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Mechanical and Physical properties of Medium Density fiber board made from rice husk and fiber coating

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Abstract

The study includes the preparation of Medium Density fiber board(MDF) made from the coating paper and rice husk, which are used in the prefabricated furniture panels, and manufacturing of these panels using PVA polymer as bonding materials. The flexural strength reach 3.73 MP compared with imported panels of 3.5 MP, thus these manufactured panels are resistant to combustion. The present study used rise husk with coating paper at different rate in addition to cement and polymer materials consist of poly vinyl estate (PVA). In this paper physical and mechanical peoperties of MDF manufacturer from natural fiber studied. Experimental results show that the density of MDF are about 339 to 820 Kg/m³. The Bending test are about 0.25 to 3.73 MP. The water absorption are about 4% to 24%.

Introduction

Medium density fiberboard (MDF) is defined as a composite panel product typically consisting of cellulosic fibers combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure (1). In world wide, environmental pollution resulting from industrial wastes and waste living materials is one of the biggest problem facing the entire human race and it will be more and more serious, thus much concentrated effort is being put into solving this problem, in advanced and less advanced countries(2). Recycled waste paper boards have the advantages of improved mechanical properties and lighter weight(3). (MDF) panels ignite when exposed to fire, releasing heat, which can further promote the fire in some circumstances(4). Medium density fiberboard (MDF) is widely used in construction, transportation, furniture, decoration, and other industries due to its moderate density, good physical and mechanical properties, and have a low cost. However, the application of MDF is limited in many areas because of its flammability. Therefore, treatments with fire retardants are necessary to meet the fire retardant requirements of national standards(5). Several researchers succeeded in the recycling and utilization of waste paper .

Eom at al found the bending strength of the waste paper board and waste paper –waste acrylic raw fiber (5% wt.) decrease as the fire retardant increase (2). Yang at al found the bending strength of fire retardant treated

board decreased as the fire retardant increased, but this was nevertheless superior to gypsum boards and insulation boards (3).Krzysik et al show study thickness of waste paper fiber board with Bending strength. The Bending strength decreased as panel thickness increased, also they found panel internal bond strength decreased as panel thickness increased. The water absorption of the panel was approximately equal to the 25% limit specified in the standard (6).Deppe manufactured medium density fiberboard (MDF) made of waste paper and wood fibers using a dry-process, and reported that physical and mechanical properties decreased as waste paper content increased(4).Ellis et al produced a composite from phone books and various wastes vinyl products and reported that although the mechanical properties ware superior, the dimensional satiability was poor in the composite(5). Stokke and Liang tested a wood based composite produced by mixing waste paper and wood based raw material (flak, particle, TMP, wood fiber) at 50/50 ratio and reported that although this board showed the similar bending strength was commercial board, it showed a low internal bending strength with more than 25% increase in thickness swelling (7). Jaber studied the MDF made from old newspaper and found reduction in bending modules as increase the compressive strength as the panel as cement was treated from (10-40%)In this present study used rise husk with waste coating paperhave been mixed in different ratiowith cement and polymer materials consist of Poly ester poly (PVA) and Poly Ol (P.O), and study the physical and chemical properties and ignition properties.

Experimental

Materials

1- Poly vinyl estate (P.V.A): this commercial materials used as resin adhesives.

2- Cement: Portland cement used this study Table (1) explained the chemical properties of cement.

Table(1) chemical properties of cement.

Silica	SiO_2	22.54%
Alumina	Al_2O_3	6.11%
Ferous Oxide	Fe_2O_3	2.26%
Calcium Oxide	CaO	65.27%
Magnesium Oxide	MgO	2.9%

3- Coating paper cut into small pieces and weight then placed in an electric blender and mixed, the water drained from them and then weighed again and weight of the Coating fiber before shredding subtracted from the resulting value, the final output subtracted from the weight of the water that will be added to the concrete mix.

4- Rise husk: to use rise husk from Najef mills after washing from dust, drying, milling and sieving in sieve graded size 600 mm. Rise husk obtained from a target moisture content 10wt%, crashed size and oven-dried till moisture content 4wt%.

Mixture proportions

The mixture proportion of natural fiber board are shown in Tables (2,3 and 4) where the water to cement matrix ratio is0.6by weight. In order to compare the effect of natural fibers we add different ratio of PVA in volume to medium density fiberboard.

Experimental part

1- Physical and mechanical properties

The section describes the processing that were necessary to convert the various fibrous materials a from that could be used to fill bircded MDF

For the MDF with coating paper and PVA table (2) type(1) or with different cement table(3) ratio type(2) or with rice husk table(3) type(3)

1- Weight the constituents as shown in table (2,3and4)

2- Mix the PVA with coating paper type(1) or PVA with coating paper and cement type (2) and the rice husks with coating paper type3together during two minutes at dry condition.

3- Cut the coating paper to small pieces and weight. Then put into electric blender, mixed then drain from water and squeeze, and weight again and the subtracted weight of the paper before shredder from the resulting value, the final output subtracted from the weight of water that will be added to the concrete mix.

4- Mix PVA and coating paper and add to the mixer with moving continual and add to the cement gradually with moving.

The mixture was poured in a steel mold with inter dimensions of (20, 10 and 0.1) cm. Each mixture is compacted to a known pressure of 1.5 Mp for 10 second ,then the steel molds are dismantled and the specimens whose dimensions were (20, 10 and 0.1) cm was taken out .The specimens were in dried at100˚c for 2hr ,then the specimen read to cut according the ASTM shows in table (5)

2- Burning Test

The Burning Test of specimens were tested according to ASTM (635-81). Time extent of buring(ATB) and Average burning rate (AEB) are measured and reported for all materials (burns to 100mm mark from the ignited end), table (5) shows the ATB and AEB for the specimens

Average Time of Burning (ATB) = ∑t-30s/number of specimens

Average Extent of Burning (AEB) = ∑100-unburned length/number of specimens

Table (6) shows the Water content ratio %, density, Bending test, capability ratio

Table (2)shows the effect (P.V.A) on the properties.

Sample No.	P.V.A %	Paper coating%
A1	10	90
A2	20	80
A3	30	70

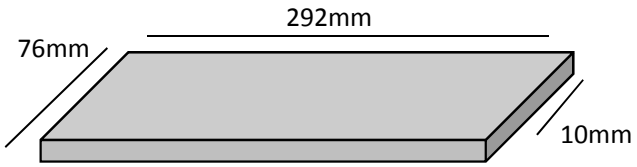
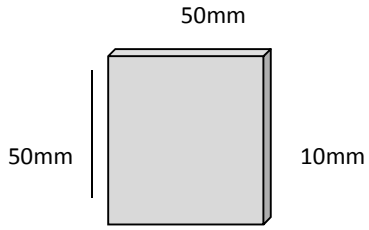
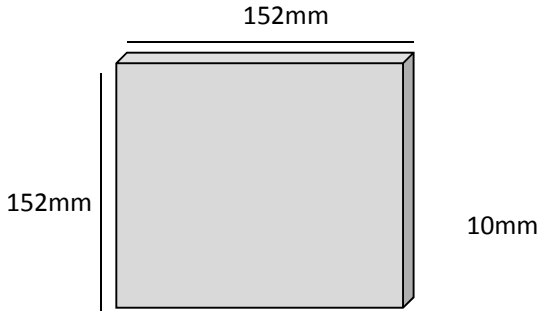
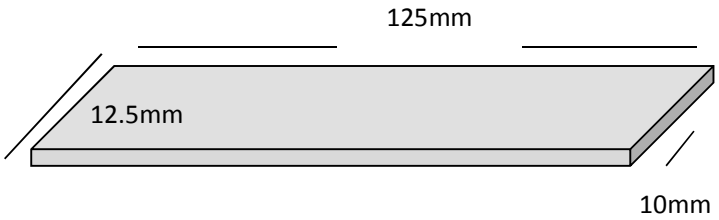
Table (3) shows the effect Cement/ Paper coating on the properties .

Sample No.	P.V.A %	Cement/ Paper coating %
A2	20	0 /80
A4	20	20 / 60
A5	20	40/ 40
A6	20	60 / 20

Table(4) shows the effect Rise husk/ Paper coating on the properties.

Sample No.	P.V.A %	cement %	Rise husk/ Paper coating%
A7	30	30	10 ⁄20
A8	30	30	15⁄15
A9	30	30	20⁄ 10

Table (5) dimension of specimens

Sample	Dimension	Type of specification
Bending test		ASTM 1073
Water absorption		
Density		ASTM 1073
Rate of burning		D635-81

Result and Discussion

Mechanical and physical properties data for the samples are presented in table (6 A,B and C)each value in an average 3 tests The results of the MOR of MDF produced are shown in table (6 A,B and C) and figures (1.2 and 3) which indicates:

1- Modules of rapture (MOR)

The table (6a), show the bending strength value increased as PVA increased and values exceeded the MDF standard also noticed the MOR decreased with increased of cement and rise husk ratio. The result showed that the increase in cement and rise husk lead to increase the value of MOR it can be interpreted this behavior, the cement and rise husk full the holes formed in the composition material.

2- Density and Water absorption

The tables (6 A,B and C) shows the result of density and the water absorption ratio. Table (6-A) shows as the density increased and water absorption decreases with increases of the PVA. Table (6-B) shows as the ratio of cement/paper coating in the mixture the density decreased and water absorption increased. Table (6-c) shows as the ratio of rice husk/paper coating increased the density and water absorption decreases with constant of PVA and cement ratio. The increased the cement lead to full the hole in structure of samples that lead to increased the density and decreased the water absorption, also increased of the rise husk leads to full the holes in structure of sample but leads to the decrease of the density and water absorption because the density of rise husk less then density of cement.

1- Burning test
The burning rate of samples are shown in figure (4,5) and tab (7). The burning rate of the sample decreased as the cement and rise husk ratio increased, all the sample without cement ratio were of high burning rate.

Table (6 A) the effect of PVA on the coating paper .

specimens No.	**Water absorption ratio %**	**Density Kg/m³**	**Bending test MPa**
A1	2.400	339	1.26
A2	1.998	408	1.7
A3	1.7	520	2.24

Table (6 B) the effect of cement on the coating paper and PVA .

specimens No.	**Water absorption ratio %**	**Density Kg/m³**	**Bending test MPa**
A2	1.998	408	1.7
A4	1.596	455	1.18
A5	1.018	528	1.02
A6	0.507	723	0.25

Table(6 c) the effect of Rice husk of on the coating paper, cement and PVA .

specimens No.	**Water absorption ratio %**	**Density Kg/m³**	**Bending test MPa**
A7	0.717	820	1.52
A8	0.555	625	2.03
A9	0.404	582	3.73

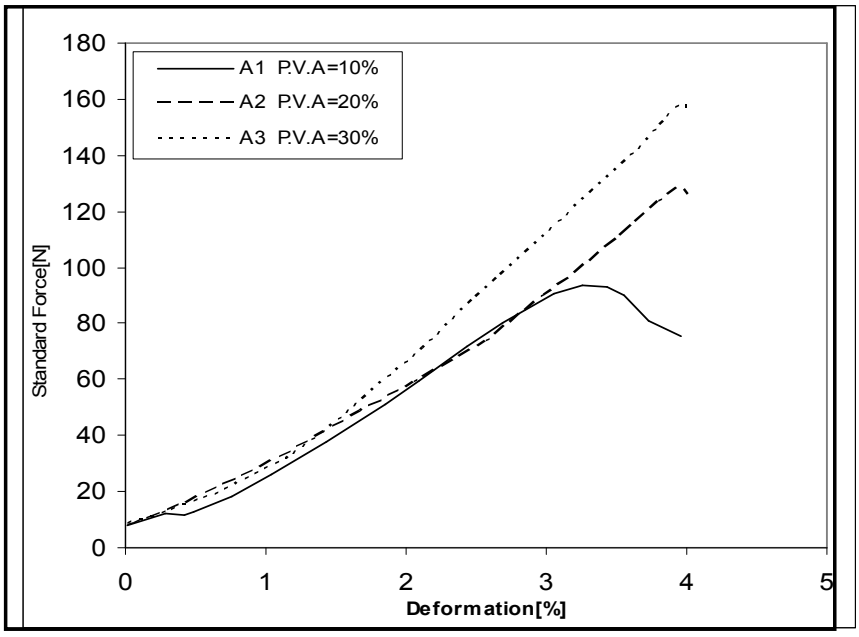


Fig.1 P.V.A apparent addition of Beading test.

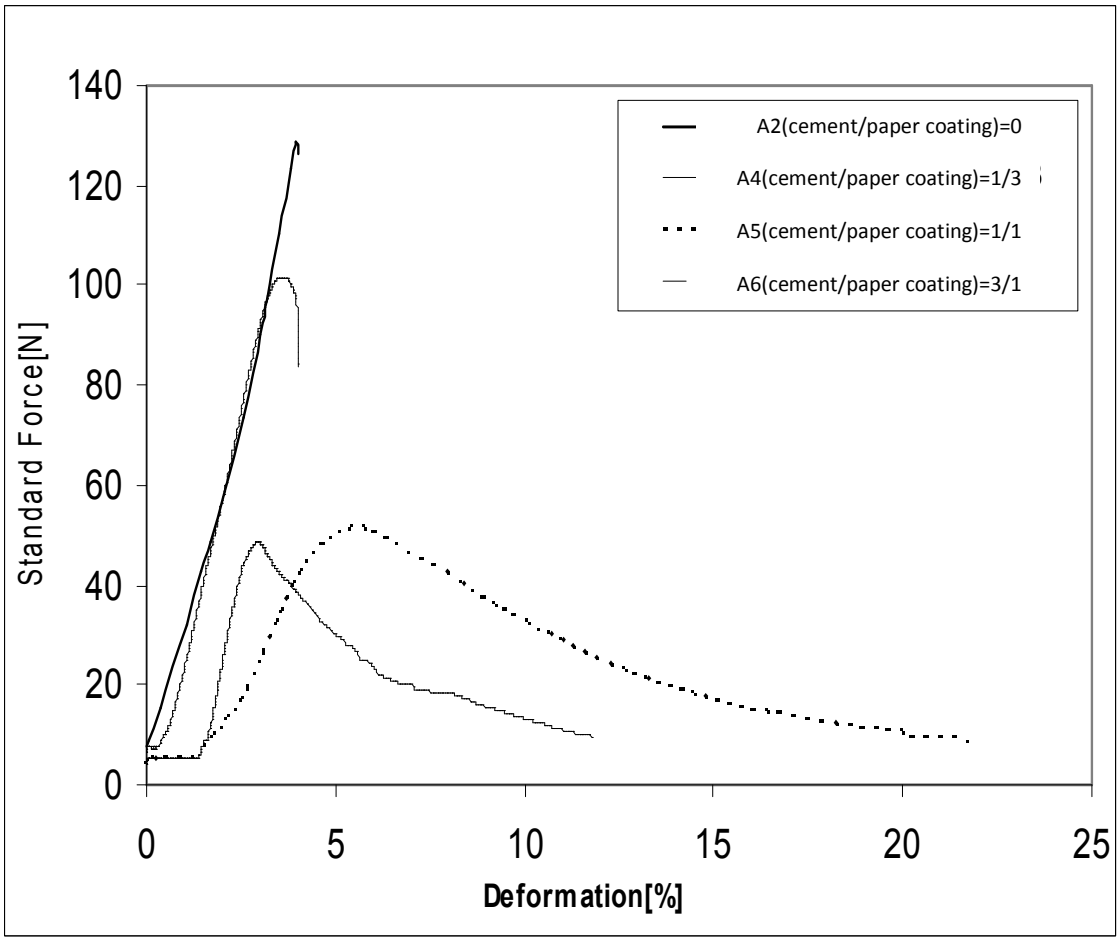


Fig.2 cement apparent addition of Beading test.

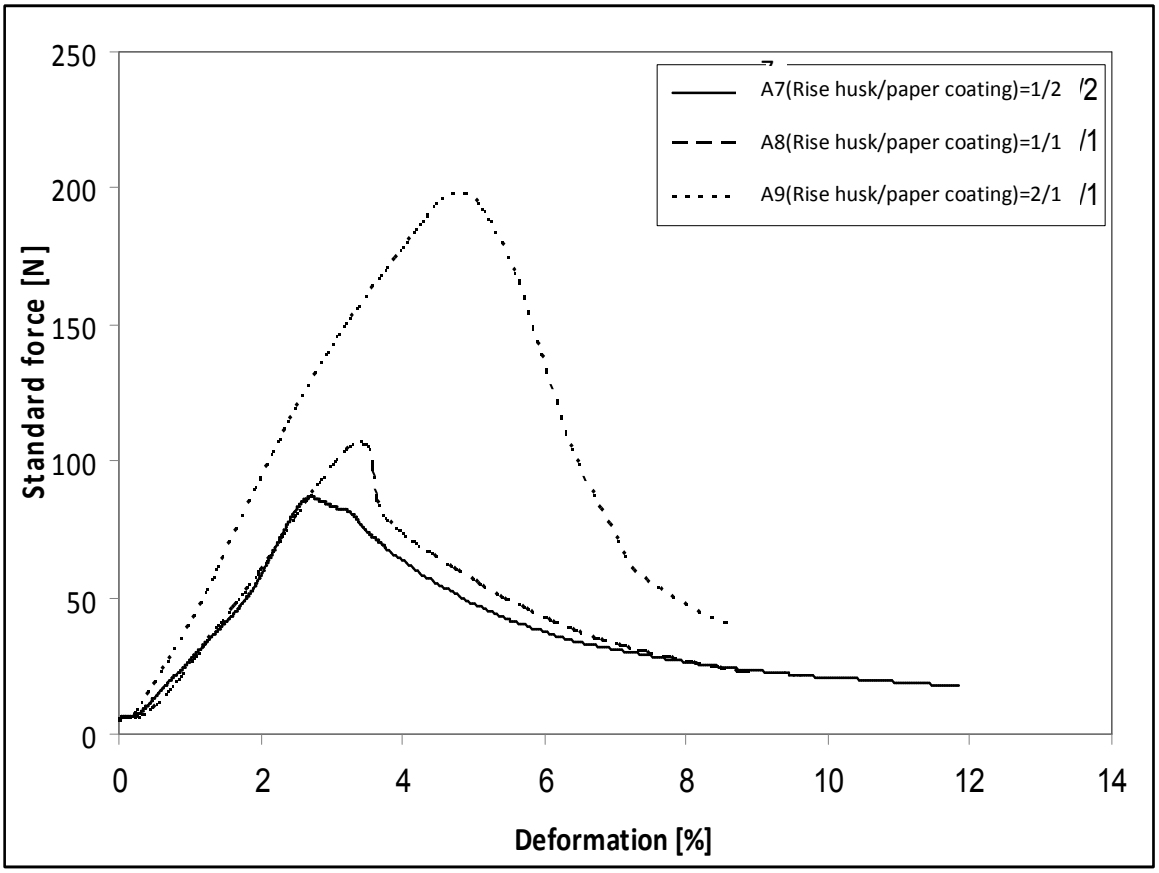


Fig.3 rise husk apparent addition of Beading test.

Table (7) data of ASTM measurement of specimens.

specimens No.	ATB (sec)	AEB (mm)	Extent of burning (mm)	Burning Rate (cm/min)
A2	390	100	0	10.7
A3	450	100	0	11.6
A4	750	25	75	0
A5	1170	0	100	0
A6	570	100	0	5
A7	870	0	100	0
A8	1230	0	100	0

A9	570	10	90	0

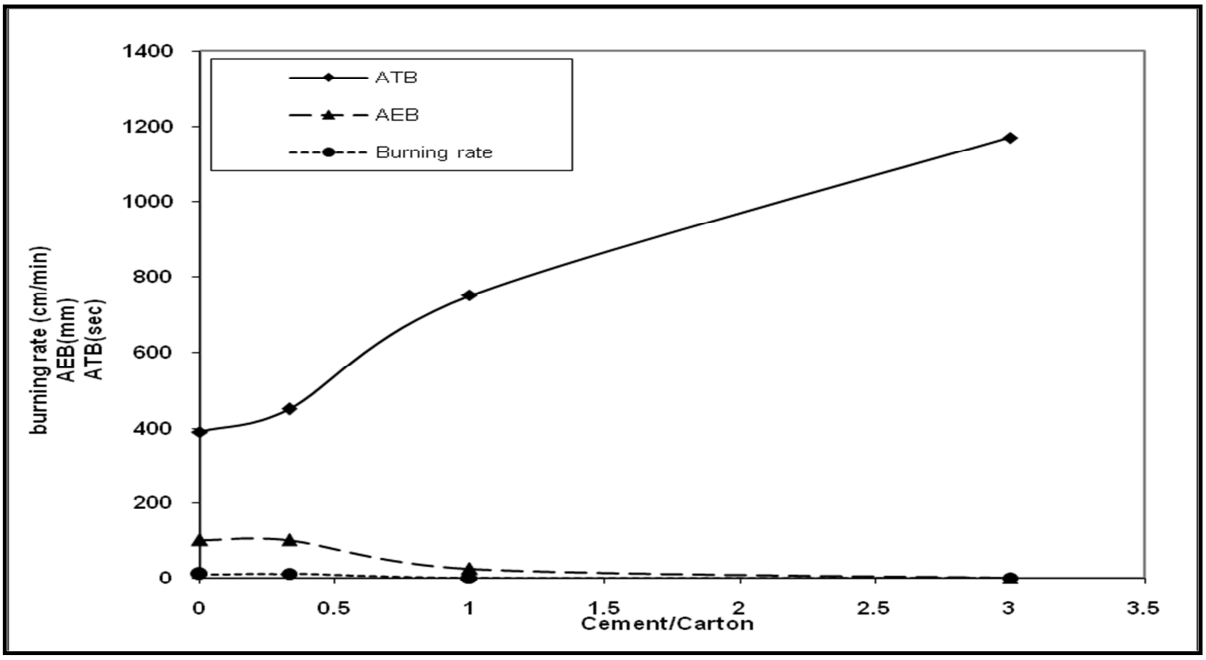


Fig. (4) ESTM standard.

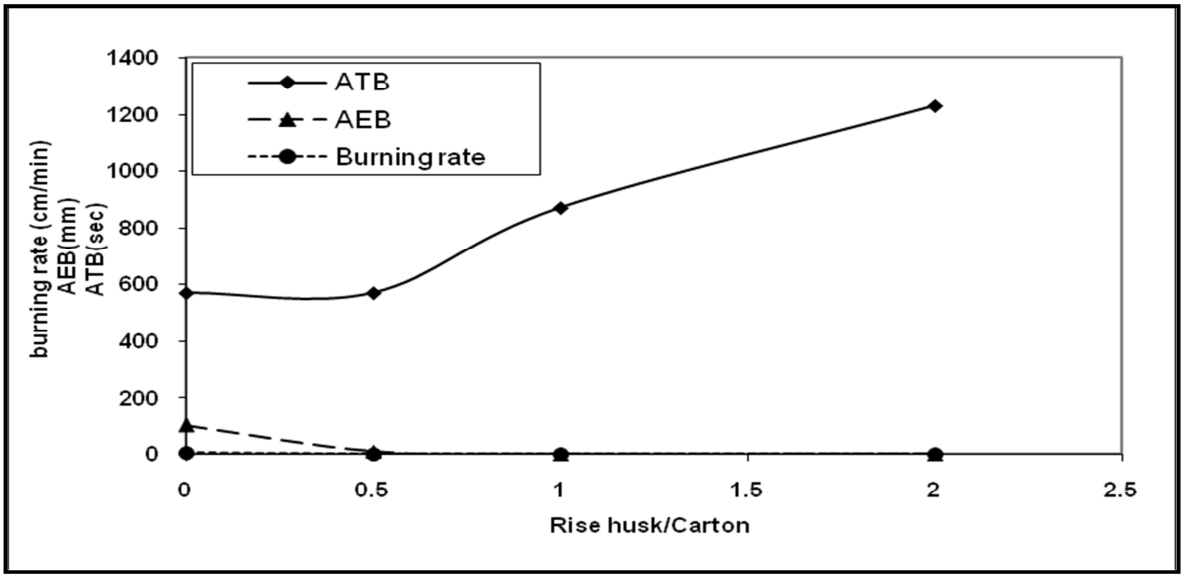


Fig. 5 ASTM stander.

Conclusion

MDF made from coating carton and fiber prepared with PVA showed the highest MOR (3.73 MP), and lowest burning rate(0). MDF made from carton and rise husk can be used as a MDF used for furniture.

1- Where it was observed that increased add the cement\carton not leads to increased the strength but increased polymer (P.V.A) leads to increased in strength force where up to 1.45 when to be (P.V.A) rate 30%.

2- Where it was observed that increased add rise husk lads to decreased in strength force because increased add rise husk leads to spacing between bonds to add decrease the strength force.

3- Where it was observed that increased add the rise husk \carton and increased cement\carton leads to increased Average Time of burning(ATB).

4- Where it was observed that increased add the rise husk \carton and increased cement\carton leads to decreased Average Extent of Burning (AEB), when its be rise husk\carton ratio= 0 AEB= 100, after increased rise husk\carton ratio where up to 1.5 AEB= 0.

5- Where it was observed that increased add the rise husk and cement to mixtures leads to decreased in Burning rate.

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