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# 3-POINT BENDING TESTS ON EXTRUDED POLYSTYRENE FOAM

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***Abstract:*** *The paper presents 3-point bending tests performed on extruded polystyrene foam panels used as thermo-insulated material as well as core for advanced sandwich composite structures. Stiffness, Young modulus of bending, flexural rigidity and other important tests features are presented.*
***Keywords:*** *stiffness, 3-point bending test, extruded polystyrene foam, flexural rigidity, Young modulus of bending*

## 1. INTRODUCTION

In general terms, polystyrene is an aromatic polymer made from the aromatic monomer styrene, a liquid hydrocarbon that is manufactured from petroleum. Polystyrene is a thermoplastic substance that generally exists in solid state at room temperature, but melts if is heated and becomes solid again when cooling off. Pure solid polystyrene is a colorless, hard plastic with limited flexibility. It can be cast into molds with fine detail. Polystyrene can be transparent or colouring agents can be added to take on various colours. It is economical and is used for producing license plate frames, plastic cutlery as well as models from which molds can be manufactured. Polystyrene's most common use is as expanded polystyrene (EPS). Expanded polystyrene is produced from a mixture of about 90-95% polystyrene and 5-10% gaseous blowing agent, most commonly pentane or carbon dioxide [1]. The solid plastic is expanded into foam through the use of heat, usually steam [2]. Extruded polystyrene (XPS), which is different from EPS, is commonly known by the trade name Styrofoam. The voids filled with trapped air give it low thermal conductivity. This makes it ideal as a construction material and it is therefore sometimes used in structural insulated panel building systems or as core material in advanced sandwich composite structures. It is also used as insulation in building structures, as molded packing material for cushioning fragile equipment inside boxes, as non-weight-bearing architectural structures (such as pillars), and also in crafts and model building, particularly architectural models [3].

## 2. SPECIMENS AND TEST PROCEDURE

Five specimens with dimensions 20 x 30 x 400 mm have been cut from large XPS panels and subjected in 3-point bending test on a “LR5K plus” testing machine produced by Lloyd Instruments, UK (fig. 1).
The testing machine presents the following specifications [4]:

- force range: 5 kN;
- speed accuracy: <0.2%;
- travel: 840 mm
- load resolution: <0.01% of load cell used;
- extension resolution: <0.1 micron;
- load cell: XLC-5K-A1;
- analysis software: NEXYGEN plus.

The specimens have been subjected to a test speed of 3 mm/min and the span has been chosen of 340 mm. Following main features have been determined: stiffness, Young modulus of bending, flexural rigidity, maximum bending stress at maximum load, maximum bending strain at maximum load, maximum bending stress at break, maximum banding strain at break, load at break, extension at maximum load, extension at maximum extension, extension at break, etc.


**Figure 1:** "LR5K plus" testing machine during the 3-point bending test of XPS foam

## 3. RESULTS

Stiffness, Young modulus of bending, flexural rigidity and other important features determined during testing extruded polystyrene foam have been presented in figs. 2 – 8.

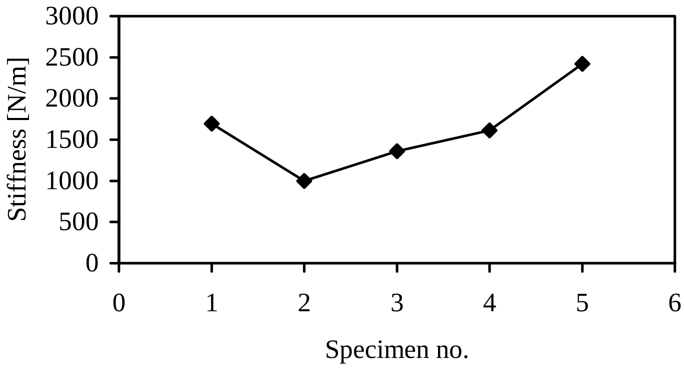


**Figure 2:** Stiffness of XPS foam specimens

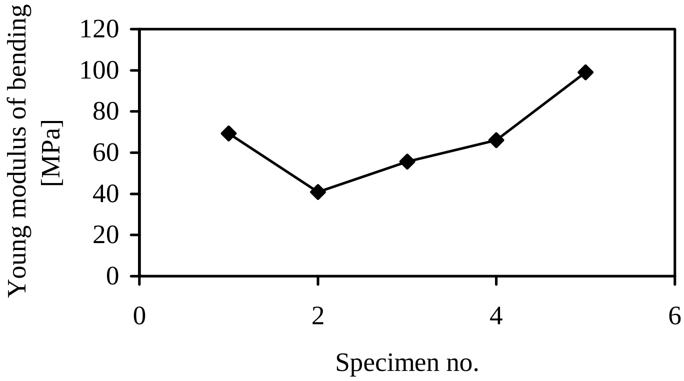


**Figure 3:** Young modulus of bending of XPS foam specimens

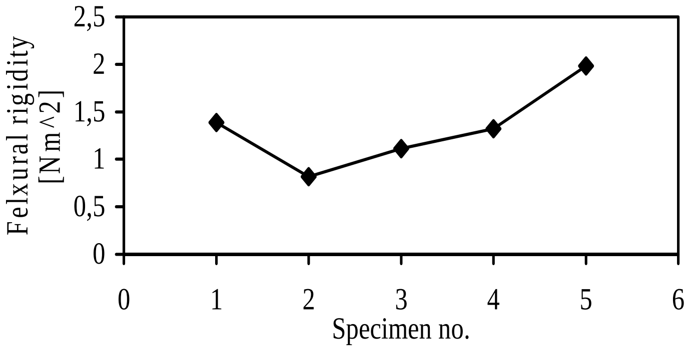


**Figure 4:** Flexural rigidity of XPS foam specimens

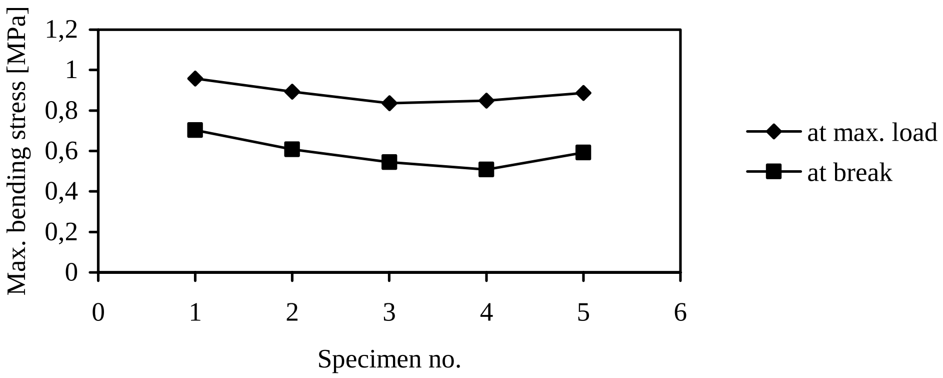


**Figure 5:** Maximum bending stresses of XPS foam specimens

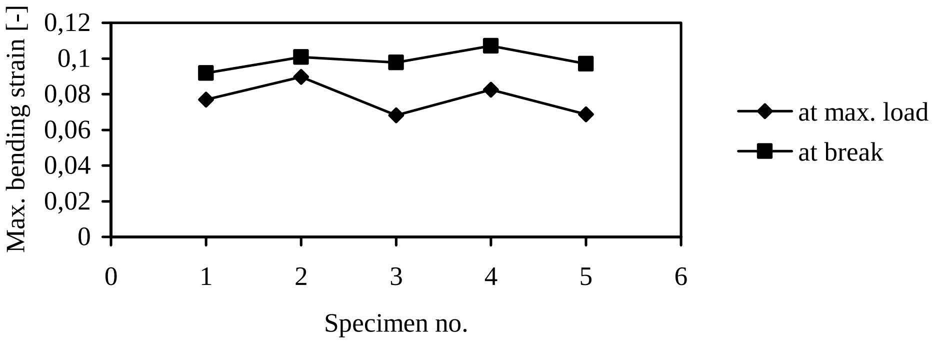


**Figure 6:** Maximum bending strains of XPS foam specimens

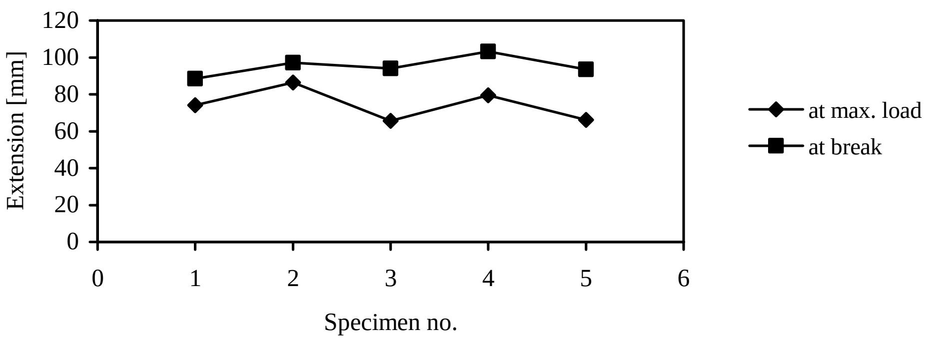


**Figure 7:** Extensions of XPS foam specimens

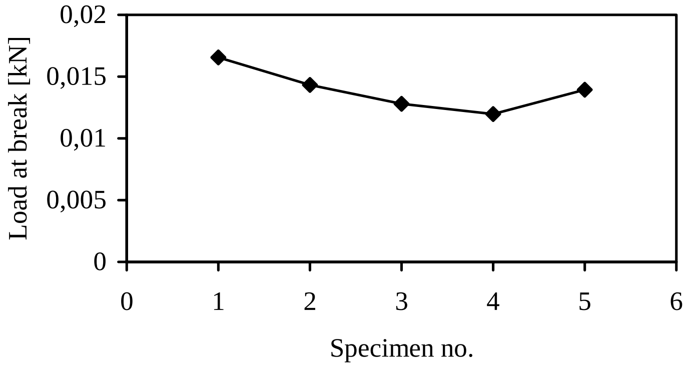


**Figure 8:** Load at break of XPS foam specimens

## 4. CONCLUSION

After an average extension at break of 95 mm, the extruded polystyrene foam specimens present a brittle fracture, the crack starts from the outer to the inner surface of the specimens (fig. 9). The crack propagation follows an irregular path (fig. 10).

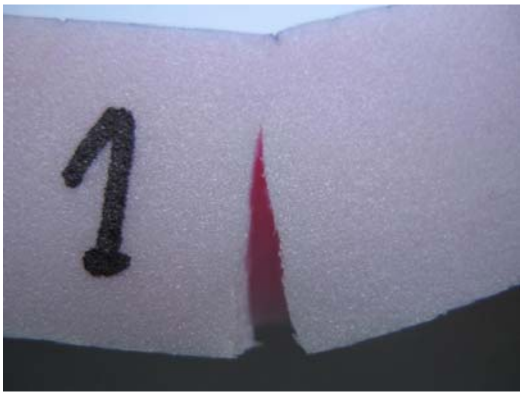

**Figure 9:** Crack beginning of XPS foam specimen no. 1

**Figure 10:** Irregular path of crack propagation in the outer surface of XPS foam specimen no. 1

## REFERENCES


[1] http://www.bpf.co.uk/bpfindustry/process_plastics_moulding_expanded_polystyrene.cfm
[2] http://geofoam.syr.edu/GRC_Manufacture.asp
[3] http://en.wikipedia.org/wikj/Polystyrene
[4] Lloyd Instruments. LR5K plus User Manual.