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Investigation of Literature in E-Glass / Epoxy Layered Composites

İbrahim Yapıcı[1]
[1]Department of Technical Vocational School, Bitlis Eren University, 13000 Bitlis, Turkey

Abstract:

In this study, a literature review on the dynamic response of E-glass / epoxy-coated com pose plates exposed to low-speed impact was conducted. At the end of the study, theoretical and experimental outputs were compared. Evaluations were made by interpreting the reasons why the outputs were different.

Keywords

Low-speed impact, e-glass, epoxy, laminated composite, method

1. Introduction

In our case, people's needs are increasing with the development of technology. New material production is one of these requirements. It is seen that the limited number of main materials and the properties of these materials are insufficient in the development of technology. Therefore, the studies to produce both economic and strength and very light materials have been intensified. Thus, the composite materials obtained have become very important by combining the physical properties of multiple materials with different properties with special methods.

Composite materials; In order to produce a suitable material in the design, it is the new materials obtained by combining two or more materials of macro size. A macro size means that the material is sized to be visible to the naked eye or magnifying glass. Composite material is a structure obtained by combining it in macro size to obtain better mechanical or thermal properties. Composite materials are composed of the main structure and the reinforcement material, usually called the matrix, to show the best properties of the materials that make them. Therefore, the determination of the mechanical properties of these materials is important for the determination of the usability of the materials in this class.

In engineering applications, especially in mechanical applications, it is desirable that the material be able to give the most appropriate answer in order to prevent unexpected results against any external impact. The application can be subjected to many different ways of impacts to which the material may be exposed according to the application and the purpose of use. In general, pulses are classified as low-speed or high-speed, but there is no clear transition between these categories. Research shows that no clear result has yet been obtained in determining this transition. Some of the studies on this subject have argued that the low-speed impact should be evaluated as speeds ranging from 1 m / s to 10 m / s depending on the stiffness of the target, the material properties and the mass and rigidity of the multiplier.

However, the response to the impact is also determined by the material itself. That is, the metal and metal alloys result in the impact of the impact and the surface exposed to the impact. In composite materials, the damage caused by the impact can occur on the surface which is not exposed to the impact according to the type of impact. It can be seen as the delamination between the layers in the interior structure. Although the impact response in metals is a rupture or fracture as a result of the plastic k deformation, the composites can be damaged in many different modes and in these damage modes there is no significant change in the structural integrity of the part.

The laminated composites are used in many EE stress areas and may be subject to impact by foreign bodies. Damage due to impact can occur during production, maintenance and service operations. As an example of the impact during use, after the aircraft's high speed gains during the take-off and landing, the impacts of stones and small particles escaping the runway can be given. The tools used during production and maintenance can be reduced on the structure. In this case, the impact speeds are small but the effect is large. The layered composite structures are more sensitive to impact damage than similar metallic structures. In composite structures, the impact creates internal damage that cannot be determined during the examination. This internal damage causes a reduction in strength and grows under load. For this reason, the effects of wild hammer impacts on composite structures should be understood and appropriate precautions should be taken into account during the design phase. The effects of impacts on the performance of composite structures are a limiting factor in the use of composite materials. For these reasons, the impact problems of composite materials at low speeds represent important practical and theoretical applications (Kara, 2006).

One of the areas where composite materials are used is the efficiency of electricity generation from renewable energy resources . More durable or lighter solar panel frames or wind turbine blades can be manufactured using composite material. In this respect, the advantages of high-strength composite materials can be utilized in the field of electricity generation from renewable energy sources (Cengiz and Mamiş, 2015;(Cengiz et al., 2015;Cengiz et al., 2016;). Along with the development of technology, the changes in many areas brought along the many problems they have never encountered before, as well as the convenience they bring to human life. One of these problems is the problems caused by sudden load changes in the handles of moving systems. The effects of the inertial forces resulting from the accelerated movement on the element can have unpredictable results. Sudden acceleration decreases as a result of dynamic collisions, and sudden acceleration changes due to the constant change of forces acting on the element may also have unexpected consequences. The forces created by these sudden acceleration changes are called dynamic forces.

The forces of inertia resulting from the momentum movements of the elements, the forces that change over time, the sudden forces acting on the system in very short periods of time and the effects arising from the collisions are called dynamic forces.

The most important difference of the dynamic forces from static quacks is that the stresses and deformations they form on the body do not increase gradually as static forces, but they have an effect on their character. Therefore, other principles are applied in the calculation of dynamic stress and shape change.

In the light of the studies in the field of strength, dynamic forces can be found with the calculation principles of static forces using some additional coefficients.

In fact, the single main principle is taken into account in the calculation of all of the aforementioned forces. This principle is D'alembert principle. In short, if this principle is to be opened, the forces acting on the system affect the effect, which is in balance with inertial forces (Güvensoy, 2010).

In this study, low speed pulses were applied to E-glass / epoxy coated composite plates of the same dimensions using finite element method. As a result of these coups; velocity-time, displacement-time, momentum n and contact force-time variations were obtained. As a result of the study, these data were compared with the data obtained in Metin (2008) experimental studies and the study was completed.

2. Literature Review

The Numerous experimental studies have been carried out on the response of layered composite materials to low-speed impact and analytical methods have been developed. Some of the important studies in this area are:

Initial studies to characterize composite materials under dynamic loading were described by Rotem and Lifshits (1971), Lifshits (1976) and Sierakowski et al. (1971). Sierakowski and Chaturvedi (1997) and Abrate (1998) have made advances in various pulse models and examination methods .

Theoretical calculations were made to predict the pulse response. Sun and Chattopadhyay (1975) and Dobyns (1981) used plate equations to examine an orthotropic plaque simply supported by Whitney and Pagano (1970) . Green (1992);

1993) used the theory of floating propagation to evaluate the stress areas under impact. Chritoforou and Yigit (1996) studied the transverse impact of a composite beam that was simply supported using the torque equilibrium method. Sankar (1992) presented a semi-empirical formula to predetermine pulse characteristics, such as the greatest contact force, contact time and the largest deformation on the rear surface.

The low speed pulse response of layered composites was analytically analyzed by Ramkuar and Chen (1982), Sun and Jih (1995) and Abatan et al. (1998). Gong and Lam (1999) provide an approximate solution for predicting plate response to low-speed impact. This solution includes the movements of the plate and the reinforcement elements, such as the contact force and the effect of transverse slip deformation. Low-speed impact-dependent response of hybrid-layered composite plates was performed by Lee et al. (1997). Kim and Kang (2001) have developed a new analytical method from the dynamic deformation of the composite plates exposed to the transverse impact to predetermine the impact force.

Goo and Kim (1997) performed dynamic contact analysis of laminated composite plates under low speed impact. Simple laws such as the modified Hertz contact law were used to adapt the dynamic contact situation of composite plates. Pierson and Vaziri (1996) present an analytical model for the pulse response of layered composite plates.

Lal (1982; 1983) conducted an experimental and analytical study on the transverse impact behavior of graphite / epoxy layers. A simple energy dissipation model was developed to detect the residual strength of nu munen after impact.

The dynamic response of a composite sandwich plate impacted with a rigid sphere is numerically and experimentally by Lee et al. (1993). Wang and Vukhann (1994) investigated the low speed pulse of PEEK cross layers with carbon fiber using two simple approaches.

Whittingham et al. (2004) carbon / epoxy under pretension investigated the low-speed pulse response of the layers. The amount of impact tip, the amount of impact tip, the amount of impact tip, the amount of impact tip, and the maximum impact force were determined experimentally.

Belingardi and Vadori (2003) investigated the effects of plate thickness on low speed pulse behavior in carbon / epoxy composite materials . Semi-static and dynamic impact loadings were performed on three different thickness test samples. The force-displacement curves were removed and the samples investigated energy swallowing abilities at different pulse rates. Mitrevski et al. (2005) examined the impact effects of different impact tip geometries on composite material. They made impacts on the carbon / epoxy layers with spherical, conical and pointed impact tips. They evaluated the effects of pulse tip geometries by experimentally detecting force-time change and the amount of energy swallowed by samples.

Hosseinzadeh et al. (2005) examined the damage response of the fiber-reinforced composite boards in the weighted weights. They made low-speed pulses on four different fiber reinforced sheet layers. By removing maps of the damage zones in the samples, they have obtained the change of impact energy-damage diameter. They reported changes in different samples. Sugun and Rao (2004) studied low speed pulse characteristics by performing repeated drop tests on glass, carbon and kevlar reinforced composites. They made repeated pulses until they were punctured on the composite plates. They have experimentally determined the greatest force-pulse number change and the pulse-energy-pulse number changes. After the last impact, the maps of the damage zones in the samples were examined.

The behavior of E-glass / epoxy layer composite plates under shock was studied experimentally by Mili and Necip (2001) t. They used a weight reduction impact device in their work. They evaluated the effects of pulse tip velocities and stratification order on the behavior of the composite plate. Aslan et al. (2003), Aslan and Karakuzu (2002) evaluated the dynamic behavior of fiber reinforced laminated composites exposed to low speed impact. They conducted experimental and numerical research on time-dependent analysis of glass / epoxy composites. Numerically calculated contact force-time values were compared with experimental results. They determined the importance of impact velocity, impact mass, dimensions and thickness of composite plate in low speed impact exposed composites. Baucom and Zikry (2005) examined the damage advances in E-glass composite systems in low- speed impact. Low-speed pulses were made at the same energy level until the puncture occurred in the sample, and thus obtained the greatest contact force-pulse number and energy distribution-pulse count graphs. Belingardi and Vadori (2002) examined low speed pulse behavior of glass / epoxy composite plates. One-way and braided composite material having three different orientations made tests with free dart reduction device. The pulse-energy value, the contact force-time changes were obtained and the impact behavior of the samples with different characteristics were evaluated.

Kara (2006) examined the dynamic behavior of E - glass / epoxy - layered composites exposed to low - speed impact . Unidirectional fortified tabakacık [0 ° - 45 °, + 45 °, 0 °, 90 °, 0 °, + 45 ° - 45 °, 0 °] s as arranged E - glass / epoxy composite material has been produced. The impact tests are made with a specially designed vertical weight reduction tester. A 24 mm diameter striker with a semi-spherical tip is used. The boom mass is 30 kg. Tests were performed at multiplication speeds of 2.0, 2.5 and 3.0 m / s. In the studies, 180 iki 50 mm, 180 ve 100 mm, 180 ozit 150 mm sized two-sided built-in composite boards were used and the impact was made to the center of each plate. Graphs were obtained for different experimental samples which gave the force change according to time.

Uyaner and Kara (2007) examined the dynamic behavior of E-glass / epoch layered composites exposed to low speed impact .

Uyaner et al. (2007) investigated the effects of plate sizes on material damage in E-glass / epoxy laminated composites exposed to low speed impact.

Uyaner and Kara (2007) investigated the effect of stratified forms of low-velocity pulse response of layered com positons . Using the weight reduction tester, 90 ° and 120 ° taper, semi-spherical with 24 mm and 12 mm diameter and 120 °

a low speed pulse was applied to the specimen with a pyramid tip . Impact energy is 62.5 J and impact velocity is 2.5 m / s. They used 18 layer test specimens of 180 mm x 50 mm and 7 mm thickness. They examined the force-time changes obtained from the experiments. In addition, each shooter

evaluated the damage areas on the sample .

Yüce (2007) experimentally examined the dynamic response of E ı glass / epoxy laminated composites under low velocity impact. Fortified unidirectional layers [+ 45 °, -45 °, 90 °, 0 °] s shape arranged from 8 to afford layered samples. By taking the symmetry of the same angular arrangement, 16 layer samples were obtained and two different thickness samples were produced. The impact tests were performed with a specially developed vertical weight reduction tester . A 24 mm diameter striker with a semi-spherical tip is used. The boom mass is 30 kg. Tests were performed at multiplication speeds of 1.0, 1.5, 2.0, 2.5 and 3.0 m / s. The two remain in operation Samples with dimensions of 140 mm 140 rities diameter were subjected to the impact test by connecting to the die of 100 mm. At the end of the experiment, swallowed energy, amount of damage, contact forces and shape changes were examined.

Eren (2007) examined the impact of aluminum-thermoplastic composite panel . The impact test was performed at different heights with constant weight. The damage of 15 J, 30 J, 45 J and 60 J on the sample was investigated. Experimental results are shown graphically.

Akın (2008) experimentally examined the impact of E ini glass / epoxy composite plate. The test specimens were produced with an average thickness of 2 mm with 8 symmetrical layers in the fiber orientation of 0/90, -45/45, -30/30. The experiments were carried out on four sides of the samples and in two built-in connection conditions. Impact tests with constant 3 kg weight and 0.5 m, 0.75 m, 1 m,

At 1.5 m and 2 m heights were taken into consideration by taking the puncture conditions of the material into account. The data obtained by means of a piezoelectric force sensor placed between the falling weight part of the impact tester and the striking end is converted into a force time graph. With these data, speed-time, force-collapse and energy-collapse graphs were calculated. At the end of the experiment, experimental studies on the dynamic behavior of composite boards under the effect of time-dependent dynamic load have been made and the differences resulting from the connection have been demonstrated by the interpretation of the graphs.

Yapici and Metin (2009) investigated the effect of low speed impact damage on buckling properties of E-glass / epoxy layer composites.

Akceylan (2009) investigated the low-speed pulse response of E-glass / epoxy laminated composites. Samples were stored on a rigid floor . Using a weight reduction tester , a low speed pulse was performed on the specimen with a striker with a 24 mm diameter hemispherical tip. The multiplication speeds were 2.0, 2.5 and 3.0 m / s. The boom mass is 30 kg. 180 tır 50 mm, 180 alı 100 mm, 180 lı 150 mm, 7 mm thickness and 18 layer test specimens were used. The force-time changes obtained from the experiments were examined. In addition, the damage areas of each shooter on the sample were evaluated.

Şenel et al. (2009) designed and manufactured a unique braking and control system to be mounted on the low-speed impact tester manufactured. Low-speed impact tests were performed to see the difference between the braking system and the sample damage . In the experiments, they used glass / epoxy composite plate in 8-layer symmetrical [-30/30] 4s orientation angle. The tests were performed at 14.7 J, 22.07 J, 29.43 J, 44.14 J impact energies. As a result, the braking and control system used in the device has kept the mass in the case of the falling mass. By examining the effect of the braking system on damage, they determined the necessity of this system and its proximity to real modeling.

Şenel et al. (2009) designing a impact tester in project work they provide the possibility of preloading on composite plates. In addition to the preload effect, different striker end geometries, striking end weight variability and variations in specimen connection conditions have also been considered. They made the experiments by considering each condition separately. They investigated the effects of each condition on the sample with the impact.

Güvensoy (2010) investigated the dynamic response of E-glass / epoxy filament winding composite pipes exposed to low-speed impact. The method it has applied is finite element method and it is based on the interpretation of computer analysis results. Modeled filament winding composite pipe and impact event. The striker he used for simulation has a 24 mm diameter, spherical tip geometry. The impingement mass is 6.35 kg. The study was conducted at multiplication speeds of 2.0, 2.5 and 3.0 m / s. [+ 55 °, -55 °] 3, [+ 55 °, -55 °] 4 and [+ 55 °, -55 °] 5 , 6, 8 and 10 layered E-glass / epoxy material 72 mm inner used composite pipes that could stand in the V ne bed, and made the blow to the width of each pipe . According to these data, the force-time diagrams on the material during impact, energy exchange and energy-change velocity graphs are obtained. He completed the study by interpreting the multiplication time interval.

Lead and Senel (2011) E-glass / epoxy layer composites have investigated the low-speed pulse response. Samples were produced and tested in one-way reinforced layers [0, 90] 2s. Studies II 140 × 140 mm in size and 2 mm thick specimens were used. They conducted the impact tests with a specially developed vertical weight reduction tester.

In their work, 12 mm diameters with a semi-spherical tip were used. The impeller mass is 3.1 kg. As a result of this test, they obtained the force-time, energy-time and force-displacement graphs on the material and ended their studies.

Shokrieh and Fakhar (2012) examined the dynamic response of composite sandwich panels subjected to low-speed impacts numerically, experimentally and analytically.

Kumar and Kishore (2012) investigated the dynamic response of fiber reinforced polymer (FRP) stratified composites subjected to low-speed impact using the finite element method.

3. Results and Discussion

In this study, the dynamic response of layered composite materials was investigated. According to this;

- In terms of speed-time change and d s damage on the composite material with increasing impact velocity increases when examined results eneysel is.
- When the contact force-time variation is investigated, sudden decrease observed after the applied pulse rate reaches a maximum value of the force curve.
- Pulse rate increases finely largest contact force is also increasing.
- The reason for the deregulation and differential results is the formation of damage during the impact on the composite material, and thus the matrix cracking, the hand loss and the layer separation.

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