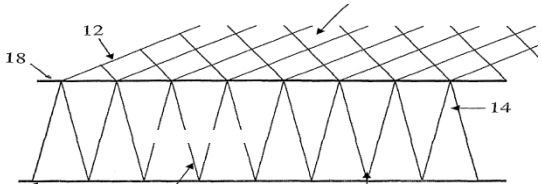

Fig 2 Cross Section of Concrete Sheet

The flexible concrete sheet is combination of canvas sheet knitted with the Teflon sheet and a cotton sheet at the top. The space between top and bottom layer has filled with cement mix (1:3).

Fig 3 Diagrammatic Illustration

According to present invention the flexible concrete sheet, consist of following

- First face i.e. permeable member, which will help in hydration.
- Second face separated by first face, which is canvas sheet.
- In between two faces, the 3-D fiber matrix has introduced.
- The matrix has filled with a settable material.

The amount of settable material in the space in the fabric is preferably such that, when the material has set, it occupies considerably all the space between the first and second faces.

MATERIAL PROPERTIES

The selection of material should be proper and in accordance to the required strength, durability and workability. In addition to all these, the economy should also be maintained. The materials used in this experimental program are as follows

a) Cement
b) Sand
c) Water

Cement (OPC 43 grade) conforming to IS 8112: 1989

Sr. no.	Material	Property	Value	
1	Cement	Normal consistency	25.6%	IS code 8112 – 1976

		Initial Setting Time	95 min.	IS code 12269- 1987
		Final setting time	210 min.	
		Specific gravity	3.15	
		Fineness of cement	5.0%	IS: 4031 (Part 1) – 1996
		Soundness	2 mm	IS Code 4031 - 1996 {Part -III}
2	Sand	Sieve analysis	Zone III	
		Specific gravity	2.53	

TEST CONDUCTED

Compressive Strength Test

For a proportion of (1:3), a set of three standard cubes were casted to determine compressive strength of mortar at 7-days, 28-days of curing.

Fig 4 Compression Testing

Bending Test

The test is done in accordance with the BS EN 12467-2004. The flexural stress of the flexible concrete sheet is measured.

Fig 5 Bending Test

Bullet Impact Test

The test is done with the gun. The impact impressions are observed on the flexible concrete sheet.

Fig 6 Bullet

Fig 7 Gun

Puncture Resistance Test

The puncture resistance is measured means of the falling cone method as per the IS 13162 (Part 4): 1992.

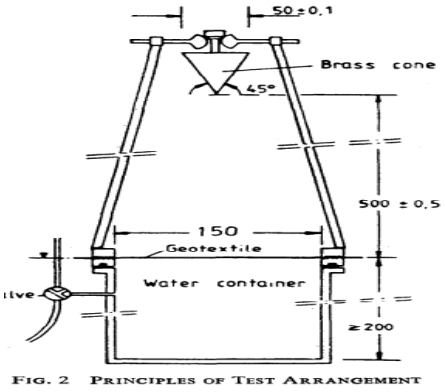

FIG. 2 PRINCIPLES OF TEST ARRANGEMENT

Fig 8 Puncture Testing Machine

Abrasion Test

The water abrasion test was conducted on the flexible concrete sheet sample. The sheet is inserted into the hydraulic tilting flume.

Fig 9 Hydraulic TiltingFlume

RESULTS

Compressive strength of cement mortar

Mix	7-days (N/mm^2)	28-days (N/mm^2)	Avg. Strength (N/mm^2)
1:3	19.26	26.10	22.68

The compressive strength of the mortar (1:3) has found to be 22.68 N/mm2.

Bending Test

Bending test on the material has conducted in accordance with the BS EN 12467-2004.
Flexural strength f = 18.75 N/mm2
From the above test results, it has found that the material is not flexural rigid material and hence it has concluded that it is an elastic material.

Gun Impact Test

The bullet has been fired from the different distances

Sr. No.	Firing Distance	Penetration Observed	Rebound Obtained
1	4m	0 mm	1.5m
2	4m	0 mm	2.0m
3.	3m	0 mm	2.5m
4.	3m	0 mm	2.8m
5.	2m	0 mm	4.0m
6.	2m	0 mm	4.2m

During entire bullet firing test it had been observed that there is no impression of the impact.
1. Puncture Resistance Test
The average penetration during the cone puncture test is found to be 2.07cm.
It is also observed that the flexible concrete sheet gives the penetration which after sometime regains its shape.
No failure was observed during the entire puncture test.

Abrasion Test

The water abrasion test was conducted on the flexible concrete sheet with help of hydraulic tilting flume. The test was conducted at different slope values.
The Manning's coefficient for the material is found to be 0.0031.During the entire abrasion test the observations were made: -
a. No abrasion was observed on the top surface during entire test.
b. Since, the value of Manning's constant is low i.e. the frictional resistance to flow is also low.
c. The velocity of flow will be high resulting in the low evaporation losses.
d. With, increase in velocity the discharge capacity of the channel section will also increase.

FINANCIAL STUDY

For the construction with flexible concrete sheet or even before its use it is very essential to make a comparative study of flexible concrete sheet with the conventional plain cement concrete and also with reinforced cement concrete. In view of this, the cost comparison of flexible concrete sheet hasdone as follows: -
As per the Current Schedule rates of Nagpur 2015-16 the cost of 1 cu.m.of P. C. C. is found out to be Rs.4790/-
Spec. No.: Bd.E. 1/Page No. 287/I.S. 456 (2000) [1–4]
As per the Current Schedule rates of Nagpur 2015-16 the cost of 1cu.m.of R. C. C. is found out to be Rs.8047/-
Spec. No. Bd.F.8/Page No.302/I.S. 456 (2000) [4–6].

From the following table the cost of flexible concrete is found in the following way: -

Sr. No.	Particular	Rate	Per	Qty.	Value
1	Cement	250	bag	2.5 kg	12.5
2	Fine Aggregates	732	cu.m.	0.005 cu.m	3.6
3	Adhesive	152	kg	1 kg	152.0
4	Impermeable member	85	sq.m	1 sq.m	85.0
5	3D Fiber matrix	250	sq.m	1 sq.m	250.0
6	Permeable member	150	sq.m	1 sq.m	150.0
7	Labor	408	day		204.0
	Total				857.1

From the above analysis it can be clearly seen that the initial cost incurred by flexible concrete sheet is much less than that of the PCC and RCC and hence the concrete sheet can be predominantly preferred where ever find suitable.

CONCLUSION

The effect of various parameters on the bending and stability characteristics of the homogeneouscomposite flexible concrete sheet panels has been studied. The results can be summarized as follows:

a. The average compressive strength of the mortar (1:3) used in this project work is found out to be 22.68N/mm2. It is also seen that the strength of the mortar increases with the time and depends on the mortar mix ratio.
b. The cone puncture resistance test showed that the material does not fail under the impact load even when the penetration of the cone rises up to 2.7mm. It is also observed that whatever penetration occurs is regained after the removal of the load.
c. c.The bending parameter is based on the theory of pure bending. The test leads to the inference that the material is not flexural rigid material.
d. From the bullet test it can be observed that there is no effect of bullet impact on the material. Moreover, the top layer of the material is also not distorted.
e. The water abrasion test shows that the Manning's constant for the flow of water from the homogeneouscomposite flexible concrete sheet panels is quite low as compared to conventional concrete leading to higher velocity of flow.
f. The homogeneouscomposite flexible concrete sheet panels were also studied for the initial cost of the material and were found to be economical in its initial phase of construction.
g. Life expectancy of the material is found to be nearly three – four years and which can be increased to seven- ten years by little improvement and change in the material.

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