USE OF ECO SYNTHETICS AS CONSTRUCTION ENGINEERING MATERIAL AND TESTING PERFORMED THROUGH ANOVA

Umesh Verma[1], Shiv[2], Mr. Anand[3]
[1,2]M.Tech. (Civil), [3](Asst. Prof)
[1,3]Bharat Institute Of Technology, Sonepat, [2]Bm Group Of Institutions, Farukhnagar, Gurugram

Abstract: In order to respond to increasing global environmental awareness, an increasing number of people are conducting scientific research to develop environmentally friendly and sustainable building materials. Due to the increasing demand for these materials in the construction industry, the relatively low quality requirements and the widespread use of construction sites in the industry, the use of recycled materials and agricultural waste in buildings is one of the most attractive options. The main purpose of this paper is to evaluate the performance of glass / waste cement compounds. Linen fibers are used to strengthen both systems. The first system contained only ordinary Portland cement (OPC) as a bond, while in the second system; part of the OPC was replaced by a fine ground powder powder. By applying a central composite design to determine fiber parameters for experiment planning, developing mathematical models and improving fiber standards.
Keyword: ordinary Portland cement (OPC), ACG (Amrapali Construction Group,Noida) construction, Fibre composite cements.

I. CONSTRUCTION MATERIALS

Many types of Building materials are used in the building construction and construction industry to create buildings and structures. These categories of materials and products are used by architects and construction project managers to specify the materials and methods used for building projects. Some building materials like cold rolled steel framing are considered modern methods of construction, over the traditionally slower methods like block work and timber. Many building materials have a variety of uses; therefore it is always a good idea to consult the manufacturer to check if a product is best suited to your requirements.

1.2 Case Study of ACG (Amrapali Construction Group,Noida) construction

The beginning of the new millennium witnessed tremendous developments taking place in India that unleashed the latent entrepreneurial energy in various enterprises including construction. One such development was the emergence of the Amrapali Group that started off some 10 years ago under the able guidance of its Chairman & Managing Director Dr. Anil Kumar Sharma, a proud NIT & IIT alumnus. This group is now leading the ranks in the real estate domain and that too in a very short span of time. Today the group enjoys a pan-India presence and has already delivered over 25 world-class projects. The group also has more than 50 projects comprising residential, commercial and IT parks, in the pipeline. Amrapali's projects delineate the skyline of Noida, the satellite city of Delhi, and other cities such as Indore, Raipur, Jaipur, Patna, Udaipur, Lucknow etc. The group, consolidating on its success, has made impressive forays into hospitality, healthcare, education, entertainment and FMCG manufacturing.

1.3 Laboratory

Each ACG office has construction materials laboratories. Each laboratory has state-of the-art equipment that is continually inspected and calibrated in accordance with the highest industry quality assurance standards. Each laboratory can test materials such as soils, aggregates, concrete, masonry, steel, and asphalt.

II. LITERATURE SURVEY

[1] M. B. Chougule and NP Sonaje studied the Anova law and the T-Test method as a statistical tool for monitoring the performance of the test water used during the wet processing of the organization in July 2014. They are increasing; the textile industry is currently consuming water shortage, civilization, industrialization, natural water resources. Wastewater from local governments is a drought-resistant water source that can be used to process textiles and reduce water shortages. In addition, municipal wastewater further processed in the pilot plant said it is technically suitable for wet textile processing. The suitability of this pilot plant water was analyzed using statistical methods such as analysis of variance (ANOVA) and fitting T test. Analysis of variance (ANOVA) makes it possible to test the quality of the water used in the pilot plant and their use in wet processing of the fabric. They focused on Anova method and adapted T-test method to monitor the performance of test water during wet textile processing.

[2] Hamed Niroumanda, M. F. Zainb, and Maslina Jamilc studied statistical methods for comparing the 2013 building methods and building evaluation datasets. They said that building methods and building assessments require statistical methods. Statistical methods are included in various types, but each method requires many selection criteria. These methods must contain two main criteria: one is the data type and the other is the target. In questionnaires and questionnaires, you need to choose from a variety of statistical methods. In this article, various statistical methods were examined.

[3] Zhang Huidong, Wang Yuanfeng, and Han Qinghua studied the non-linear material loss factor of a single-layer grid ground motion in 2016. They are important concerns for dynamics in structural studies. At present there is no clear

consensus on how to solve the dumping problem. The Rayleigh attenuation model that combines mass ratios and stiffness ratios results in reasonable engineering requirements for the structure within the elastic range, but does not include nonlinear response history analysis. On the other hand, a large number of material tests have shown that the stress-strain relationship exhibited by most cyclically loaded metallic materials is not elastic even at stresses well below the yield point, but the damping effect of the material under dynamic conditions is difficult It is considered for analysis. In this study, we propose a method based on the Goodman material energy dissipation theory that explicitly considers the attenuation effect of additional materials. This method is applied to the nonlinear dynamic analysis of a single-layer mesh dome under earthquake. Parametric studies are being performed to assess the loss factor of structural materials at different earthquake hazard levels. Finally, we discussed the comparative study of the effect of material attenuation on dynamic response. The purpose of this study is to quantify the loss factor of structural materials and obtain a reasonable dynamic seismic measurement through numerical procedures. This method is easy to apply as proposed in this paper.

[4] Kamal H. KHAYAT and Iman Mehdipour studied, without economic cracks in the laying of high-performance concrete and transportation infrastructure in 2016. They stated that the main goal of the study was a new type of environmentally friendly, low-cost, high-performance concrete (HPC) called Eco-HPC. Proposed project, (I) HPC pavement construction (ecological paving - Crete), (b) Bridge infrastructure HPC (ecological bridge Crete). The content of paste, cost, CO2 emissions and reduction of shrinkage are limited by the amount of each binder 320 kg/m3 (540 lb/cubic yards) and 350 kg/m3 (590 lb/m3) of these building materials. The Eco-HPC type is optimized to ensure not only high durability but also high shrinkage crack resistance. If a relatively low binder content is given, the ratio of the binder composition to the aggregate is a method based on the packing density to reduce the paste optimization required to fill the gap between the agglomerated particles. Taking into account the use of low paste content and various shrinkage strategies, the optimized concrete mix shows low natural and dry shrinkage. These strategies include the use of CaO-based bulking agents (EX), saturated light sands (LWS), and the synthesis or regeneration of steel fibers. Suitable substituents for cements with secondary cementitious materials (SCM), in which the bulk density of the solid particles increases, reduces the demand for water/fluidizer and leads to improved rheological and solidification properties of the cementitious material.

III. EFFECT OF FIBRE PARAMETERS ON THE MECHANICAL PROPERTIES OF CEMENT COMPOSITES

For this study, the experiment was designed based on two variables central composite design. Trial batches of flax fibre cement composites were developed by varying one of the process variables in order to determine the working range of each variable. Increasing fibres by more than 1.5% in volume faction and 50 mm in length creates disruption. The low specific gravity of the flax fibres causes the fibres to float on top of the slurry and creates a lack of homogenous mixture in the composite because the top surface of the composite fills with accumulated fibres. Therefore, making specimens with an excess of 1.5% in volume fraction and more than 50 mm in length was stopped. Table 3.1 shows the fibre input parameters and experimental design levels shows the fibre input parameters and experimental design levels that were used for this material. The experiment was carried out according to the design matrix shown in Table 3.3 and in a random order in order to avoid any systematic error. Eight mathematical models were successfully developed to predict the following responses: porosity (P), flexural strength (Fflex), fracture energy (Gf), impact strength (Fimp), compressive strength (Fcom) and the toughness indices I5, I10 and I20. The procedures described earlier in this chapter were then followed to determine and record these responses. The averages of at least three measurements for each response are presented

Table 3.1: Process Variable and Experiment design levels

Variables	Code	Unit	Limits coded/actual		
			-1	0	1
Fibre volume fraction	V	%	0.5	1	1.5
Fibre length	L	mm	10	30	50

Table 3.2: Design Matrix in actual values

Exp. No.	Run order	V	L	Exp. No.	Run order	V	L
1	9	0.5	10	10	13	1	30
2	4	1.5	10	11	7	1	30
3	12	0.5	50	12	2	1	30
4	6	1.5	50	13	11	1	30
5	5	0.5	30	-	-	-	-
6	8	1.5	30	-	-	-	-
7	1	1	10	-	-	-	-
8	10	1	50	-	-	-	-
9	3	1	30	-	-	-	-

Table 3.3: Experiment data and result for treated flax fiber cement composites

Run	P (%)	F_{flex} (Mpa)	F_{com} (Mpa)	F_{imp} (J/m2)	G_f (N.mm)	I_5	I_{10}	I_{20}
Plain mortar	9.5	5.31	21.98	255	307	1	1	1
1	9.8	5.63	22.41	380	3164	4.46	6.07	7.19
2	10.8	7.10	18.63	499	3996	5.15	7.95	9.90
3	10.5	5.91	22.46	493	3425	5.26	6.84	7.74
4	11.5	7.90	14.58	996	6239	5.47	8.21	12.12
5	10.2	5.40	22.76	473	3718	4.64	6.81	8.02
6	11.0	7.42	18.22	780	4009	4.96	7.87	10.75
7	10.2	6.68	21.92	447	3547	4.47	6.08	6.81
8	10.9	7.00	18.36	760	5155	4.93	6.09	7.62
9	10.6	7.01	21.73	620	3665	4.89	6.42	7.42
10	10.6	7.12	21.73	615	3671	4.99	6.55	7.58
11	10.7	6.98	21.46	622	3663	4.92	6.456	7.47
12	10.6	7.05	21.87	617	3670	4.79	6.28	7.27
13	10.7	6.95	21.33	624	3667	4.77	6.266	7.25

As a result of analyzing the measured responses by the design expert software, the fit summary output indicated that the linear model was statistically significant for the compressive strength, porosity and toughness index I5; therefore, it was used for further analysis. For the other responses, the quadratic models are statistically recommended for further analysis as they have the maximum predicted and adjusted R2. The test for significance of the regression models, the test for significance on individual model coefficients and the lack of fit test were done using the same statistical package for all responses. By selecting the step-wise regression method, the insignificant model terms can be automatically eliminated. The resulting ANOVA tables for the reduced quadratic models outline the analysis of variance of each response and illustrate the significant model terms. The same tables, also, show the other adequacy measures' R2, adjusted R2 and predicted R2. As it can be seen from Tables through 3.3 most of the adequacy measures are close to 1, which is in reasonable agreement and indicates adequate models. The adequate precision compares the range of the predicted value at the design points to the average prediction error. In all cases the values of adequate precision are dramatically greater than 4, which indicate adequate model. For the flexural strength model, the Analysis of Variance indicates that the main effects are; of fibre volume fraction (V), fibre length (L), and the second order effect of volume fraction (V2). The same trend was observed with the toughness index I20 model. For the compressive strength model, the ANOVA analysis indicates that there is a linear relationship between the main effects of the two parameters. Also, in the case of the toughness index I5 and the porosity models, the ANOVA analysis shows a linear relationship between the main effects of the two parameters. In the case of the impact strength model, the main effects of fibre volume fraction (V), fibre length (L), the second order effect of fibre length (L2) and the two level interactions of volume fraction and fibre length (VL) are significant model terms. Finally, in the case of the fracture energy and toughness index I20 models, the ANOVA analysis shows that the main effect of fibre volume fraction (V), fibre length (L), the second order effect of fibre length (V2) and the two level interactions of volume and fibre length (VL) are significant model terms.

IV. CONCLUSION

The fibres obtained from the optimised alkali treatment were used to fabricate all cement composites. Alkali treated flax fibres are a satisfactory fibre for incorporation into a cement matrix. Mechanical and physical properties of both untreated and treated flax fibres were studied. Treated flax fibre cement composites revealed some improvement in mechanical and thermal performance compared to untreated composites. These improvements appeared to be due to the changes in morphology and in chemical composition of the fibres, which leads to increase the ontact area and to improve the fibre surface adhesive, hence giving rise to additional sites for mechanical interlocking. Fibre volume fraction plays a significant role in determining the composite mechanical properties. The mechanical properties of composites are highly influenced by the fibre content. This study was carried out by fabricating cement composites with three different fibre volume fractions (i.e. 0.5, 1 and 1.5%). The results showed that the increase in fibre content has significant positive effects on the fracture energy, toughness indices, flexural and impact strength; however, these improvements are always associated with a decrease in compressive strength. Fibre length plays an important role in the mechanical performance of fibre cement composites. If the fibre is long enough (length ≥ 30 mm), a greater amount of fracture energy is needed to pull the fibre through the matrix and the composite can be tougher and stronger. This work was carried out by fabricating cement composites with three different lengths (i.e. 10, 30, 50 mm). The results showed that when short fibres (10 mm) were used as reinforcement and compared with longer fibres (30, 50 mm), a reduction in composite fracture toughness and flexural and impact strength was observed. For example, at 1% by volume fraction the short fibre composites showed around 10-15% decrease in fracture energy and impact strength and around 20-22% decrease in flexural strength compared to composites containing the same amount of the longer fibre. The mathematical models for the fracture energy, toughness indices, porosity, flexural, impact and compressive strength of flax fibre cement composites were obtained by using central composite design using two fibre parameters (fibre length and volume fraction). The results indicate that within the limits of fibre parameters used in this study the proposed models predict the above properties adequately.

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