Structural Analysis Of Lexan Polycarbonate

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ABSTRACT: This paper presents advanced and reliable structural analysis of poly carbonate. Glass is most commonly used transparent material. However, glass is not suitable in applications where low weight, high strength and complex shapes are required. For many applications there exists a need for mechanically strong materials of high optical quality and transparency equivalent to window glass. For this poly carbonate is a viable solution. Poly carbonate is a transparent, impact resistant polymer that provides protection against breakage or intrusion. The present review includes (i) brief introduction of poly carbonate material. (ii) a review of mechanical analysis of poly carbonate mechanical data's are obtained by tensile, flexural, hardness, impact and double shear tests. He result of the study show that the poly carbonate has the significant effect on the mechanical properties.

Keywords : Composite material; Transparent composite; Lexan Polycarbonate ;Mechanical properties; Structural analysis.

1 INTRODUCTION

Polycarbonate (also known as Lexan, Makrolon) received their name because they are polymers containing carbonate groups (-o (c=o)-o-). It is an engineering plastic with outstanding transparency. Poly carbonate is an amorphous material with excellent impact strength, clarity and optical properties **[1].** And it is a durable material with impact resistance, heat resistance. Poly carbonate is highly transparent to visible light with better light transmission than many kinds of glass. Polycarbonate is available in clear in opaque forms, making it the ideal choice for construction and security related purpose. The characteristics of polycarbonate are quite like those of polymethylmethacrylate (PMMA, acrylic) but polycarbonate is stronger and usable over a greater temperature range [-40°F to 280°F] **[2].** Unlike most thermoplastics polycarbonate can undergo large plastic deformation without cracking or breaking. The weight of polycarbonate is one tenth of that of glass and polycarbonate panels are very light. When compared to acrylic and other plastics. Literature survey indicates that very work has been done on mechanical behaviour of polycarbonate. The unique properties of polycarbonate have resulted in applications such as bullet proof windows, unbreakable lenses, compact discs, etc. based on high peformance lexan^{TM} polycarbonate resin clear sheet products offer excellent clarity with attractive aesthetic properties and high impact strength. The molecular structure of lexan polycarbonate is

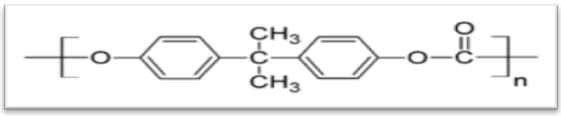


Fig-1: *structure of lexan polycarbonate*

Polycarbonates are also to design and form opaque sheet products combine excellent performance and stiffness with case of thermoforming or cold forming. They offer a consistent high quality surface and cost effective part differentiation through wide colour availability. The polycarbonates are manufactured by many other different methods. Among these methods heat treatment and molding process is effective, economic, good surface finish and easy fabrication **[3].**

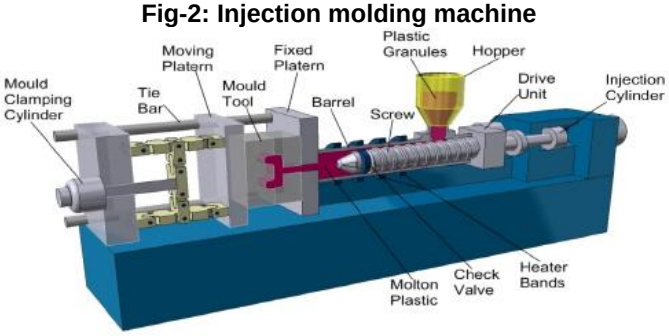
2 EXPERIMENTAL PROCEDURE

2.1 Fabrication

Laminated polycarbonate sheets are fabricated from Saudi Basic Industries corporation (SABIC) innovative plastics. These sheets are layer of polycarbonate lexan resin with the PVB-Polyvinyl Butyral resin solution. Polycarbonate sheets of the 5mm thickness, 2×1 feet is fabricated. The most manufacturing process is based on the reaction of biphenol A (BPA or Bis A) and phosgene dissolved in a chlorinated organic solvent such CH_2Cl_2 (methylene chloride). This process is called nonphosgene process **[4].** Sabic lexan polycarbonate is most commonly manufactured by injection molding process **[5].** Steps involved in Injection molding procedure are

- Material handling and preparation
- Machine preparation
- Mold release agents
- Recommended purge materials for LNP compounds
- Shutdown procedure

Fig-2: Injection molding machine



3 TESTING OF MECHANICAL PROPERTIES

The structural analysis –mechanical testing work was done at METMECH Engineers, Chennai. The following tests were carried out, as per the ASTM Standards. **[6].**

- Tensile test
- Flexural test
- Izod impact test
- Double Shear test
- Hardness test

3.1 Tensile test

Tensile test was carried out using an Universal Testing Machine (UTM) of capacity 5 ton. The test specimen is prepared according to ASTM standard D638-08. Theoretically the tensile strength is calculated according to the following formula. **[7& 8].**

$$\sigma = P/A$$

Where,
P→ ultimate load on the specimen (N)
A→ area of the specimen (b×h) (m^2)

For gradual loading, the gear rotation speed is 1.25, 1.5 and 2.5mm/min

Fig-3: *Tensile test in UTM*

3.2 Flexural Test

The flexural test is carried out the universal testing machine of capacity of 5 tons. The test specimen was prepared according to ASTM D790 standared **[9].** The flexural strength is calculated according to the following formula

Flexural strength = ^{2} $3PL/2bh$

Where,
P- Maximum load (N)
L- Span length of the specimen (mm)
b- Width of the specimen (mm)
h- Thickness of the specimen (mm)

Fig-4: *Flexural test in UTM*

3.3 Izod impact test

Izod impact test, also known as the charpy key-hole notch test is a standardized high strain rate test, which determines the amount of energy absorbed by a material during fracture. The test specimen was prepared according to ASTM D256 standard **[10]**. The temperature ranging from -320^{0}F to over 2000^{0}F. Dead weight in the oscillator is 80kg.

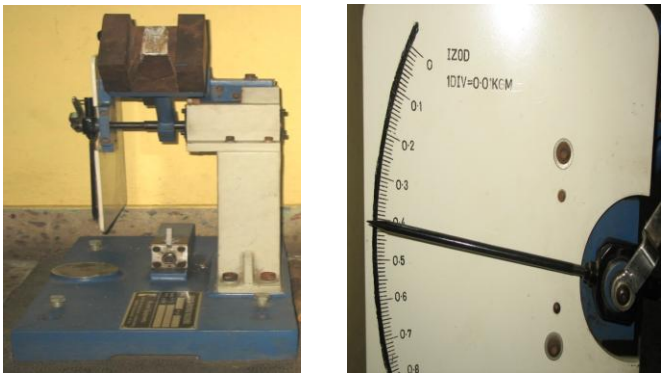


Fig-5: *Model K-1.4 impact machine*

3.4 Hardness Test

The test was conducted using Wilson Rockwell L-scale, which is especially for plastic material. The indentor chosen is of steel ball of 1/4th diameter. The amount of load 60kg was used for this test. The test specimen was prepared according to ASTM D875 standard [11].

Fig-6: *Rockwell L-scale machine*

3.5 Double shear test

The double shear test is carried out using the Universal Test Machine of capacity 5tons. The test specimen was prepared according to the ASTM 2324 standard **[12].** For gradual loading, the gear rotation speed is 1.25, 1.5& 2.5mm/min.

Fig-7: *Double shear test in UTM*

4 Result and Discussion

4.1 Tensile test

The tensile test properties were evaluated as per ASTM D638 and the resulting of stress Vs strain and load Vs displacement are shown in fig.1. This graph was studied by using software FIE. It is clear from that fig that the polycarbonate shows high elastic nature. In load Vs displacement curve, we can see that polycarbonate can withstand the maximum load with minimum displacement. In stress- strain relation, elongation of polycarbonate is 17.8% with ultimate stress of 0.062Gpa. From these values we can calculate the mechanical properties such as Youngs' modulus and Shear modulus.

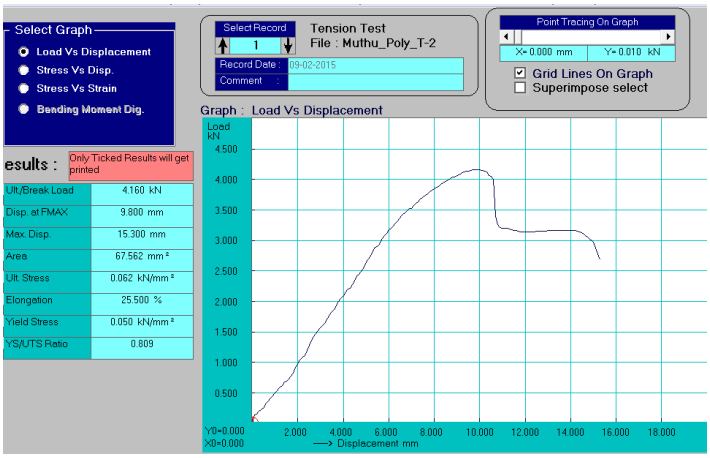


Fig-8: *Load vs Displacement*

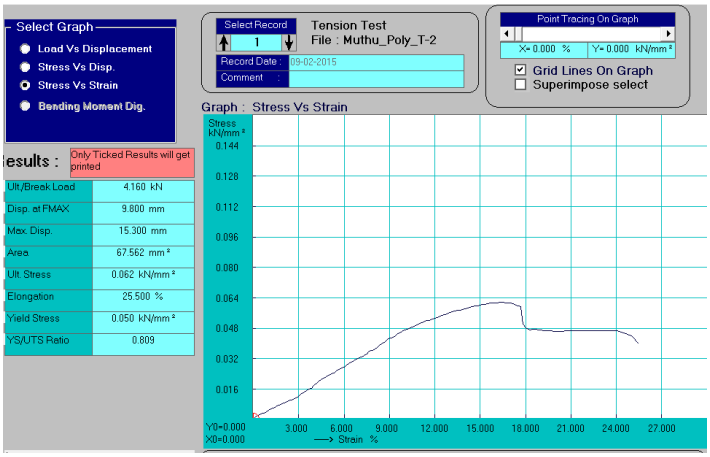


Fig-9: *Stress vs Strain*

4.2 Flexural Test

In load Vs Displacement curve indicate that the displace

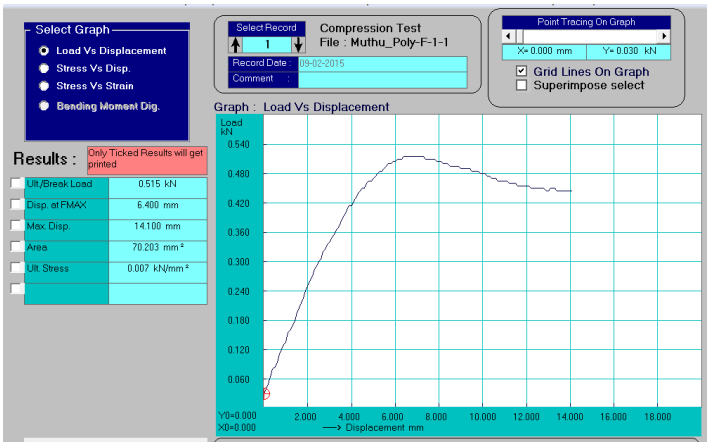


Fig-10: *Load vs Displacement*

ment occurs at break load of 0.53kN and the ultimate stress for this result is 0.008Gpa.

4.3 Izod impact test

The polycarbonate has high impact value of 9.6 joules.

4.4 Hardness test

From the result of hardness test,we can see that polycarbonate has good hardness value of 98 HRL.

4.5 Double shear test

In load vs displacement, the result of double shear test indicates that the displacement occurs at break load 3.36kN and the ultimate stress for this displacement is 0.064Gpa.

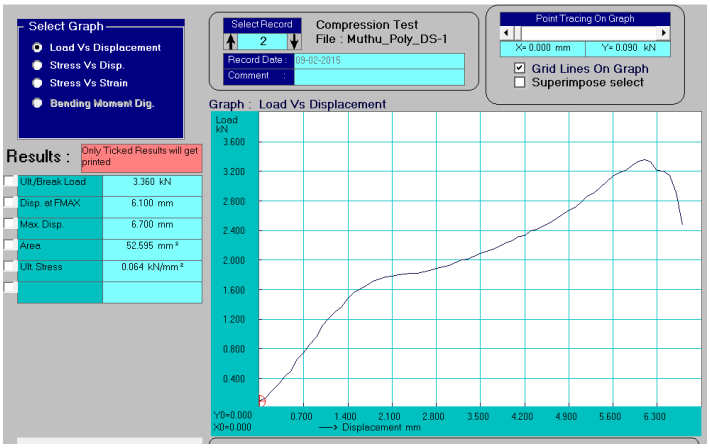


Fig-11: *Load vs Displacement*

5 CONCLUSION

Polycarbonate was successfully fabricated by molding process and testing of mechanical properties was held successfully. The result of this study is in good agreement with those obtained mechanical properties using standard FIE software. The analysis of different testing and loading arrangements leads to a better understanding of the mechanical properties of polycarbonate. Experimental results shown in this paper indicate that the impact testing gives better result than the chopped e-glass fibre.

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