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Effect of sustainable palm fiber on high strength concrete properties

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Abstract. Date palm fiber is one of the common wastes available in the M. E. countries essentially Iraq. The aim of search to investigate the performance and effects of fiber date palm on the mechanical properties of high strength concrete, this fiber was used in three ratio 2, 4 and 6 % by vol. of concrete at ages of (7, 28, 90) days. Results demonstrated improvement in the compressive strength increased 19.2 %, 23.6%, 24.9 % for 2%, 4%, 6% of fiber respectively at age 28 days. Flexural strength increases 47.6%,66.2%,93.8% form (2,4,6) % of fiber respectively at age 28 days. Density increase about 0.41%,0.61 % 0.69 % for (2,4,6) % of fiber respectively at age 28. Absorption water decrease 7.4 %,14.8%,7.4%for (2,4,6) % of fiber respectively at age 28. The ideal of sustainability has stabilized the exploitation of manufacturing and agrarian trash in the unit to replace traditional item. In order to build low cost green building, requires produce new units or sustainability unit.

1. Introduction

Researches perfect on the manner reinforcement by fiber in HSC offer to different kind of loading and combine various fibers like polypropylene and wood fibres in different volume and shapes [1,2]. If function of natural fibers in a comparatively brash HSC is to realize and look after firmness and flexibility of the combined, then, immovability of fibers in a highly cement paste must be taken into seeing by effective modification made fibers or to the matrix overcome the inherent problem [3,4]. Many search indicated different benefit in use of fibers in HSC, among them : improved flexural strength, by far best benefit of using fibers is that they offer low cost and advantages associated with processing as compared to another fibres. That's why they are currently getting many attentions for replacing fibres (Thielemans and Wool, 2004) [5].

2. Research survey

Some types of fibers produce greater impact. Ef fibers is higher than the matrix, they help to carry the load by improving the tension stress. Aspect ratio of fiber usually segments flexural strength and impact of the matrix. Content of Cellulose is accountable for long fiber chain that ranges (28 to 53) % for date palm fibers [6].

Abeer I.Alwared et al (2016) [7]: study the performance and effects of natural fibre on the properties of mortar, ratio of paper palm fiber (0.4, 0.8 , 1) % by vol. at ages of (7, 28, 90,120) days. Results demonstrated major improvement in the compressive strength A significant improvement in the impact strength.

Sanjay Sen, Rajeev Chandak (2015) [8] Agricultural waste material like coconut fiber ash, which is an environmental pollutant. Coconut fiber is collected, and the fiber are properly dried and burnt in the open air with a temperature of 600 c to 700 c. When the fibers turned into ash. The percentage strength gained.



3. Materials and Experimental Works

3.1. Materials

1. Cement (Type I) was used. It complied with IQS No. 5.
2. Natural sand was used in all mixes. The grading and properties of the used sand complied requirements of the IQS No 45.
3. Water: used clean water for curing samples and for concrete mix design.
4. Super plasticizer was used complied ASTM C 494.
5. Fiber date Palm used as reinforcement for mixes. The fiber was added at this ratio (2%, 4% and 6%) by vol. of mixture for all.

3.2. Mix proportion

For all specimens have been mixing the Portland cement with sand and mixing them (1:2) by weight, then adding water with SP to the mixture in order to get 43 MPa at 28 days. For sample with fiber, it is added later. The mixing process was conducted by using mechanic mixer and thus is obtained mix concrete coherent. After the completion of the mixing process is casting concrete in the metal molds after lubrication of the inner walls of oil. Then conducted compaction process using an iron rod to reduce voids.

3.3. Tests of Hardened Concrete

3.3.1. Test of Comp. Strength

Use [ASTM C 109] for this test. Three cubes (50×50×50) mm are tested for each mix at curing age (7, 28, 90) days for the determination of compressive stress. They are placed in the compression device on one of their sides, so that the compressive force is applied perpendicularly to the direction of sample placement in the molds with constant rate of force.

3.3.2. Flexural strength test

Center point loading method use to get modulus of rupture is performed like [ASTM C 293-02] at curing age of (7, 28, 90) days.

3.3.3. Density

Cube specimens of (50×50×50) mm are used in this test at age of (7, 28 and 90) day. Test is performed according to requirements of [Guidelines 1992 No. 278].

4. Result and Discussion

4.1. Comp. Strength Test

It is clear that the comp. strength increased when using palm fiber for all percentages, paper palm fiber has better properties. It improved with time and increased it when Vf increased show table 1.

Table 1. Result Compressive strength (MPa)

Curing age days	Reference	Palm fiber 2%	Palm fiber 4%	Palm fiber 6%
7	37.5	38.8	39	38.1
28	45.3	54	56	56.5
90	51.2	58.4	60	61

4.2. Flexural Strength Test

Flexural strength of concrete is defined as its ability to resist failure from bending. The flexural strength is done according to (ASTM C-293-02).

The effect of palm fiber on flexural strength show in table (2), flexural strength increases with time for specimens containing 2%, 4 % and 6%.

Table 2. Result of flexural strength (MPa)

Curing age days	Reference	Palm fiber 2%	Palm fiber 4%	Palm fiber 6%
7	5.6	8.5	9.6	10.8
28	6.5	9.6	10.8	12.6
90	7	10.5	11.9	13.2

4.3. Density Test

The density is one of the important properties for it relation to the physical properties including Compressive strength, Flexural strength and absorption. The density test found by take the average density of three cubs cement mortar mix (reference and with different proportion of, palm fiber) for ages (7,28,90) days. The effect of palm fiber on density increase with time for specimens containing palm fiber show in table 3.

Table 3. Result Density (kg/m³)

Curing age day	Reference	Palm fiber 2%	Palm fiber 4%	Palm fiber 6%
7	2384	2390	2395	2398
28	2450	2460	2465	2467
90	2480	2490	2493	2496

4.4. Water Absorption

The absorption is one of the important properties, it is found by taking the average of two prisms of cement mortar mix (reference and with different proportion of palm fiber) for ages (7,28,90) days. The effect of palm fiber on Absorption, it decreases for specimens containing palm fiber comparing with specimens without palm fiber show in table 4, and decreases with time, decreasing in Absorption comparing with specimens without palm fiber due to the voids and increasing permeability

Table 4. Result Absorption%

Curing age day	Reference	Palm fiber 2%	Palm fiber 4%	Palm fiber 6%
7	3.5	3.3	3.1	3.3
28	2.7	2.5	2.3	2.5
90	2.1	2	1.8	1.9

5. Conclusions

1. Using of palm fiber with mortar has a significant improvement in compressive strength. increase 19.2%, 23.6%, 24.9% for 2, 4, 6% fiber content by vol of HSC respectively at age 28 days.
2. The use of palm fiber in mortar improved the flexural strength, increase 47.6%, 66.2%, 93.8% for 2, 4, 6 % fiber content by vol HSC respectively at age 28 days.
3. The use of palm fiber in mortar density increase 0.41%, 0.61, 0.69% for 2, 4, 6% content of fiber respectively at age 28 days, increase.
4. The use of palm fiber in mortar the absorption decreases with age and increase little with increase fiber content because increase voids when use fiber.
5. Therefore, use natural fiber to produce construction unit is benefit and economic to construction of green building, comfortable for housing human in terms of thermal insulation and sound and have improved mechanical properties.

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