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Research Article

STUDY AND ATTAINING AT MODERN WOODEN RECYCLED BODIES BY USING RECYCLED AND NATURAL GUM (FOR APPLYING IN CREATING ARTISTIC WORKS AND REPAIRMEN THE OBJECTS)

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ABSTRACT
With regard that every day significant amounts of wooden waste are produced in the world while creating artistic works and since returning the wasted materials into the production cycle in the different fields is one of the modern challenge in preventing the waste of present natural resources and on the other hand, using the natural materials in creating and repairing the objects is one of the concerns of present artists, then it can be asked whether the waste wooden materials can be used in creating and repairing the artistic and applied objects. In answering this question, various issues including wood recycling history and its methods, recognizing any kinds of recycling materials and their capability, recognizing the natural and recycling additives for creating the coherence and resistance in the body of the works are studied**.** In this study, data was collected in descriptive and experimental way and the results have been presented through the tables and diagrams. The aim of the present study is to delineate the way and to attain at fully natural bodies from the waste of the wood by using the least harmful chemicals for using the artists, craftsmen and investigators toward production and repairmen of artistic-applied by recycling the wood in handicrafts, sculpture, external and internal area architecture, repair, etc, in which after doing the studies, fourteen body types with different capabilities were obtained whose capabilities including special paste and final body weight, granularity of the body, shrinkage extent, etc, have been introduced in the separate tables.

Keywords*: Recycling, Wooden Recycling Bodies, Various Kinds of Gum, Natural Gum, Recycling Gum*

INTRODUCTION
Environment is a gift from God for human-being and its protection, maintenance and restoration is an important task for all human-beings. Beside preserving the health of the man, protecting the environment results **in** benefiting from the available endowment in the nature. Then, protecting the environment I necessary- using the recycling methods is one of the guidelines for its maintenance and restoration.

Figure 1: Produce the vats with dimensions 45.50.50 (cm) by houshang fathi with the bodies produced from the precedent investigation

Since every day significant amount of wooden waste are produced during building the artistic and applied works (Kashani, 2004) and also wood-cutting and cover-making factories produce about 30% and 50% of the waste materials (Hesse and Amiri), respectively, and this practice is repeated in artistic and applied wooden work, then it is necessary for the artist and craftsmen of this field to find the ways for recycling these materials**.**

Of course, it should be noted that these wooden wastes are used for producing pressboard and MDF in Iran and other countries' industry, resulting in producing flat and plate films with determined dimensions for producing the works which have been considered as flat works and also for producing sculpture, pot, profile, etc, till now, these materials have been widely and practically used for repairing the work (figure 1).

Of course, today the samples called plastic wood are also available in the market which are produced from integrating the polymer materials and chemical resins into wood particles and other cellulose material and mostly are used in furniture industry, creating texture free surface and visual quality of the wood and finally uniform laminar color covers these products. It should be said that in producing these products, pressboard and MDF, resin and chemical gum in class isosionate are used which are harmful for the health (Taremian and Dosthoseini, 2005) and result in some respiratory problems (Suchsland and Woodson, 1992). Therefore, using the wooden recycling materials for producing artistic and applied works with natural gum is necessary.

Questions of this investigation about producing and repairing artistic and applied works by recycling the wood are as the following: what are the wooden recycling materials? What are their capabilities and properties? Since these materials need gums and additives for attaining at the bodies (Body means dried and fixed product resulting a combination of recycling material with sticky transforming materials) or repairing the wooden works, which gum should be used? Is the natural gum applicable?

With regard to this fact that using these materials requires the knowledge about the history of wooden recycling works and the available methods, wooden wastes, any kinds of wood, any kinds of gum and primary paste (Recycling paste is a humid flexible product resulting a combination of recycling material with sticky transforming materials) transforming material, then in this paper it is tried to present some data about the ingredients of recycling bodies. In fact, it should be noted that in this study just the ingredients of recycling bodies, manner of their integration and production along with their properties and capabilities.

MATERIALS AND METHODS

Method

The method of investigation is applied- theoretical and has been studied in descriptive-practical method. Study type is library and laboratory and the data was gathered based on the information obtained from study tools including interview, network, observation and laboratory. Samples produced in this investigation have been produced for doing the tests as resistance measurement and resistance against stroke in recycling bodies by using 2.2.28 moulds and for testing the stiffness 1.8*7.5*7.5 moulds have been used.

Finally and after comprehensive explanation of each group, 14 produced paste types have been studied for testing and recognizing the capabilities of different bodies. It should be noted that for assuring the results of the tests, 12 samples were produced for testing (For additional information refer to “wood technology”, 2011.written by Parsa pajooh, p: 106-112 hardness test with Brinell way, resistancy against stroke with toughness way and resistancy against pressure with astem way). Mean and tolerance of the results are finally presented.

History of Wood Application and Summary of its Recycling

Wood is among the first materials exploited by the mankind, tree crust was probably the first pot the mankind used for drinking the water. According to the archeological documentations, along the rivers of Europe and specially Robenhausen River in Germany, some houses have been found whose architecture basis was on using the wood of trees (Hesse and Amiri).

According to the discoveries and investigation, role of wood in preserving and developing of man civilization seems so significant. When we studied the works available in Altone museum in Hamburg and also Natural science Museum in London showing revolution end exploration of wooden tools in the mankind life, we found that producing most applied objects of mankind wasn't possible without considering this applied material and one of the important hunting tools before the metals was wooden spear whose sample is available in Natural Science Museum of London and belongs to 10000 years ago when the man didn't found the metals, yet after that with regard to the capabilities of this material, producing the tools from it is inevitable. Boat sample come back 5000 years ago is also kept in this museum (Hesse and Amiri)**.**

Art and wooden industry revolution in Egypt in Third millennium are among more recent case. About the ancient kingship, a sample of applying the wood in making applied artistic works for accompanying the king in the spirits world is found. Famous wooden sculpture Sheikh-el-balad has been obtained from a grave in Saghare and now is stored in Ghahere museum. Of course, besides the mentioned cases and using the wood in fretwork and wooden volume, we see some developed cases of applying wood and wooden cover in Egypt including Toot Anakh Amoon coffin, famous Egyptian Pharon.

In Rom Empire, this material and its capabilities have been employed in so extent that we observe wooden covered works in ancient Rom and it is interesting that Roman have exploited beautiful designs near the ring and roots of the trees for making the cover. These samples implies prevention from wasting this valuable material whose maturity and productivity takes many years.

Traditional method of using wood and its productivity continued until 1808 when the first bet-pulley saw was used in England, then new age in wood industry is emerged following it, increasing wood industry productions and decreasing the resources of this valuable material and increasing the amount of the wastes, elevating man's expectation from the life, productivity demand of wood and its wastes toward preserving the environment is occurred. wastes of wood are recycling in a slow pace in eighty recent years and in higher pace from 2002 than before and the wastes which were consumed for fuel in the past, today is used in MDF and pressboard manufacturing factories (Kashani, 2004).

Some artists in European countries have benefited from sawdust paste complex for creating the artworks including bench (Lefteri, 2003). It should be noted that the works made by these artists are mostly experimental, have limited gum sample and lack required studies in practical perspective, also in these studies, there hasn't done any accurate research and test about the complex of various wood particles and different gums, this can be extended to repair discussion and by comprehensive describing the usable wastes in structuring and repair sections and also any kinds of natural gums and transforming material, it has been tried to obtain and present desirable bodies applicable in various steps of wood repair and also in term of the repairer's needs. It is obvious that coincide with the need to repair the wooden goods, their repair and maintenance has been performed and most wooden works are repaired by using these same wooden waste and various gums. In this paper, it has been tried to present some known and fundamental complexes for repairing the wooden works with regard to the need and application of the materials, serving as a guideline for the repairers to choose accurately the suitable body complex for wood repair.

Recognizing the materials Apoplied in wooden recycling bodies: For desirable producing and repairing a n artistic and applied work, recognizing the materials is a major issue, then it is required to first study the paste and ingredients of the body before making wooden recycling objects. Ingredients of recycled paste are divided into three major groups including basic materials, connecting materials and transforming materials. Each group has its own subsets whose increase or decrease is influential in the properties or capabilities of the obtained paste**.**

Basic Materials

This group includes the materials which are the major ingredient and basis of wooden recycled paste. These materials have wooden texture and are produced from various methods from cutting the trees in the forest to making the artistic or non-artistic works in the big and large workshops through polishing, cutting, planning and crushing. These materials include sawdust and straw which are named based on production origin, dimension and size (Hesse and Amiri)**.** Common clustering of these materials is based

on appearance shape (size and granuality), in turn depends on the manner of production of these wastes. Generally, wastes made from sawing are called granules and the second one is called wool wood.

Finally, three groups are coded D1 to D3, where sample coded D1 has granules, one in D2 has the combination of granules and wool wood and one in D3 has wood wool granules. For obtaining some information about special weight and the manner of granularity of each group, refer to table 1-1. It should be noted that the size and granules of the particles for finer particles than 0.1mm have been measured by using micro-meter and for courser ones by using caliper and micrometer.

Table 1-1: Compare the special weight (The formula to special weight is $D = \frac{W}{V} = \frac{weight}{volume}$) of sawdust (granule) and grater with different non-gum granularity

Granularity code	Particle type	Particle granularity (millimeter)	Tested sample cm^2	Particle weight gr	Special weight of particle $\frac{gr}{cm^2}$	average special weight of basic materials $\frac{gr}{cm^2}$
D1	Granules	0.05 to0.5	1000	320	0.32	0.5
D2	30:70 complex of granules to grater dust	1*0.5*0.05 and 00.05to0.5	1000	290	0.29	0.5
D3	Grater dust	3*0.5*25	1000	250	0.25	0.5

***Source**: by writer*

The reason of classification of the granules based on special weight is that by limiting the granularity into three mentioned groups, we obtain the relationship between the granularity of the basic materials and such factors as body weight, flexibility, amount of the consumed gum for the determined amount of granule(sawdust), duration of drying the body with different granularities, extent of crack, extent of spin, extent of resistance to stroke, resistance to pressure and body stiffness which are used both in building the recycled bodies and in repairing the objects.

Granules

Among the most used materials in making the recycled bodies, we can refer to granules. it is produced during the processes including cutting, sawing and polishing, the products resulted from this operation usually include micro-granules having 0.005 to 0.5 mm diameter and 0.32gr/cm2 weight **(**Special weight shows 320 grams of wood granule placing in 1000 cm^3 space**).**

It is recommended to use granules for building smaller bodies (Hesse and Amiri), for example 25-30cm^3, first because the fine granules exists, it is possible to build the body wall as finesse as 2mm. second, because having micro-granularity, granules has

More flexibility than wool wood and in repairing the pores existing in the wood, this same granularity is employed. From the primary results of Table 1-1, it is clear that courser particles have less weight for filling the known area, showing less particles in this volume, less connection between the particles and more porous area and finally attaining at lighter body than finer granularity.

Shaving

These particles normally are produced from wood-cutting factories and furniture-producing workshops, have different dimensions which are able to flex and spin, can be used for making wood paste and are suitable for recycling bodies. Dimensions used for producing the paste include fibers 0.5to 25 in length, 0.1 to 1mm in thickness and 1-3 in width (Hesse and Amiri)**.** Bigger fibers are recommended for making bigger volumes than 100cm^3 because they don't easily flex and spin. As the samples studied in this paper

aren't bigger than 100cm^3, it is adequate to just examine the capabilities of these same samples presented in table.1.

Connecting Materials

These materials connect the ingredients of wood paste and are the most important factor in making the body firm. Then it is necessary for them to smoothly cover the particles surface so that a strong and firm connection is created. It should be noted that while using course granularity, gum should encompass all sides of wood wools because with regard to this fact that wood wools are produced parallel to wood fibers, they are susceptible to fold and this results in such problems as non-accessibility of some parts of wood wool for sticking process.

From ancient years, gum has been used for connecting the parts first as herbal and animal gums and then from century 17, consumption of wood gum for producing multifold board became common. This prevalence was more obvious for building ships and multifold boards during first and Second World War and industrialization. Among the common usages of wood paste, pressboard and MDF can be indicated. Connectors are classified into three groups: mineral connectors, mineral organic connectors and artificial organic connectors (Hesse and Amiri)**.** Forth group is added as "recycled organic connectors" by the writer himself, in the following we discuss about used samples of this group. For obtain some information about the clustering of the pastes (gum), refer to

Table 2: Clustering of different pastes based on the origin of production

Origin of production	**Mineral pastes**	**Natural organic pastes**		**Artificial organic pastes**		**Recycled organic pastes**
		Herbal organic pastes	Animal organic pastes	Thermoplastic	Thermosetting	
Pastes types	Silicates (sodium silicate)	Starch paste Herbal paste Arabic resin tannin past caoutchouc	Gelatin fish glue, albumin paste, casein paste, cartilaginous glue	Cellulose pastes, polyvenilic pastes, caoutchouc pastes	Phenol: Phenol-formaldehyde resin formaldehyde Amino plus: melamine formaldehyde Urea-formaldehyde	polystyrene paste

Source: *by writer*

Natural Organic Connector

These connectors include herbal and animal pastes. Herbal organic pastes are obtained from such plants as potato, wheat, rice, corn, soybean and false acacia. Animal pastes are obtained from various parts of animal body including cartilage, liver, marrow and blood. In this investigation, natural herbal organic pastes have been used. After doing the tests and making primary samples by animal pastes, because of the different problems resulted from them in producing artistic works, animal pastes were excluded from the study.

Herbal Pastes Employed in this Invertigation

From the mentioned herbal pastes in table.2, starch paste and herbal glue are most consumed ones.

Starch: Starch is obtained from heating root, bulb, fruit and other parts of such plants as rice, wheat, corn and potato and generally is marketed as course and fine particles or as powder. Its other name is gluten and is the major carbohydrate obtained from the plants (Hejazi, 1985)**.**

The preparation and production method of this paste is as the following: first 1litre cold water is poured into a dish, then gradually 10-15% starch is added to it, this procedure should be performed gradually while stirring to prevent the starch from conglomerating. Then, dish is heated in mild temperature and while baking, mixture should be blended. Primary color of the solution is white but as it bakes, it is color changes to dark gray and has gelatin state. In this step, paste is ready and should be taken from the oven. When the temperature of paste reaches at 20-30˚, it can be used. For assuring its smoothness, it should be screened to remove any course granules and finally uniform paste is produced. Advantage of using this paste is its low price relative to the artificial pastes and easy production in different concentration and sticking the parts by using cold press without the need to heating apparatus. Other advantage is its longer consumption period before fermentation, normally after 3-4 days it doesn't mould and for extending this period, 5-10%glycerine can be added to it. It is recommended to use artificial organic connectors such as polyvinyl as 30-50% for enhancing this paste. Also transforming agents presented in tables3 and 5 can be used for enhancing these pastes.

Herbal Paste

This herbal paste is produced from root and rhizome of a flowered plant from liliaceous species. It smells sweet and is easily solved in the water. This material also should gradually add to water to prevent it from glomeration (Hejazi, 1985).

For providing suitable glue for producing recycled herbal paste, 1litre water should be mixed with 8-15% glue, this herbal paste has the ability to solve basic materials with D_1 granularity to 3.5 times and with D_1 to 4.5 times the weight of its glue. Advantages of using this herbal paste are easy and rapid production, one of its capability is to adjust the amount of Fluidity by using more or less water. One of its disadvantage is its short storage period because it begins fermentation 12-14h after the production, then it shouldn't be used in building the bodies unless the body is thin or transforming agents are used in the body to prevent the body from herbal paste decay.

Artificial Organic Connectors

Artificial organic pastes are polymers composed of artificial organic materials. Polymers refer to the materials constructed from various and too many molecules and they are connected through media. The most common media in the ingredients of artificial organic pastes in ethylene.

Polyvinil Acetate

This paste is known as PVA and its ingredients include vinyl and acetate which are obtained from the reaction between acetylene and acetic acid in vicinity of catalysts. Elementary sample of this paste entitled vinyl acetate has been invented by Klat P.H.D in 1912 (Sadr, 2009). This paste is in soft heat paste group and in 60˚ its firmness decreases and moves toward being soft. This is true also in vicinity of the water too but its firmness is relatively high in dry state. Its advantage are easy access to it, its high firmness and resistant recycled paste, high resistance capability in comparison to combination with natural pastes including starch and glue (Hesse and Amiri). One of its disadvantages is that when it is used in recycled paste in the thick bodies, drying process is delayed because paste is dried in the layer on the body and preventing air entry and exit, in this situation, middle layer is slowly dried and in some cases, more than 100-300h is needed for primary drying.

Yellow Foam

Other consumed paste is in artificial organic paste group which is delivered to the consumers as spray. This spray is produced and supplied in the packages containing 750 and 800ml. special weight of these foams is 0.1 to 0.2 gr^2/cm^2. Of the properties and advantages of this paste is using the buffing and volume-increasing agents.

Different puffing agents are used in these sprays and in the new sample, it has been tried to use the agents less damaging the environment and some rules are established in this respect. Puffing agents are the agents which produce co_2 and N_2 in the vicinity of the air, resulting in bubble formation in the foam body and increase in the produced body, one of the advantage of this foam is resistance against liquids, this foam is used as heat and moisture insulator, but in the present study it is used as connector in the body paste. Other advantages are its low special weight, finally resulting in light body weight and short drying

duration to 20-30min. Its disadvantages include expensiveness, small amount of the paste in each can, low solubility. Then, the body produced from these foams takes higher cost than the other ones.

Recycled Connectors

This pasties produced by using the complex of benzene and polystyrene. It is produced from polystyrene wastes which are very light material and account to majority of household and industrial wastes, it can easily be produced by combining with small amount of benzene (gasoline).

The production process is as the following: 1litre benzene is poured in a dish and cleaned particle of polystyrene are placed into it, these particle are easily solved in the gasoline, study and observe the solution show that the paste has been divided into two phase as pink and pink-white or upstream dilute phase and downstream dense phase, in this state polystyrene addition should be continued so that two phases are transformed to a smooth and homogenous solution, then the paste is ready.

Polystyrene: gasoline weight is normally 65:70%. Its advantages include easy, rapid and low-cost production, resulting in polystyrene recycling and the resulted paste has high resistance against the liquids. Other advantage is rapid stick, resulting in 3-5% lower stick time than artificial and herbal organic pastes**.**

Its disadvantages include high special weight, leading to heavy produced works. Because its solvent is gasoline, its contact with the skin and respiration should be avoided. It is recommended to necessarily use mask and gloves. Finally it is required to refer to each paste: solute ratio and also solubility of each paste in table.3. Studying this table, we can obtain accurate concentration and amount of consumed paste for determined amount of granules.

Table 3: Study the relationship between paste, solvent and critical concentration of solubility (The critical concentration of the soluble amount of sawdust code D2 (in this experiment) is 100 g glue)

Paste name	Critical concentration of granules	Paste:solvent percent	Solvent
1-strach	22-26%	10-15%	water
2-herbal paste	23-28%	8-15%	water
3-Polyvinylacetate	25-28%	50-60%	water
4-iolofoam	12-15%	---	---
5-ionolite paste	28-34%	65-75%	Gasoline(benzene)

Source: by writer

Transforming Materials

Transforming materials are those which improve or change the physical and chemical properties of the recycled paste. For obtaining accurate information in this respect, table04 has been designed. It should be noted that these materials are considered as secondary materials and without them, recycled bodies can be produced, but for improving the quality of the products and enhancing or weakening some properties, it is recommended to exploit these materials.

Table 4: Transforming materials and their effect on the pastes

Material name	Source	Effect of consumption
Glycerin	Tested	Keeping the paste humid, preventing the body paste from cracking, elevating coherence extent, stiffness improvement, resistance against stroke and body pressure. Darkening the body color, accelerating the drying duration as 3-5%
borax	(Wilkinson *et al.*, 2008)	Prevent the starch paste from fermentation
Formaldehyde	(Wilkinson *et al.*, 2008)	Prevent the starch paste from fermentation
ammonium chloride	(Wilkinson *et al.*, 2008)	Increase the stick of the paste in the short time
Hexamine	(Wilkinson *et al.*, 2008)	Stability and durability of the paste
Mole	Tested	Fuller, brightening the produced paste, elevating the special weight of the paste and preventing from crack
Bicarbonate of soda	Tested	Puffing and increasing the volume, lightening the body by creating bubblers, delay in fire, resistance against stroke and pressure
Sodium hydroxide	Tested	Puffing and increasing the volume, delay in combustion, elevating stick property, accelerating the drying, resistance against water penetration
sodium trichlorfonate	Tested and (Wilkinson *et al.*, 2008)	Preventing the paste specially glue from decay
Citric acid	(Wilkinson *et al.*, 2008) and (Hesse and Amiri)	Accelerating the drying duration to 507%
Calcium Sulfate	Tested and (Wilkinson *et al.*, 2008)	Elevating the special weight of the body, fuller the pores of the body, accelerating the drying duration up to 2-6%
Calcium oxide	Tested and (Wilkinson *et al.*, 2008)	Puffing, accelerating the drying duration up to2-6%, elevating the special weight and resistance against water penetration in combination to soda
Shot concrete	Tested	Increasing the drying duration up to 2-4%, increasing the special weight of the body.

Source: *by writer*

Study the Recycled Producted Bodies

After introducing the required materials for making yeast and recycled bodies and performing different tests on these materials, it was necessary to present the behavior and properties of the bodies in a table. In this table, samples combined with granularities presented in table.1, connectors presented in table3 and finally transforming materials presented in table.4 have been made and tested. As mentioned before, out of each tested sample, 12 bodies were made for testing and were tested, figures in table.5 represent the mean and tolerance**.**

Table 5: Introducing the properties of the produced bodies

Body code	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**	**N9**	**N10**	**S**	**BE**	**POV**	**Y**
Granularity of the body	**D2**	**D1**	**D3**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
Special weight of the paste gr/cm^2	1/16	1/23	1/13	1/25	1/19	1/25	1/17	1/25	1/25	1/33	1/17	1/03	1/1	0/61
Special weight of the body $\frac{gr}{cm^2}$	0/33	0/36	0/31	0/35	0/36	0/5	0/34	0/37	0/43	0/49	0/34	0/58	0/61	0/082
Drying rate in first 4hours in 25-35˚	4-5%	3/5-4/5%	5-7%	4-5%	5-6%	4-5%	9-7%	5-6%	6-8%	6-8%	5-7%	7-9%	5-6%	100%
Drying rate after first 4hours in 25-35˚	1-3%	1-1/5%	2-3%	1-2%	2-3%	1-2%	2-3%	2-3%	2-3%	2-3%	2-3%	2-4%	2-3%	------
Drying rate in first 4hours in 35-45˚	6-7%	5-6%	8-9%	6-7%	7-10%	6-8%	10-15%	5-7%	8-10%	8-10%	8-9%	9-11%	6-7%	100%
Drying rate after first 4hours in 35-45˚	2-3%	1/5-2/5%	2-3%	2/5-3/5%	2-3%	3-4%	4-5%	4-5%	4-5%	2-3/5%	3-4%	3-4%	2-3%	-----
Drying rate in first 4hours in 55-60˚	12-19%	10-17%	12-20%	12-19%	14-19%	14-19%	14-19%	14-19%	12-20%	12-20%	12-20%	12-19%	8-14%	100%
Drying rate after first 4hours in 55060˚	6-8%	5-8%	6-8%	6-8%	6-8%	6-8%	6-8%	6-8%	7-9%	7-9%	6-8%	8-10%	6-7%	----
Transforming material	-----	-----	-----	0/5-2%Caustic soda	1-3%glycerol	10% mel	5-10%citric acid	10%Concrete Shot	10% Acetic acid	%10chalk	------	------	------	-----

Stiffness	1.13	2.6	0.8	3.4	1.7	1.4	1.08	2.1	2.3	3.3	0.8	0.5	0.9	0.01
Resistance against stroke	0.25	0.3	0.2	0.9	0.7	0.75	0.4	0.7	0.75	0.85	0.2	0.9	0.75	0.9
Resistance against pressure	21	20	18.5	29	26.5	27.5	16	27	28	28	14	29	27.5	45
Spin extent	1.5-2%	3%	1-1.5%	3-4%	0.5-1%	0.5-1%	1-2%	3-4%	1-1.5%	1-2.5%	1-2%	0.5-1%	0.5-1%	0
Contraction extent	5-6%	5.5-6.5%	4-5%	3.5-4.5%	1-2%	1-1.5%	3.5-4.5%	4.5-5.5%	1.5-2.5%	1-1.5%	2-3%	0.25- 0.5-%	0.5-1%	-10-15%
Granules: paste percent	26%	30%	24%	25%	25%	30%	25%	30%	30%	30%	27%	33%	28%	15%
Consumed paste	Starch	Starch	Starch	Starch	Starch	Starch	Starch	Starch	Starch	Starch	herbal Paste	Polystyrene	POV	Yellow foam

Source: *by writer*

Among the cases are observed in studying the samples and should be considered in building and producing the applied artistic works specially repairing the objects is the extent of crack in the bodies having granularity D1 in comparison to courser granularities. For comparison, figure 2 refers to study and compare two samples. As seen in the figure, micro-granularity bodies have more cracks than medium and macro-granularity bodies which are highlighted during this study. Refer to figure.3 to study this subject.

Figure 2: Difference between cracks in micro-(left) and macro- (right) granularity bodies

Figure 3: **Extent of crack in the bodies made by micro (lefty) and macro (right) granularity**

As in some repair cases or making an artistic work it is necessary to use micro-granularity, other bodies were made with regarding to the volume of the repaired part or the produced work. Meanwhile adding such materials as glycerin, lime and mole significantly prevent the bodies from crack. A sample was gradually dried, resulting in desirable outcome and the extent of the crack became so insignificant or in some cases completely disappeared. Figure 6-3 shows the micro-granularity sample which has been gradually dried.

Figure 6: Extent of crack in micro-granularity body which was gradually dried

Analysis and Summarizing Table

Studying and comparing table1-3 and first three samples of table.5, we concluded:

Higher special weight of granules and wood wool shows finer granularity and more body weight. The finer be the granularity of the basic particles in body, the lesser is drying rate of the body and more is the extent of required paste for complete connecting the particles. Micro-granularity bodies have more stiffness, resulting from more paste consumption and also more number and amount of particle in the determined volume**.**

Granularity with more special weight, following the increase in the number of granules available in the sample volume, results in more connections and spins among the fibers and granules. Micro-granularity bodies are more resistant to the pressure, then it can be concluded that micro-granularity results in more coherence bodies because the amount of ingredient and the particles of the body increases in the same volume unit and we can see a more compressed granularity. Of course, micro-granularity partly decreases the resistance against the stroke, it can be seen by comparing first three column of table.5. The probable reason of this is come from insignificant mechanical among the particles in micro-granularity and lack of physical spine. Extent of contraction and spine in micro-granularity particles is more than macro-granularity ones, resulting from to many particles (granules) in the granularity with less special weight. Subsequently, water absorption of these materials is more in the paste state and when drying, they are more concentrated.

Studying and comparing samples N4 to N10 in tab.5, the following results were obtained:

Caustic soda results in elevating the stick in starch paste and finally improving the mechanical properties of the body. In the one hand, it increases the spin of the body about 2% and in the other hand it prevents contraction of the body about 1.5to 2.5%. Glycerin improves the mechanical properties of the body and elevates their resistance. Also it accelerates drying in the body and partly prevents the bodies having high special weight from crack. Mole improves the mechanical properties of the produced bodies and also elevates their special weight. It improves the extent of spin and contraction to 1-1.5 and 4-5%, respectively. It should be noted that extent of paste consumption in this sample, because of using mole which has high special weight, increases about 4% in comparison to the basic sample(NI).

Citric acid accelerates drying process of the body but partly weakens its mechanical properties. It can be used for accelerating the drying process specially in combination with other transforming agents including caustic soda. This material can improve the contraction and spin of the body to 1-1.5%.shot concrete enhances the mechanical properties of the body and prevent them from cracking, but it increases the extent of spin and contraction.

It should be noted that the extent of paste consumption in this samples, because of high special weight and elevating the particle level, increases about 4% more than the basic samples. Lime improves the mechanical properties of the produced bodies. It decreases the extent of spin and contraction to 0.5-1 and 3.5-4.5, respectively. It should be noted that the extent of paste consumption in this sample like shot concrete and mole, increases the paste extent as 4%. Plaster enhances the mechanical properties of the produced bodies. It results in drying acceleration of the produced bodies. It also elevates the paste consumption about 4%.

Studying and comparing final 4 samples of table5, the following results were obtained:

Using glue paste weakens the mechanical properties of the body but improves the extent of spin and contraction to 0.5-1 and 4-5%, respectively. Polystyrene paste increases the special weight of the body, resulting from high special weight and concentration of this paste in producing the body. Having gasoline solubility, it accelerates drying duration, decreases the stiffness of the body but significantly improves the resistance against stoke and pressure. It significantly improves the extent of concentration and spin. White wood paste with polyvinyl acetate increases the special weight of the body and decreases the stiffness of the wood but improves the resistance against stroke and pressure. It improves the extent of spin and contraction to 1-1.l5 and 5-5.5, respectively. Yellow foam paste significantly lightens the produced bodies. It also accelerates the duration of drying but decreases severely the its stiffness and improving the resistance against stroke and pressure. One of the other properties of this paste is 10-15% puffing of the body while drying and also low solubility of granules in it.

RESULTS AND DISCUSSION

Results

From the literature about recognizing and manner of producing the wooden artifacts and using granules and wood wool in recycling the wooden material area, many articles including "evaluating the physical – mechanical properties of broken wood of poplar treated with water" by Hamid Hatefnia, Aliakbar Enayati, Kazem Dousthosseini and Mohammad Azadfallah can be indicated.

With regarding to the findings of this investigation, it is proposed to use natural and recycled bodies introduced in table 5 for producing applied and artistic works and also repairing the wooden objects, resulting in both keeping the wooden wastes in the production cycle and also with regarding to wide variety of paste, transforming and basic materials introduced. These materials can be used for producing and repairing the artistic and applied works including small or big, smooth or rough with thin or thick walls, heavy or light and with wide variety of resistance amplitude. In different methods including casting and with the least facilities, it can be attempted at producing and repairing the works and there isn't a need to heavy and expensive machineries for producing these works**.**

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