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Weathering action on thermo-viscoelastic properties of polymer interlayers for laminated glass

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HIGHLIGHTS

- The effects of weathering have been produced on small laminated glass elements.
- Humidity action, solar radiation and thermal variation were simulated in laboratory.
- The use of small specimens enabled reproducibility of the mechanical tests.
- The effects of weathering on the constitutive response of interlayer were evaluated.
- Hypotheses on the structural changes of the material at molecular scale were made.

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ABSTRACT

Mechanical properties of interlayer polymers are recognized to be essential for a correct design of laminated glass structures. Although several researches have been carried out on the consequences of weathering actions on a laminated glass, few quantitative data on the properties of polymers are available. The response of structures to a long duration load is therefore evaluated taking into account the effects of viscosity of the interlayer, but in the hypothesis that the interlayer material does not degrade over time. In this paper the results are reported of an experimental analysis of the thermo-viscoelastic properties of polyvinyl butyral used as interlayer of laminated glass, subjected to weathering actions (humidity, thermal cycles and UV radiation). The results were interpreted in the light of the connection between microstructure and rheology of polymers, and highlight two different damage mechanisms, promoted in different extents by the different weathering actions.

1. Introduction

The contemporary architecture is increasingly using structural glass, usually in the form of laminated glass sheets [1], often assembled with other materials [2], in order to reduce the consequences of glass fragility and to confer toughness to the structural element. The necessity of evaluating the mechanical response of such structural elements has required, first of all, the development of calculation methods for laminated glass [3,4]. Considering that, in structural usages, glass always remains in the linear elastic range up to brittle failure, simplified approaches are used that describe a generic laminated glass plate as a laminated composite made of elastic phases. In this way, the laminated glass can be modelled using generalized Newmark models [5], widely employed for schematizing such phenomena in case of composite elements made of other materials as, for example, the steel–concrete interactions in reinforced concrete [6].

In view of the design of laminated glass structures, both a simplified prediction and a careful description of mechanical behaviour of structural elements can be faced only if an accurate knowledge of the thermo-viscoelastic response of interlayer polymer is available [3,4]. For this purpose, the authors have already proposed an experimental procedure for carrying out dynamic tests on small dimension laminated glass specimens, that permits to overcome some difficulties and some inconsistencies of the tests on polyvinyl butyral (PVB) interlayer [7]. As the coupling capability of interlayer is not negligible, [4,8], weathering can significantly modify the structural response of laminated glass structures. For this reason, a comprehensive description of material behaviour

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