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Comparison of the Use of Palm Fronds and Reeds Plants as Alternative Materials of Sand in Concrete Mixture / Based on GIS Technique

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Abstract: ***This research focuses on the environmentally friendly material used as an alternative to traditional materials of concrete, such as reeds and palm fronds to reduce environmental pollution. This study aims to make a compression study between the effects of powder and ash of untreated palm frond and reed on the compressive strength of concrete which have been replaced by the weight of sand as follows, 1% and 5%. Also, the GIS software (V.10.1) is used for comparing the spread areas of palms and reeds in Yusufiya /Baghdad/Iraq during the years 2015-2020. The results showed that the mixture has 1% vegetal fibers gives better compressive strength for 28 days age as compared with plain concrete and 5% vegetal fibers mixture.***

Keywords: Alternative materials, Compressive Strength, GIS Software, Reeds, and Palm Fronds

1.Introduction

Recently, several studies have emerged concerned with the use of agricultural waste as alternative materials to some of the concrete components or adding them as a proportion from cement or aggregate, such as rice and groundnut husk, corn cob, and coconut shell. It is considered as a solution to reduce environmental pollution by recycling and using the agro-waste in concrete, which is characterized by its lightweight and cheapness when compared with the component of concrete (cement and aggregate) which characterized by its high cost **[1].** The cultivation of palm trees in the Middle East due to high temperature and dry climate. This led to an increase in the production of dates in addition to increasing the agro-waste resulting from them which is characterized by harsh texture and abundant fibers **[2].** Some of these studies are concerned with the replacement of cement or aggregate with the ash of palm oil fuel after burning the fruit with palm leaves in a boiler under high temperature then crushed to be ash with gray color and the granules of regular size, which have properties like cement [**3].** The testing results show that there an increase in the compressive strength of palm oil ashes concrete sample by about 12.5% than the compressive strength of ordinary concrete samples. The results revealed that the utilization of palm slag will reduce the environmental damage of palm oil slag. As for reeds, **Alaa [4]** investigated the improvement of reed to overcome the rote in concrete; which owns high PH values by painting them with coating material like epoxy paint, SBR, PVD, and liquid mastic. As well as immersing reeds in salts solutions such as sodium chloride, sodium sulfates, and sodium nitrite for a while before using them in concrete. It has been found that the epoxy paint and sodium chloride solution is the pest in reducing reed degradation within the concrete**. Ahmad et al. [5]** investigated the effect of bamboo fibers on compressive and flexural strength of 27 concrete cubes with 1% bamboo fibers by volume, and studied also the behavior of concrete beam reinforced with singly and doubly bamboo sticks. The results revealed that the strength of bamboo concrete cubes becomes twice the strength of plain concrete cubes in 50 days. Moreover, the bamboo sticks increased the flexural strength and modulus of elasticity of bamboo reinforced beams as compared to plain concrete beams. **Venkateswara et al. [6]** investigated the mechanical properties of bamboo fibers filled with fly ash filler reinforced hybrid composites. The specimens were prepared to tests the tensile, impact, and flexural (strength and modulus) properties. The results show that the tensile, strength, and flexural modulus, and strength of bamboo fibers incorporated with filler is increased up to 0.5 of volume fraction of fiber after that slowly decreased.

In this paper, a comparative study is made for cubed samples with proportions 1% and 5% of powder and ash of untreated palm frond and reed used as a substitute for sand on the compressive strength of concrete with ordinary concrete at 28 days of pouring. Also, the GIS program (V.10.1) is used for comparing the spread areas of palms and reeds in Yusufiya / Baghdad / Iraq during the years 2015-2020.

2.The Location of Study Area

Yusifiya district is considered one of three districts of Mahmudiyah Township; which are Yusifiya, Latifia, and Al-Rasheed districts. It is located southwest of the Iraq Capital; Baghdad about 29 Km, as shown in **Figure 1.** Mahmudiyah Township is located at the latitude of 32º 48'-33º 15' N and a longitude of 44º 36'-44º 57' E. The samples of palm fronds and reeds are taken from the Yusifiya district.

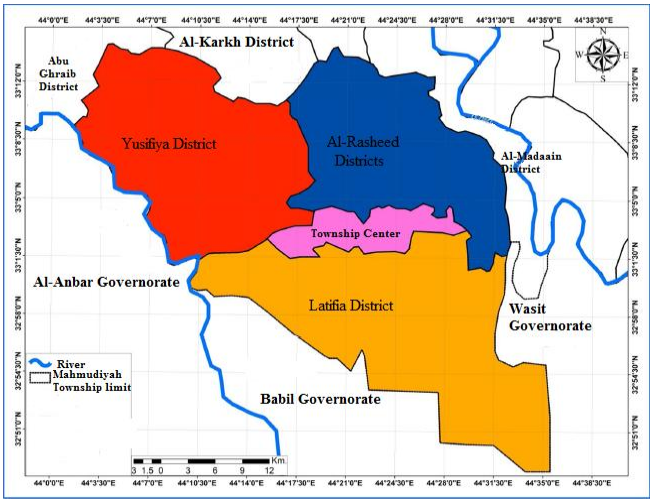


Figure 1: Map of Iraq capital (Baghdad), scale 1: 1000000, [7]

3. The Selection of Palm Fronds and Reeds

To select the vegetal samples, the following notes should be taken into consideration, **[8]**:

1. The selected vegetal must free from any rot, fungus sprouting, or puncture due to the white termite.
2. The chosen reed has a yellow to brown color.
3. The reeds must be cut in the dry season, due to its dryness and easy to cut.

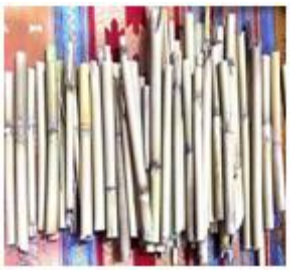
4. Preparation of Short Vegetal Fibers

To prepare short vegetal fibers, have to follow these steps:

1. The chosen palm and reed are cut to pieces by cutting machine with length 15cm and soaked in boiled water for one hour to remove the starches that draw insects, and dried at room temperature for 3 months as shown in **Figure 2**.
2. The reeds spacemen are crushed by a crushing machine and cut to pieces with a length of 3cm
3. The vegetal pieces are divided into two groups the first one is dried by oven at 160c^{o} for 20 minutes, **[9]** and the second one are burn at 400c^{o}
4. The vegetal samples are grinding with a grinder then sieved with a sieve vibrator
5. The short fibers passing from the sieve of aperture size 250um are used as shown in **Figure 3**.

It is worth mentioning that these tests were carried out in advanced research materials center in Ministry of Science and Technology/Baghdad/Iraq.

(a) Palm fronds samples



(b) Reeds samples

Figure 2: Palm fronds and reeds samples.

(a) Palm fronds powder

(b) Palm fronds ash

(c) Reeds powder

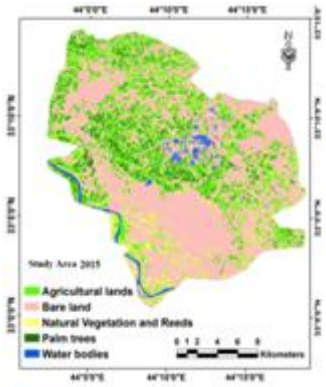
(d) Reeds ash

Figure 3: Powder and ash of palm fronds and reeds

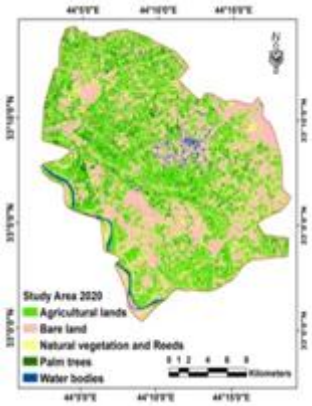
A Survey Comparison of the Palm Trees and Reeds Plants in Yusifiya District / Based on GIS software (V.10.1)

It was noticed from **Figure 4** and **Table 1** that the speared area of reeds and palm trees in the Yusifya decreased in the year 2020 as compared to the year 2015 by about (15.25 and 17.14) % for reeds and palm trees, respectively. Moreover, the area of the agricultural land has increased in

the year 2020 by 95.74% compared to the year 2015. Also, it was noticed from **Figures 5** and **6** that the spectral reflection of palm trees is more than the spectral reflection of reeds, which are taken from the spectral reflection device and used in the GIS program to find the areas of reeds and palm trees. Besides, the wavelength of both begins at 350 and ends at 2500. The GIS technique and tests were carried out in Ministry of Science and Technology/Directorate of Space Technology and Communications/Remote Sensing Department/Baghdad/Iraq.



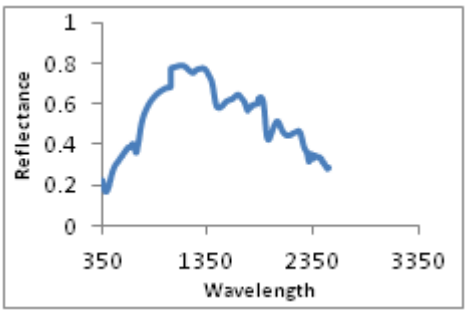
(a) Study area 2015



(b) Study area 2020

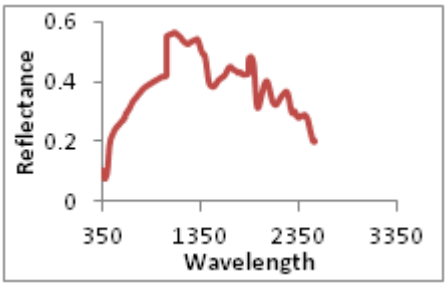
Figure 4: GIS Photo for the study area in years 2015 and 2020, Landsat 8, GIS software (V.10.1).

(a) Palm trees



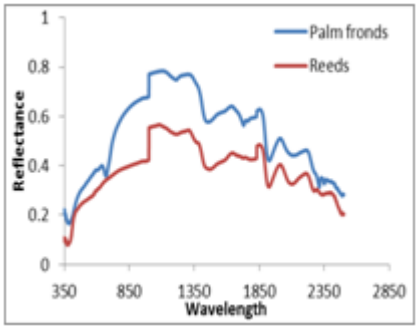
(b) Palm fronds spectral reflectance

(c) Reeds plants



(d) Reeds spectral reflectance

Figure 5: The spectral reflectance for palm fronds and reeds.



(a) Spectral reflectance of palm fronds and reeds plants

(b) Spectral reflectivity device

Figure 6: Spectral reflectance of palm fronds and reeds plants, spectral reflectivity device.

Table 1: The areas of plants and lands in Yusifiya district

Name	Square area (Km) 2015	Square area (Km) 2020
Agricultural lands	94	184
Bare land	220	146
Natural vegetation and reeds	59	50
Palm trees	35	29
Water bodies	9	8

5.The Experimental Work

Twenty-seven cubes with 150 mm dimensions were cast and tested after 28 days of curing to obtain the compressive strength of concrete according to **ASTM C39 [10]**; properties of the material used are summarized in **Table 2**. Three of the cubes have been cast as plain concrete and tested to compare them with the rest of the cubes that have been reinforced with 1% and 5% of powder and ash of untreated palm fronds and reeds which have been replaced by the weight of sand.

Table 2: Material properties

1-Concrete mix design		
Concrete grade	M20	
Mix design ratio	1: 1.55: 2.38	
Water cement ratio	0.47	
2-Cement		
Fineness	388 m^2/Kg	
Initial setting time	2 h/min	
Final setting time	4: 30 h/min	
3-Aggregate		
Max. Size of coarse agg.	10 mm	
Fineness modulus of fine agg.	3.1	
Density of fine agg.	1600 Kg/m^3	
Specific gravity of fine agg.	2.67	
4-	**Palm fronds**	**Reeds**
Density	0.926 g/cm^3	0.3176 g/cm^3
Moister content	6.604%	2.277%

The compressive strength of the specimens is listed in **Table 3**, It is worth noting that the symbols for mixtures are as follows: plain concrete mixture (PC), palm frond fibers mixture (powder, PP and ash, PA), and reed fibers (powder, RP and ash, RA).

Table 3: Cubic compressive strength f_{cu} after 28 days

Type of concrete		Compressive strength f_{cu} (MPa)			Average
Plain concrete (PC)		22.1	28.5	27.7	26.1
Palm fronds mixture					
Powder (P_P)	**1%**	31.8	30.2	28.9	30.3
	5%	27.8	25.9	26.5	26.7
Ash (P_A)	**1%**	32.3	31.7	29.5	31.16
	5%	21.8	25.6	20.3	22.56
Reeds mixture					
Powder (R_P)	**1%**	39.2	36.9	38.3	38.1
	5%	19.2	21.8	20.6	20.5
Ash (R_A)	**1%**	28	29.5	26.9	28.1
	5%	22.4	20.8	21.2	21.4

6.Results and Discussion

Table 3 illustrated that the compressive strength for the plain concrete mixture (PC) was less than the mixture that included 1% palm frond fibers (powder, PP and ash, PA) and 1% reed fibers (powder, RP and ash, RA). Where the compressive strength is increased by about (16.09 and 19.38) % and (45.97 and 7.66%) for 1% palm frond fibers (PP and PA) and 1% reed fibers (RP and RA), respectively as compared to the compressive strength of plain concrete. This is due reduces porosity and air in the air voids within the concrete mix, which leads to an increase in the bonding strength of the mixture, [**11]**. And when comparing the compressive strength of the concrete mixture containing 5% of vegetal fibers (powder and ash) with the compressive strength of the plain concrete; it is found that it is less than by about (13.56) % for the ash of palm fronds and (18.01 and 21.45) % for the ash and powder of reeds respectively, except the specimen, contain 5% of powder of palm fronds, PP increased by about 2.29%. This decrease in compressive strength is due to existing of vegetal fibers, which are generally characterized by an organic characteristic. Moreover, the reed fibers are considered from the materials which have hydrophilic nature that leads to absorption of mixing water and the early appearance of cracks in concrete, [**12]** and **[13]**. The compression results are listed in **Table 4.**

Table 4: The compression results

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %	Decreasing in compressive strength %
Plain concrete		26.1	0.00	0.00
Palm fronds mixture				
Powder (P_P)	**1%**	30.3	16.09	-
	5%	26.7	2.29	-
Ash (P_A)	**1%**	31.16	19.38	-
	5%	22.56	-	13.56
Reeds mixture				
Powder (R_P)	**1%**	38.1	45.97	-
	5%	20.5		21.45
Ash (R_A)	**1%**	28.1	7.66	-
	5%	21.4		18.01

Also, it can be noticed that the compressive strength of concrete mixture having 1% and 5% ash of palm fronds increased by about (10.88 and 5.42) % respectively as compared with a mixture having 1% and 5% ash of reeds at 28 days as listed in **Table 5**; this is an indication that palm fronds ash has completely turned into carbonate as cement**.** The compressive strength of concrete mixture having 1% powder of reeds increased by about 25.74% as compared with a concrete mixture having 1% powder of palm fronds as shown in **Table 6**; this is due to the lack of air spaces inside the concrete mixture, which led to an increase in the compressive strength of concrete. While the concrete mixture having 5% powder of palm fronds give better compressive strength as compared with a concrete mixture having 5% powder of reeds by about 30.24% as shown in **Table 7**; this confirms the fact and nature of hydrophilic nature reed, and the increase in its percentage in the

mixture negatively affects the compressive strength of concrete. The compressive strength of concrete having 1% ash of palm fronds and reeds increased by about 38.12% and 31.3%, respectively as compared to a concrete mixture having 5% ash of palm fronds and reeds as shown in **Table 8**; this behavior is due to the same reasons mentioned above. And also it was seen that the Compressive strength of concrete having 1% powder of palm fronds and reeds increased by about (13.48 and 85.85) %, respectively as compared to a concrete mixture having 5% powder of palm fronds and reeds as shown in **Table 9**; this confirms that the best mixing ratio of vegetal fibers is 1%.

Table 5: The compression results of palm fronds ash and reeds ash concrete mixture.

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %
Palm fronds con. mixture			
Ash (P_A)	**1%**	31.16	10.88
	5%	22.56	5.42
Reeds con. mixture			
Ash (R_A)	**1%**	28.1	0.00
	5%	21.4	0.00

Table 6: The compression results of palm fronds powder 1% and reeds powder 1% concrete mixture

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %
Palm fronds con. mixture			
Powder (P_P)	**1%**	30.3	0.00
Reeds con. mixture			
Powder (R_P)	**1%**	38.1	25.74

Table 7: The compression results of palm fronds powder 5% and reeds powder 5% concrete mixture

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %
Palm fronds con. mixture			
Powder (P_P)	**5%**	26.7	30.24
Reeds con. mixture			
Powder (R_P)	**5%**	20.5	0.00

Table 8: The compression results of palm fronds powder and reeds powder concrete mixture

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %
Palm fronds con. mixture			
Ash (P_A)	**1%**	31.16	38.12
	5%	22.56	0.00
Reeds con. mixture			
Ash (R_A)	**1%**	28.1	31.3
	5%	21.4	0.00

Table 9: The compression results of palm fronds powder and reeds powder concrete mixture

Type of concrete		Compressive strength f_{cu} (MPa)	Increasing in compressive strength %
Palm fronds con. mixture			
Powder (P_P)	**1%**	30.3	13.48
	5%	26.7	0.00
Reeds con. mixture			
Powder (R_P)	**1%**	38.1	85.85
	5%	20.5	0.00

7.Conclusions

- The results showed that the mixture had 1% vegetal fibers gives better compressive strength as compared with plain concrete and 5% vegetal fibers mixture.
- Adding 1% ash of palm fronds in concrete mixture gives better compressive strength rather than 5% powder of palm fronds.
- Adding 1% ash and powder of reeds in the concrete mixture gives maximum value in compressive strength rather than using 5% ash and powder of reeds in the concrete mixture.
- The speared area of reeds and palm trees in the Yusifya decreased in the year 2020 as compared to the year 2015 by about (15.25 and 17.14) % for reeds and palm trees, respectively due to the expansion of agricultural lands and to cut down some palm trees for their illness and death.

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