Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 4967 - 4975
Received 25 April 2021; Accepted 08 May 2021.

Exploiting Environmental Waste) Plastic Medical Syringes) To Prepare Structural Sections

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Abstract. In this paper, particles from the waste of plastic medical syringes (WPMS) were recycled with a polymeric resin that hardens with heat from unsaturated polyester (UPS) used to produce an adhesive at a low-cost and multi-use structural sections that have a wide variety of applications in buildings and a number of industries, including (Furniture, toys, etc.). The method of manual casting of the prepared samples was used and the percentage of particles (WPMS) was in such fractions (0%, 30%, 40%, 50%, 60%, 70%, 80%) and in a granular size of (0.45mm). The samples were subjected to mechanical tests to study some mechanical properties (tensile elasticity modulus, bending strength, impact) and at laboratory temperature of (27°C). The results of the mechanical properties (tensile elasticity modulus, bending strength, impact strength) showed ideal values, that are enhanced by increasing the volumetric ratios of WPMS particles, and through the obtained practical results, this type of waste can be used in the construction of the ready-made structural sections at the lowest cost, in addition to reducing the risk of pollution resulting from those wastes instead of burial or incineration, noting that this type of recycling is used for the first time in manufacturing such structural sections.

Keywords: Exploiting environmental waste, Plastic syringes, Unsaturated polyester, Structural sections.

1.1 Introduction

The preservation of the environment through waste recycling operations is one of the most important advances of our time, because we will be able to benefit from these wastes on one hand and develop the economy from waste of raw materials and their depletion on the other hand, as the accumulated materials have become one of the sources of attraction for investors and manufacturers and their use has increased in various industries and technological applications with its various ideal properties, including high strength and rigidity, low cost, and light weight [1]. Compound materials are those solid materials that possess desirable properties resulting from the mixing of two or more materials linked together by certain bonds and have the best properties and characteristics compared to the properties of the materials in their composition if they were alone [2]. The world population is estimated to be more than seven billion in (2011) It is likely that the number will exceed nine billion by the year (2050), and that the increasing demand for resources leads to an increase in their consumption, which generates wastes that contribute to the deterioration of the

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environment and its nature [3]. Waste poses environmental problems on a large scale in our current era. Therefore, most of the Researches nowadays have the aim of finding successful methods in how to dispose these wastes and to benefit from them [4]. Medical waste is part of the environmental waste resulting from medical activities and practices as a result of diagnosis and treatment, at the health care institutions (hospitals, outpatient clinics, medical laboratories, etc.) [5]. These wastes cause great problems on the whole life of living organisms, thus, to avoid their danger and the consequences on the human being and the environment, treatment methods must be found to convert these wastes from being dangerous and harmful into harmless materials, this is what our research covers by suggesting a recycling process involving the waste from plastic medical syringes, thus, achieving a balance through reduction of those wastes, recycling and using it again in various applications. [6] As a result of the accumulation of waste of various kinds, for example plastic materials, including waste of plastic medical syringes (WPMS), recycling has become part of the human consciousness as it relates to preserving and protecting the environment [7]. Most of the countries have resorted to benefit from recycling these wastes because they generate environmental damage through pollution. [8] In addition to increasing the environmental and economic requirements, most countries have turned to recycling to make use of these wastes in many industries and construction in order to get rid of these wastes and free the environment from its pollutants and the dangers arising from its burial or burning, suggesting its deployment in various industries such as structural sections and low cost construction and preserving the natural sources resulting from their raw materials for as long as possible, as recycling is considered one of the important pillars on which many industries depend nowadays[9].

1.2 Aim of research:

a - Recycling of waste of plastic medical syringes (WPMS) to manufacture low-cost structural profiles

b- Reducing the risk of environmental pollution.

2 Experimental work:

2.1 Recycled material

The waste of plastic medical syringes (WPMS) was circulated in the form of small particles (0.45mm) in volumetric proportions of (30,40,50,60,70,80%), after being disinfected with the use of disinfectants such as Dettol and other detergents (water, liquid soap), then left until It is dry, then the plastic material is cut and then crushed in a high-quality technical method to obtain particles with a granular size (0.45mm).

2.2 Adhesive

An adhesive from unsaturated polyester resin (UPS) was used, which is one of the resins that harden with heat quality (SIROPOL-8341), it is a viscous transparent liquid at room temperature with a density of approximately (1.2g / cm3). The hardener, which is the methyl ethyl ketone peroxide (PMEK) is added to unsaturated polyester resin at a ratio of 2 g (per 100g) to increase the hardening speed.

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2.3 Preparation of samples

The manual molding method was used to prepare samples of (WPMS) particles after cleaning them from contaminants and drying them completely, then chopping, grinding and using them in volume ratios of (30% 40%, 50%, 60%, 70%, 80%).

WPMS was mixed with the adhesive material (UPS), gradually and slowly in order to obtain a complete homogeneity between (WPMS) and the adhesive (UPS), the mixing process was done slowly so as not to cause bubbles that affect the consistency process, with mixing in all directions to ensure the uniformity process for a period of (2min) in order not to have clumping in the mixture prepared for pouring into the special molds, after ensuring proportionality and the absence of lumps and obtaining a suitable viscosity, the liquid mixture is poured into the mold regularly to the required extent and after completing the pouring process into the molds, they are left for a period of about (30 minutes) at room temperature. Once the mixture is dried, it is placed in an electric oven at a temperature of (50 ° c) for a period of (1h), then left inside the electric oven after being extinguished for a period of (3h) until it cools and then it is taken out of the oven to obtain the best interlocking of the polymeric chains and the best hardening. The process is repeated with the same steps on all the samples according to the volume ratios mentioned above (WPMS).

2.4 Mechanical Tests

Tensile tests: samples were prepared according to the required standard dimensions, following the approved American specifications (ASTMD638-03) [10]. Using (LARYEE) device, the device works to stretch the sample from the upper and lower sides and then a stress-strain (load) is placed on the sample until the collapse process occurs and the reading process begins for the histogram of the samples prepared for this test, and through the interface graph, we obtain stress curves through which we calculate the properties of tensile strength, Figure (1) represents the dimensions Standard for tensile samples according to international specifications, Figure (2) represents tensile test samples, Figure (3) shows the Tensile test device.

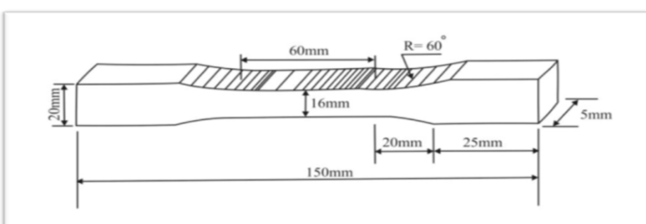

Figure (1) Scheme of tensile samples according to international specifications(ASTM).

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Figure (2) tensile test samples

Figure (3) tensile test device

Bending test: Bending samples were prepared according to the American specifications for testing materials (ASTM D790) [11]. With dimensions (4.8*10*100mm3), a Three Point Bending Test was performed for these samples as the sample is fixed between the two supporting ends of the device and then a load is placed in the middle of the sample until the moment of failure is reached, the interface graph starts reading of the test samples through which we obtain the stress-strain curves and from those curves we calculate the bending strength. Figure (4) represents the standard dimension diagram for the test samples according to the international specifications ASTM. Figure (5) represents samples of the bending test before and after the initiation of the test. Figure (6) represents the bending test device.

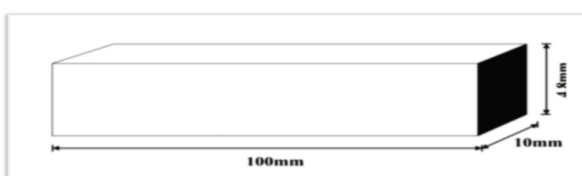

Figure (4) the standard dimension diagram for the test samples according to the ASTM

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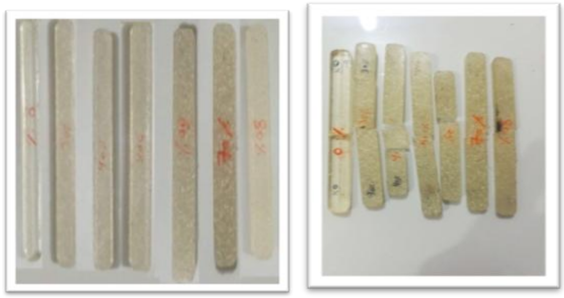

Figure (5) samples of the bending test before and after the test

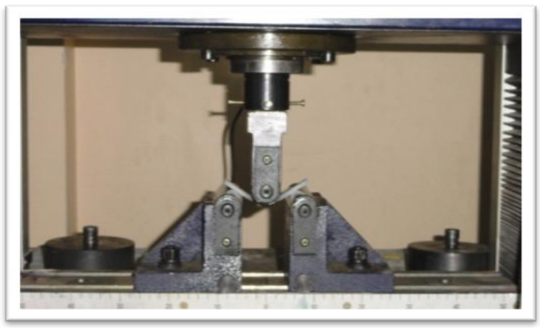

Figure (6) bending test device.

Impact strength test: test samples were prepared according to the American specifications, with sample dimensions such as (4x10x80 mm3), (ISO-180) [12]. An Izod Charpy Tension Impact Test Instrument, manufactured by Testing Machines Inc., Amityville New York, was used to examine this type of test, where the sample to be examined is placed in the device in the place designated for it, and then the Impact test device is reset, and the pendulum is raised to the top of the device in the place designated for its installation, and after confirming the position of the sample and the pendulum hammer, the test is started by releasing the pendulum from its upper place, and the potential energy in the pendulum turns into a kinetic energy that collides with the test sample, which leads to the sample being broken, then the readings are recorded. Figure (7) shows a diagram of the dimensions and measurement of the impact test samples. Figure (8) the samples before and after the impact test, while Figure (9) shows the impact test device.

Figure (7) dimensions and measurement of the impact test samples

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Figure (8) the samples before and after the impact test

Figure (9) shows the impact test device

3 Results and discussion:

3.1 Results and discussion of tensile elasticity modulus

Figure (10) shows the relationship between the tensile elastic modulus of the composite materials and the volume ratios of (WPMS) particles. It was noticed that the highest value of the tensile elasticity modulus was found in the samples that were prepared with volumetric ratios of (30%) amounting to (3Gpa), this might be due to the nature of the particles and their bonding with the adhesive substance (UPS), which made it more durable and cohesive, in addition to the homogeneous distribution of the particles that impede the restriction of movement of the polymeric chains and thus lead to an increase or decrease in the modulus of tensile elasticity, as well as the important role these particles play by impeding the slips occurring within the polymeric bonds, worth mentioning that the gradual decrease in the tensile elasticity modulus of the combined materials is a result of the decrease of the wetting property, that is because the increase in the area of the interface between the first-phase adhesive (UPS) and the amount of material from the waste is the result from the increase in the wetting property between the media content and the materials used [13].

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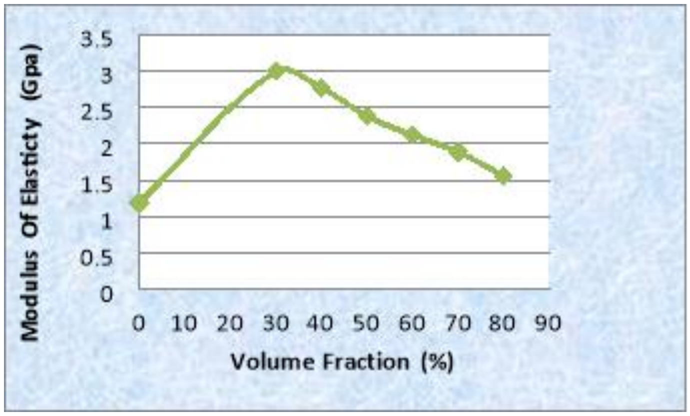

Figure (10) tensile elasticity modulus of WPMS and UPS

3.2 Results and discussion of bending resistance

Figure (11) shows that the flexural strength values gradually increase when adding WPMS particles until they reach the highest value in volumetric proportions of (30%) by (73Mpa) due to the penetration of the particles and their infiltration into the adhesive content, which allows the merging of these cracks with the particles. It is due to preventing the deformation occurring in the adhesive material, then the flexural strength begins to gradually decrease as the volumetric ratios increase comparing to the previous one until the moment of failure, this is due to the extent of linkability between the particles (WPMS and UPS), as the bending resistance is based on the existing defects and cracks in the cavity of the superimposed material [14].

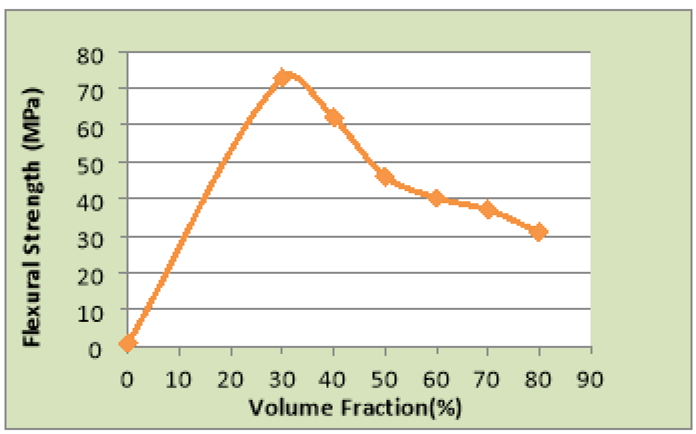

Figure (11) flexural strength values of WPMS and UPS

3.3 Results and discussion of impact resistance test

The impact strength test is considered one of the most important mechanical tests, the sample under test is exposed to a kinetic load that has a very large speed. This test was conducted using the Charpy Test method. Figure (12) shows a rise in the values of the impact strength for all samples. And the highest value was obtained by (80%) and was (0.38KJ / m2), due to the fact that (WPMS) bear the shock stresses of the material through the interface that moves from the adhesive to WPMS. These residues impede the progression and development of the fractures. As these (WPMS) work on dividing the kinetic load affecting the larger size of the prepared sample and thus reduce the stress concentration at the central spot of the sample, in addition to the optimum adhesion between the residues (WPMS) and the polymeric bonding material, by means of Interface that leads to developing the high resistance of the polymeric material to the external stresses affecting it, which results in a significant improvement in the mechanical properties, especially the strength to the impact, as the stresses are transmitted by the interface to the materials used from those wastes, which in turn leads to the need to another added energy to perform the fracturing process of the prepared polymeric material, as well as due to the polymeric chain nature and the cross-link that characterizes the samples.

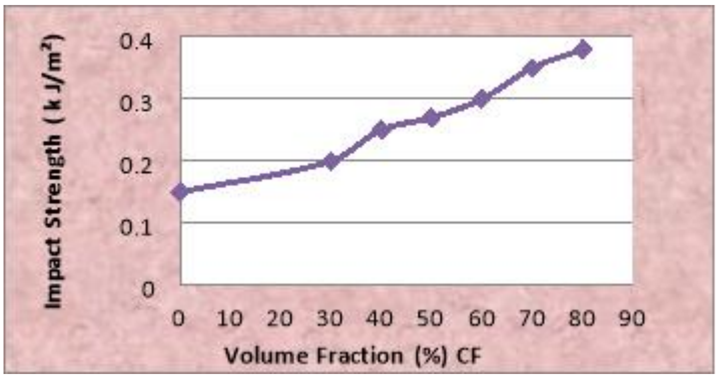

Figure (12) impact strength of WPMS and UPS

4 Conclusion:

Through the results obtained, it was found that when using quantities of (WPMS) particles with the (UPS) adhesive, there was an improvement and an increase in some mechanical properties (tensile elastic modulus, bending resistance, impact resistance) as the volumetric ratios of WPMS increased.

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