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Study on Recycled Waste Cloth in Concrete

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***Abstract* - One of the bio masses that is available in plenty without being potentially utilized is waste cut cloths obtained from tailoring shops. These waste cloths are cut into small pieces of size approximately 20mm x 20mm, used in concrete in various percentages after preliminary treatment. The incorporation of these waste cloths increases the flexural, tensile properties besides increase in energy absorption. Necessary engineering properties and physical properties are studied systematically and compared with the control concrete. The potential usage and importance of this new material has been discussed in detail.**

1.INTRODUCTION:

The disposal of solid wastes is a major problem throughout the world. Recycling and use of these waste materials, is increasing worldwide, especially in the construction industry. Using these recycled materials and wastes in construction is being more popular due to shortage of natural mineral resources and increasing waste disposal costs. However, with increased use of wastes in engineering applications, need for further understanding of engineering behavior of the composite material[1]. Textile cutting waste from the industries and tailoring shops disposed as waste product in heaps thus causing disposal problem and environmental pollution[2]. Studies have indicated that many forms of fibers recovered from various waste streams and suitable for concrete to act as reinforcement[2]. It has been reported[3-5] that polymer concretes can also be reinforced with fibers of both synthetic and natural. The textile waste cuttings when mixed with thermosetting polymer as binder produces a unique kind of composite material that can be used for low cost light weight construction[6], improved chemical resistance and mechanical strengths are achieved[6,7]. It is reported[8] that waste cloth incorporated polymer concrete display brittle characteristics that have limited its usefulness for load-bearing applications.

In this research work, these textile cut cloths collected from the tailoring shops are cut into small pieces and mixed with conventional concrete to study physic-mechanical properties and explored the positive application in construction industry.

2.EXPERIMENTAL PART:

2.1.Materials Used:

Ordinary Portland cement (OPC) 43 grade of Dalmia brand conforming to IS 8112 was used. The river sand used had a fineness modulus of 2.01. The coarse aggregate used was 10mm and down size had fineness modulus of 3.63 mm. The textile cut cloths were collected from the local tailoring shops and was mixture of synthetic and semi synthetic cloth pieces and cut into small sizes approximately 20mm x 20mm as shown in Fig 1. Thesecloths were soaked in soap solution then rinsed enough in flowing water to remove soap and dirt and subsequently these cut cloths were subjected to drying for complete removal of moisture in the electric oven.This textile cutting may not be conceived as either an aggregate or reinforcement. It does however contribute to increase in volume of the mixture (which is the major function of an aggregate), less the weight and intent to contribute to the increase in the flexural and compressive resistance (which is the major function of the steel reinforcement) due to its fibrous nature.

2.2.Casting And Moulding Of Specimens:

From various trial mix studies carried out earlier on conventional concrete, one mix proportion was selected and various percentages of cut cloths based on weight of cement. This unique kind of concrete was used to cast following test specimens for physico-mechanical strength analysis. For cube compressive strength test 150mm x 150mm x 150mm size cubes were cast, For cylinder compressive strength test 80mm diameter and 150mm long cylinders were cast , for the determination of dry and saturated densities 80mm diameter and 50mm thick disk specimens were prepared. For the determination of split tensile strength tests 80mm diameter and 250mm long cylinders were used. The flexural strength was obtained from the beam specimen of size 50mm x 50mm x 300mm. For shear strength determination small cylinders of size 50mm diameter and 100mm long specimens were cast. For finding the efficiency of the coating systems on water absorption, square tiles specimens of size 100mm x 100mm x 25mm were cast. For arriving impact resistance of this new material tile of size 250mm x 300mm x 10mm thick were prepared and after first day, the moulds were demoulded and the specimens were allowed for 28- days curing and then subjected for experimental studies. The Table 1 shows the designation and mix ratios.

Fig 1: Waste cloth used in concrete

Table 1: Mix Proportions of Waste Cloth Concrete

Mix designation	OPC	Sand	Coarse aggregate	Percentage of waste cloth By the mass of OPC	w/c
C	1.00	1. 5	2.00	-	0.40
T1	1.00	1. 5	2.00	1	0.40
T2	1.00	1.5	2.00	2	0.40
T3	1.00	1.5	2.00	3	0.40
T4	1.00	1.5	2.00	4	0.45
T5	1.00	1.5	2.00	5	0.45

3.RESULTS AND DISCUSSION:

The Table 2 shows the cube compressive strength of cloth concrete after 28 days of curing. The control concrete has high cube compressive and cylinder strength and gradual reduction in cube compressive and cylinder compressive strength as the percentage of addition of waste cloth increases.

It can be seen from Fig 2 that the reduction in cube compressive strength (f_{cu}) follows the equation

$$\mathbf{Y = 0.2336x^2 - 4.6204x + 49.368, (R^2 = 0.9543)}$$

Table 2: Characteristics Strength of Waste Cloth Concretes

Designation	Cube Compressive Strength , f_{cu} (MPa)	Cylinder Compressive Strength,f_{cy} (MPa)	Splitting Tensile Strength,f_{sp} (MPa)	Flexural Strength , f_r (MPa)	Impact resistance energy absorbed (kN-mm)
Control	63.01	34.08	2.89	6.81	1.12
T1	44.24	26.53	4.48	7.46	1.4
T2	42.63	22.53	3.73	8.26	1.68
T3	37.35	20.38	2.96	9.26	1.90
T4	33.40	18.22	2.91	9.92	2.24
T5	32.76	14.86	2.71	10.55	2.46

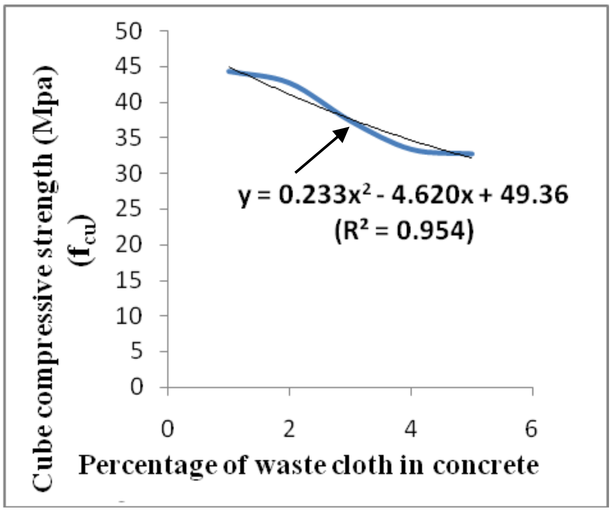

Fig2: Cube Compressive Strength of waste cloth concrete after 28 days

Similar trend was observed in cylinder compressive strength test also (f_{cy}). It can be clearly seen from the Fig 3. The reduction in strength is very steep compared to f_{cu} values and follows the equation

$$Y = 0.0907x^2 – 3.3093x + 29.434, (R^2 = 0.9879)$$

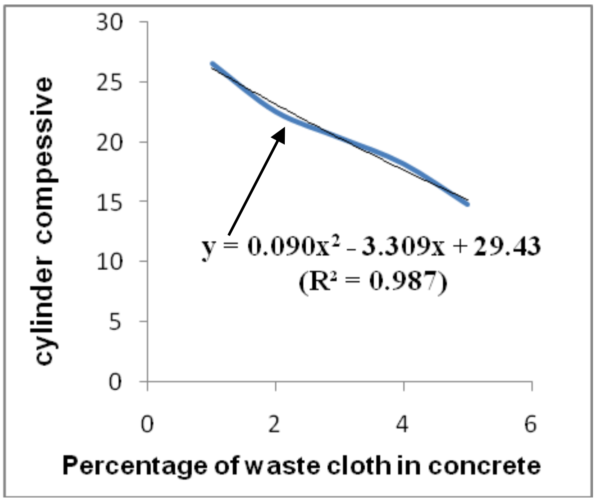

Fig 3: Cylinder Compressive Strength of waste cloth concrete after 28 days

The reduction in compressive strengths can be attributed to the fact that the cohesiveness in the concrete matrix is reduced drastically due to incorporation of waste cloths in concrete. This is true because, as the percentage of cloth is increased in concrete, the compressive strength are reduced. Another reason for reduction in strength is, the calcium silicate hydrate formation is not fully around the fine or coarse aggregate and partially formed on the waste cloth. This is a composite action that reduces the strength.

In case of splitting tensile strength test, the control concrete had a value of splitting tensile strength(f_{sp}) as 2.89 MPa which is 4.59% of cube compressive strength. Addition of cloths in concrete increased the value of f_{sp} compared to control mixturefor the percentage of additions 1% to 4% by the mass of OPC (Fig 4). For the mixture T5, ie 5% addition of cloth in concrete reduced the splitting tensile strength as compared to control mixture of concrete. this variation in strength follows the equation

$$Y = 0.13x^2 – 1.216x + 5.576, (R^2 = 0.9822)$$

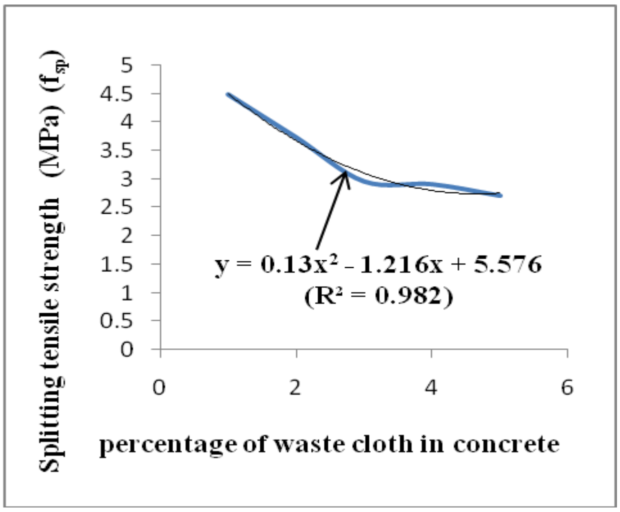

Fig 4: splitting tensile Strength of waste cloth concrete after 28 days

The Fig 5 shows the split view of the cylinder after splitting tensile strength test. An addition of waste cloths interacts in the split plane and resists the tensile or split force and hence the resistance against splitting is increased. However in T5 (5% waste cloth), the quantity of waste cloth addition seems to be high and hence reduction in f_{cu}, f_{cy} and f_{sp}. The flexural resistance or modulus of rupture or bending stress value compared to control concrete and these values follows the equation as seen from Fig **6**

$$Y = 0.0486x^2 – 1.0754x + 6.398, (R^2 = 0.9975)$$

Fig 5: Split section of waste cloth concrete

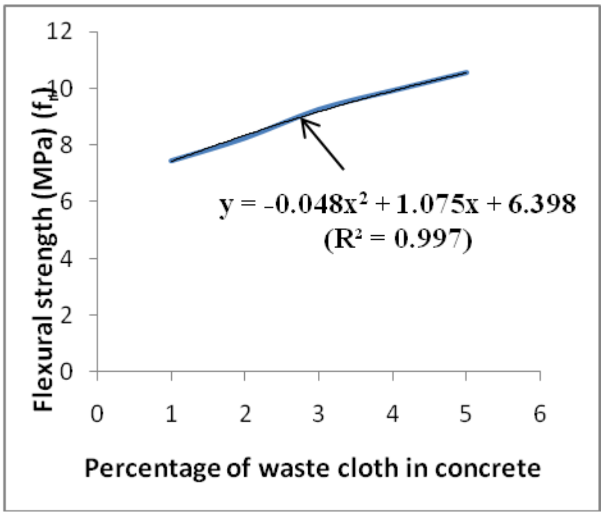

Fig 6: Flexural Strength of waste cloth concrete after 28 days

The reason for increase in bending stress being that the cloths in the concrete mix provide a high tensile strength and acts as reinforcement against bending.

Tile specimens were used for measuring impact resistance. Fig 7 shows the trend of increase in impact energy absorption as the percentage of waste cloth addition is increased. The Table 3 illustrates the height of fall of steel ball which is weighing 560gm and corresponding strain energy absorbed also computed and presented. As it has been discussed, the cloths acts as reinforcing material which enable the tiles to absorb more energy before it fail by impact load. The cracked tiles are shown in Fig 8.

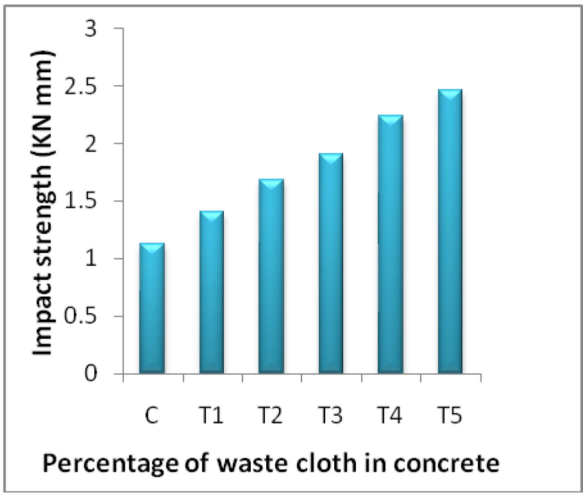

Fig 7: Impact Strength of waste cloth concrete

Fig 8: Tile specimens after impact test

Table 3: Impact Resistance test results of waste cloth concrete

Specimen Designation	Weight of Steel ball (gm)	Height of fall (mm)	Energy Absorbed (kN mm)
C	560	200	1.12
T1	560	250	1.4
T2	560	300	1.68
T3	560	340	1.90
T4	560	400	2.24
T5	560	440	2.46

The Table 4 shows the physical properties of the waste cloth concrete. From this table it can be inferred that the dry density is decreased as the percentage of waste cloth is increased in concrete and the saturated density is increased as the content of cloth is increased. This is due to high amount of water absorption by the incorporated cloths in the concrete.

Table 4: Physical Properties of waste cloth concrete

Designation specimen	% of waste cloth	Dry Density (kg/m^3)	Saturated density (kg/m^3)	Water Absorption (%)	Coefficient of Water absorption Ka x 10^{-10} (m^2/s)
C	-	2396	2460	2.67	0.98
T1	1	2320	2492	7.41	1.16
T2	2	2220	2532	14.05	1.39
T3	3	2160	2584	19.63	2.16
T4	4	2100	2628	25.14	2.27
T5	5	2060	2652	28.74	2.45

4.CONCLUSION:

- Inclusion of waste cloths in the concrete reduces both cube compressive and cylinder compressive strengths. Due to loss of cohesion.
- Inclusion of waste cloths increases the tensile properties of concrete both in splitting tensile strength and flexural tensile strength due to reinforcing effect of cloth fibers in concrete.
- Impact energy absorption was high for this special concrete and this energy absorption increases with increase in cloth content.
- This material shows very high amount of water absorption as the cloth content increases. This is due to absorption of water by cloths itself.
- This special concrete will naturally provide thermal and sound insulation and therefore it can be used as ceiling and wall panels.
- This material is suitable for structural applications and particularly for structural beams subjected to high bending stress and impact loads.
- Since this concrete has high affinity to water, a special water proof coating is necessary.

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