SELECTING THE BEST PARTICLEBOARD PRODUCTS WITH RESPECT TO CRITERIA INTENSITIES, CASE OF THE STUDY: IRANIAN PARTICLEBOARD

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ABSTRACT

The aim of research is selecting best particleboard products in Iran. Physical and mechanical specifications of the products are different together. Quality and quantity of Iranian particleboard products are growing successfully. Obtainment of higher market share will need to acknowledge preferable products with respect to criteria and their intensities. Particleboard criteria includes, moisture percent; density; thickness swilling percent; water absorption percent and bending strength, also each one of the criteria has three levels of intensities, high (H), medium (M) and low (L). There are five major products includes A; B; C; D and E which are produced in the factories. First stage the criteria and their intensities have been evaluated by applying AHP and Expert Choice 2000. Second stage five major particleboard products have been ranked with respect to results of previous section. The final results indicated that D product has the highest priority. Third stage, with respect to results of sensitivity analysis, moisture percent and bending strength are more sensitive than other criteria.

Keywords: alternative, particleboard, priority, sensitivity analysis, AHP

1. Introduction

Particleboard is one of major panels which are produced in Iran. Production of particleboard is growing at present in quality and quantity. With respect to the statistics of formal organizations the production of the paned is fast growing in past decade. Most of the consumption is in constructional panels. Table 1 shows situation of Iranian particleboard panels market.

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Table1. The amount of import, export and consumption in particleboard production in Iran from 1997 to 2007

Year	Production (m^3)	Import (m^3)	Export (m^3)	Consumption (m^3)	Population	Per capita consumption (m^3)
1997	382322	1403	1383	369842	60937000	0.006069
1998	420646	1915	9916	412645	61831000	0.006674
1999	439716	1153	9963.30	430905	62738000	0.006868
2000	409460	130	13374	396216	63658000	0.006224
2001	487774	1553	9752	490575	64528000	0.007603
2002	488542	69035	10265	547312	65540000	0.008351
2003	500947	47876	7898.90	540924	66480000	0.008137
2004	591289	33475	13100	611664	67477000	0.009065
2005	580117	11311	16510	574918	68467000	0.008397
2006	637941	9247	32056	615132	70495000	0.008726
2007	718003	18532	39275	697260	71721000	0.009722

Notes: The data were from Ministry of mines & industries and Statistics organization

The Particleboard production in 2007 amounted to 718003 m^3 and dominated over the wood panels' production in Iran. As shown in Table 1, the particleboard production in Iran increased by 87.8% from 1997 (382 322 m^3) to 2007 (718003 m^3), increased by 18% from 2003 to 2004, and has a slight decrease in 2005 due to national economic conditions. The import of particleboard in Iran showed a continued increase trend throughout the 1990s but had a decline by the end of the decade. The export of particleboard increased during the first half of the 1990s. In 2006, 5.02 % of total particleboard production in Iran was exported to the following countries: 66% in volume was exported to Iraq, 18% to Turkmenistan, 7% to Tajikistan, 6% to Afghanistan, and 3% to other countries. Also in the same period, per capita consumption of particleboard in Iran increased by 60% and population increased by 17.7. Increasing past decade consumption in particleboard leads to consider quality specifications of the panel product. With respect to above mentioned acknowledgment of the major units which produce particleboard panels according to market share, competition and quality of their products is necessary until the investors and manufacturers help to develop of the industry and response to market requirements. There are 17 particleboards units in the country, which are 10, 3, 2 and 2 in the North, Northwest, Center and south of Iran respectively. In current research we did three steps to reach the goal. First we determine major criteria which effect on specification of particleboard product; we selected 5 of them with respect to experts of Institute of standards and industrial research of Iran. The attributes considered most relevant from the expert's aspects are (1) moisture percent, (2) density, (3) thickness swilling percent (4) water absorption percent, (5) bending strength. Institute of standards and industrial research of Iran in number of 2496 consider national standard for16 millimeter thickness particleboard (Cellulose and packaging research group, 2002). In subsection of this part, numbers of 814, 813, 2489, 2488 and 2332 are related to moisture percent; density; thickness swilling percent; water absorption percent and bending strength respectively. Second step three levels of intensities have been evaluated for each of the criteria: high (H), medium (M) and low (L) (figure 1). Third step we extracted 5 of the units which are included A, B, C, D and E units which are in Gorgan, Ghaemshahr, Gorgan, Ghazvin and Neka cities respectively, and then obtained specification of the panels with respect to information of Institute of standards and industrial research of Iran. Specifications of the products for 5 units have been showed in table 2.

Table 2: Specification of particleboard panels

Criteria	A	B	C	D	E	Standard range	Overall range
Humidity (%)	6.55	8	6.4	6	6.7	6-8	6-8
Density(g/cm^3)	0.71	0.72	0.74	0.8	0.797	0.6-0.8	0.6-0.8
Thickness swilling (%)	10.5	10.16	12	6.65	23	12	6.65-23
Water absorption (%)	42	25	55	25	75	50	25-75
Bending strength(kg/cm^2)	180	195	178	210	162	160	160-210

Notes: The data were from Iranian industrial researches and standard organization

These units have been selected because distribution and location of the units were suitable and most of the units located in the North of Iran (13 units of the total),
To select the best particleboard, AHP method was applied. This method was first invented by Thomas L. Saaty in 1970s, and it is used in decision making processes which have qualitative and quantitative criteria (Saaty, 2000). For selecting the best facial tissue with respect to customer's perspective, AHP has been applied, the results showed Softlan (C) product has highest priority after that, Cheshmak (B) and Narmeh (A) products have second and third priority respectively (Azizi and Noori, 2007). Azizi (2008) used AHP method to determine effective criteria for location selection of wood composite units in Khuzestan province and also obtained the highest priority city. Alkaner and Das (2008) indicated a framework for selection of optimum technology alternative within the context of generic ship dismantling facility development. Selection of technology alternative which can be used based on set of criteria identified under health and safety, environmental, financial, internal and external factors. In this research AHP has been applied to solve the problem. Feglar (2008) developed AHP model that allows comparison of public based project management with other two private based project management system. Azizi (2005) applied AHP to determine effective criteria for selecting the best choice of raw material procurement in paper making factories in Iran. The decision has been done with base on benefits, costs, opportunities and risks. The results showed No harmful on environment has the highest priority in terms of benefits.

2. Research method

2.1. Features of the criteria influences the particleboard selection

1. Moisture percent: with respect to standard number 814, precision of measurement to determine moisture percent of the product is 0.1 percent and range of the moisture is 0.6-0.8 percent. Moisture content has been calculated via moisture content's arithmetical means of all of the related test samples.

2. Density: with respect to standard number 813 density measurement range of the product is 0.6-0.8 g/cm^2. Precision of density measurement is 0.01 g/cm^2

3. Thickness swilling percent: according to standard number 2489, with based on floatation of the sample in water 20±2 temperature and dimension of the sample 100*200 mm^2, variation of the thickness is 12 percent after 2 hour floating.

4. Water absorption percent: according to standard number 2488, with based on floatation of the sample in distilled water 20±2 temperature, after 2 hour, the weight of the water

absorption percent with relation to dry position is measured. According to standard water absorption percent is 50 percent.

5. Bending strength: according to standard number 2332, bending strength is measured and limitation of the strength 160 kg/ cm^2 is defined.

2.2. The problem of selecting the product with the greatest overall manufacturer's preference is solved in the following manner:

Step 1: Determine manufacturer's preference among the attributes by developing a matrix that compares attributes in pairs with respect to product desirability.

Step 2: Determine manufacturer's preference among the intensities of the attributes by developing five matrices that compare intensity levels in pairs with respect to each attribute.
 Now we want to synthesize these judgments to obtain the set of overall priorities that will indicate which product manufacture prefer. The remaining steps take us through this process:

 Step 3: Group the priorities of the intensities (H, M, and L) for each of the 5 attribute in columns and enter the priorities of the attributes. Then multiply each column by the priority of the corresponding attribute to obtain the weighted vectors of priority for the intensities (figure 2).

Step 4: Now select from each column the element with the highest priority to obtain the vector of desired attribute intensities (figure 2):
H- Moisture percent   H- Density   L- Thickness swilling   L- Water absorption H- Bending strength
Then add this row and divide each entry by the total to get the normalized vector of desired attribute intensities.

Step 5: Determine the perceived product standings by developing matrices that compare the five particleboard panels (A, B, C, E and D) in pairs with respect to the most desired attribute intensities (attachments 1-5).

Step 6: Group the priorities of the panels with respect to each desired attributes intensity in columns and enters the normalized priorities above the columns.
Then multiply each column by the normalized priority of the corresponding attribute intensity to obtain the weighted vectors of priority for the desired attribute intensities for each panel (attachments 6-10)

Step 7: Add each of the five rows to obtain the overall priorities of the five panels (fighure3).
Step 8: Sensitivity analysis (figure4).

2.3. Analytical Hierarchy Process

AHP is a method for decision-making by which we can make some decisions which are dependant on several criteria or multi-criteria decisions. By AHP method, first the given structure and then the criteria relevant to decision making are compared to each other and then the priority rate of each one are determined. Numbers which are used in two-by-two comparison are from 1 ÷ 9 to 9 which is in the form of a standard scale (Saaty, 2000). Advantages of the Analytic Hierarchy Process:
1)   Breaks criteria into manage – able components. 2) Leads a group into making a specific decision for consensus or tradeoff. 3) Provides opportunity to examine disagreements and stimulate discussion and opinion. 4) Offers opportunity to change criteria, modify judgments. 5) Forces one to face the entire problem at once. 6) Offers an actual measurement system, it enables one to estimate relative magnitudes and derive ratio scale priorities accurately. 7) It organizes, prioritizes and synthesizes complexity within a rational

framework. 8) Interprets experience in a relevant way without reliance on a black box technique like a utility function. 9) Makes it possible to deal with conflicts in perception and judgment (Saaty, 2000). The resulting hierarchy is shown in Figure 1.
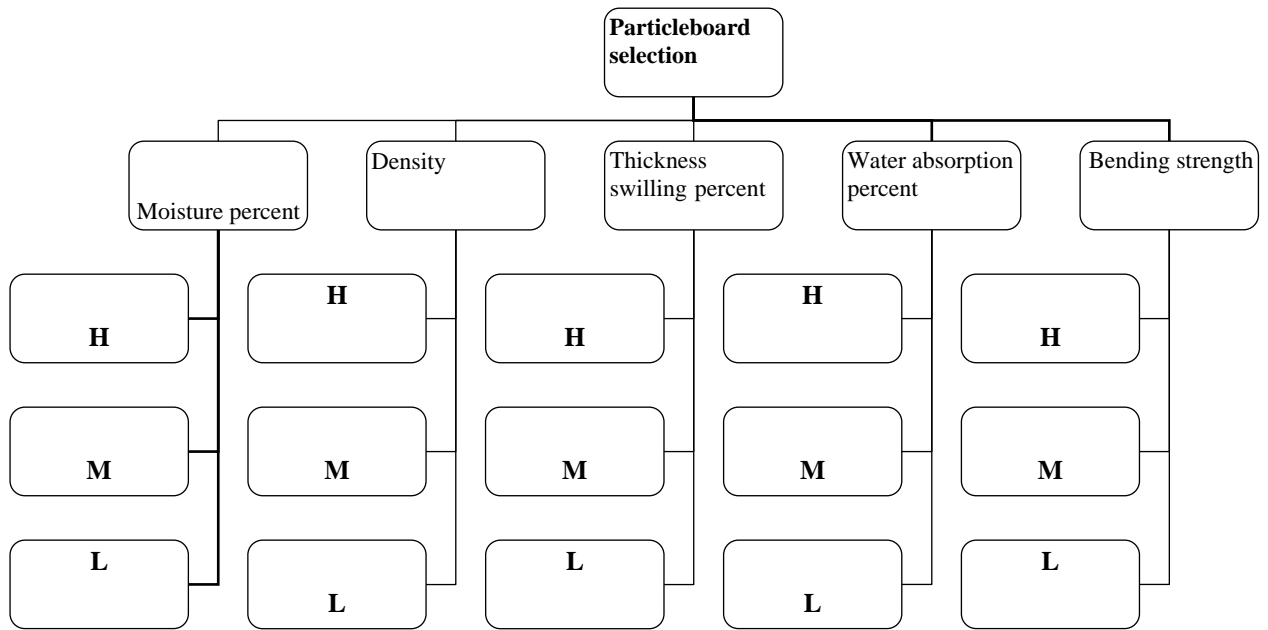

Figure 1: Hierarchy of effective criteria for particleboard product (H: high intensity, M: medium intensity, L: low intensity)

3. Results

Weighting values of the effective criteria, their intensities , the alternatives and sensitivity analysis is put forward here as results of group decision making by a group of the experts with the aid of Expert Choice Software, 2000 (Figures 2,3 and 4).
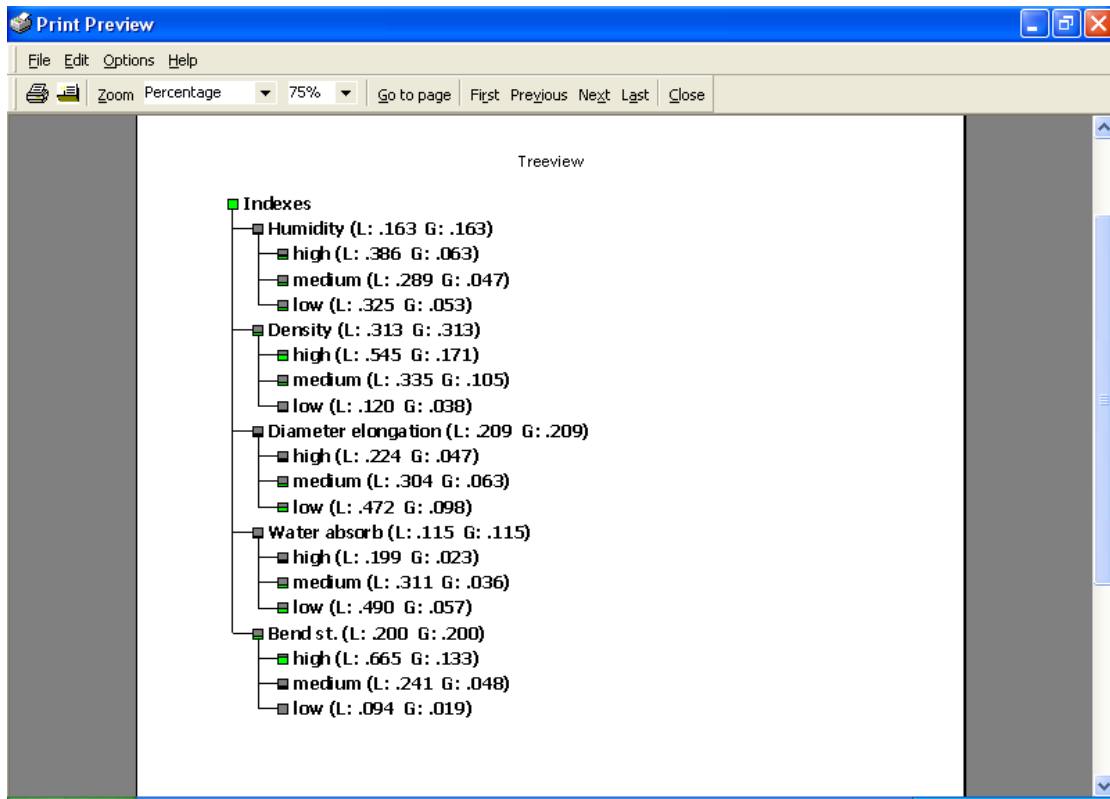
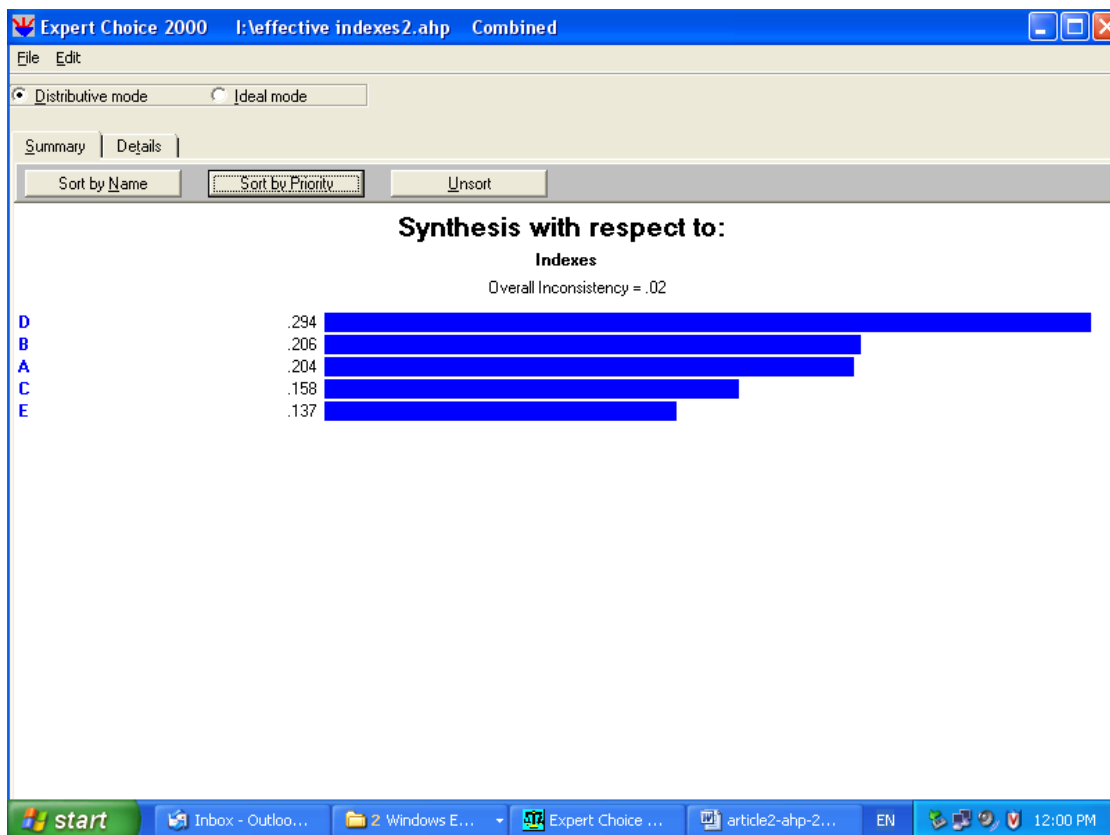Figure 2: Result of weighing values of criteria and their intensities
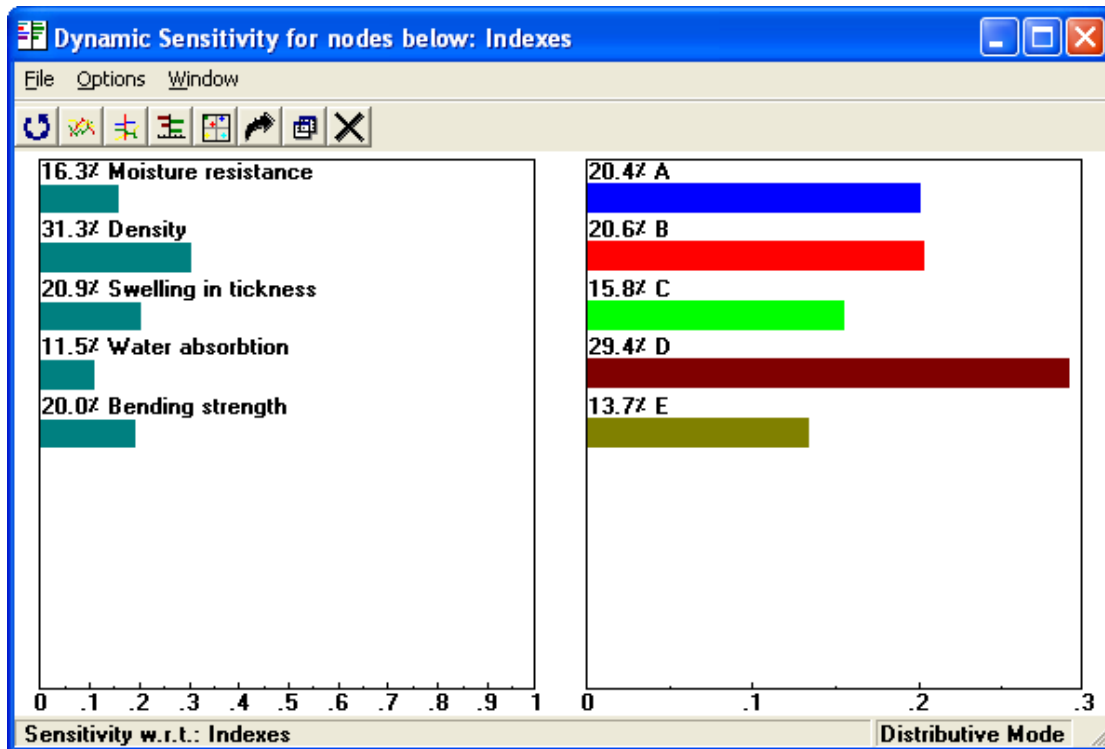

Figure 3: Final outcome

Figure 4: Sensitivity analysis with respect to basic result

4. Discussion and conclusion

With respect to t figure2, density has 0.313 weighing value which is the highest priority for the particleboard and overall consistency ratio of the current research is 0.02. Density of the product is one of the major criterion which has influences on water absorption, dimension swilling, bending resistance and internal adhesive. Also the producers trend to produce high intensity density of particleboard in comparison with other intensities (figure 2). Thickness swilling has the second priority (0.209). Value of thickness swilling of the board specified after 2 hour in floating which is special for using of particleboard. In the markets, particleboard products which have high thickness swilling percent are inappropriate boards and indicate undesirable production situation with regard to raw material density and press conditions. The panels with low intensity of thickness swilling have higher priority. Bending strength of particleboard has third priority (0.200), otherwise, the boards which have desirable production situation with respect to raw material and press condition, will have high bending strength. In particleboard bending strength has high sensitivity. With respect to the results bending strength with high intensity is preferable. The humidity percent has forth priority (0.163); it depends on press temperature, dryer conditions and environment humidity. Humidity of the particleboard has to check up after press and dryer, because humidity of the board influences on density, bending strength, color and so on. The panels with high intensity of moisture percent have higher priority. Water absorption percent has least priority (0.115) in comparison with other criteria. With respect to standard measurements, the boards are floating, during of the test, but there is not similar situation in case of furniture and construction panels as well as water absorption impressed by density, press condition, glue and additive material. With respect to the results the panels with low intensity of water absorption are preferable. For improving of the panels quality and procurement of market requirements we evaluated five particleboard panels in Iran with respect to manufacturer' aspects in titles of A, B, C, D and E. The research is based on criteria intensities. According to the final result panels D, B, A, C and E have 0.294, 0.206, 0.204, 0.158 and 0.137 weighing

values, respectively (figure 3). Accordingly panel D has the highest priority in comparison with other panels. According to criteria intensities of thickness swilling /l, water absorption/l and bending strength/h panel D has highest priority. Also with respect to specification of particleboard panels according to data of Institute of standards and industrial research of Iran, Panel D has the best conditions with regard to thickness swilling (6.65), water absorption (25) and bending strength (210) which indicates derived scale based on the judgments and the actual relative weights are compatible (table 2). Difference of weighing value between panel D and second priority is high with regard to thickness swilling (0.143), water absorption (0.016) and bending strength (0.116), which influences the final priority. Also with regard to weighing values of moisture percent and density intensities there is very low difference between panels D and A as first and third priorities.

5. Sensitivity analysis

Since there may be different judgments on the comparison of priority rates of the criteria or their sub-criteria, to achieve stability and compatibility of the analysis, we apply sensitivity analysis (Saaty, 2001). Regarding the findings of criteria hierarchy, we find out that the ratios of the alternatives could change by increasing or decreasing one of the criteria. With respect to the results (table 3) all of the criteria are sensitive. Moisture percent and density are more sensitive than other criteria. Changes in alternatives priorities are four and three times with respect to changes of moisture percent and density' weighing values, respectively.

Table 3: Sensitivity analysis results (basic priority: D-B-A-C-E)

Criteria	Basic weight	New weight	New priority	Changes times
Moisture percent	0.163	0.208	D-A-B-C-E	4
		0.622	D-A-C-B-E	
		0.723	D-A-C-E-B	
		0.993	A-D-C-E-B	
Density	0.313	0.678	D-A-B-C-E	3
		0.812	D-A-B-E-C	
		0.985	A-D-B-E-C	
Thickness swilling	0.209	0.265	D-A-B-C-E	2
		0.805	D-A-B-E-C	
Water absorption	0.115	0.082	D-A-B-C-E	2
		0.877	D-B-A-E-C	
Bending strength	0.2	0.157	D-A-B-C-E	2
		0.958	D-B-C-A-E	

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