Design and Construction of a Glass Reinforced Polyesters Skylight

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Summary

The skylight described in the paper covers a large rectangular horizontal surface and provides an efficient solution for a large administrative building with special lighting requirements. The cross sections of the individual components, the use of the double curvature, the proposed jointing system, and the manufacturing procedure and assembling satisfy the most important functional, structural and architectural qualities required by such an enclosure system.

1. Design Requirements and Constraints

The architectural constrains and the structural build up of the edifice have led to a rectangular in-plane surface (9.40 m x 10.50 m) to be covered by the lighting aperture.
The skylight has been contrived as a cylindrical dome made of glass reinforced polyesters (GRP), (Fig.1), chosen to perform as structural as well as enclosure material. A light weight closure system was also required in order to minimize the earthquake load, because the building was located in a very active seismic area. The skylight elements have been designed on the assumption that dead and snow load act simultaneously on it. No wind loads have been considered in load combinations due to sheltering effects of the neighbouring buildings.
An appropriate thickness of the dome wall was selected to supply the required lighting and to preserve enough load bearing capability.
The particular cross section (Fig.3) has been chosen in order to fulfill the following structural and functional requirements: strength and stiffness during handling transport and assembling; in service loadbearing capability and rigidity; covering function which involves the water proofness, water discharge and prevention of water seepage.
Other design data refer to: arch span, L=940 cm; rise, f=330 cm; thickness=3 mm; density of GRP=1600 kg/m^3; snow load=1000 N/m^2; ultimate short term flexural strength of GRP=25 MN/m^2; special features: dome surface divided into twelve elements connected to each other by end plates and bolts; deflection constraints: nil; environmental condition: good, no special precautions necessary because there are no aggressive gases in atmosphere.

2. Geometric Characteristics of GRP Elements

The final shape of an individual element is that of a corbeled arch imposed by architectural, service and maintenance conditions. It was decided to split the dome into twelve arch type elements consisting of two units (Fig.2) to meet the special construction requirements. The two units making an arch element were attached to one another at the highest level by means of two bolted vertical diaphragms. The edge timpans of the skylight were made of wire glass supported on a steel frame that also provides wind bracing. All dome elements and timpans rest on a reinforced concrete corbel.

3. Manufacture and Erection of GRP Elements

An open mould method, namely the hand lay-up technique, was used to take full advantage of the fact that the polyester resin does not need special conditions like heat or pressure for complete polymerisation to occur. The mould was made of timber slats to achieve the double curvature pattern of the element. A release agent was applied to the mould to prevent bonding between GRP element and the timber form.

The reinforcement in the form of woven fabric and strand mat had been precut to the correct size. A gel coat necessary to protect the fibres on the exposed surface of the composite was sprayed on the mould surface. After the gel coat became tacky and firm a first layer of resin was brushed over and the first layer of glass reinforcement was placed in position and consolidated with rollers. The required layers of resin and reinforcement have been applied until the designed thickness of the wall element was obtained. Curing of the GRP elements took place in a construction workshop under a temperature range, 17°...20°C.

Each arch element, made of two parts, was assembled with bolts then erected and laid up in the final position. A light weight steel scaffolding was used to offer a temporary support to the first GRP element while being set up on the first one and this sequence was used until the skylight was completed.

The final joints between the GRP elements and the concrete corbel were made of mild steel bolts and sealed with a plastic compound. Then, the lateral steel formed timpans filled with coloured wire glass were erected. Eventually the border elements and the timpans were jointed.

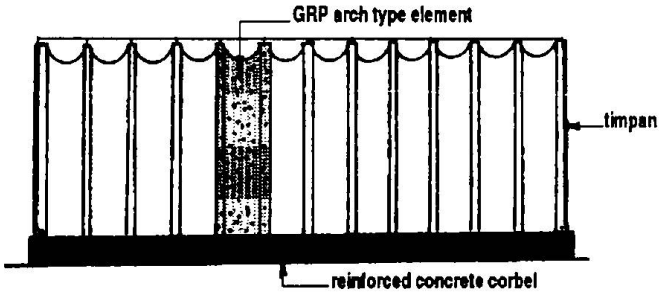

Fig.1 GRP skylight

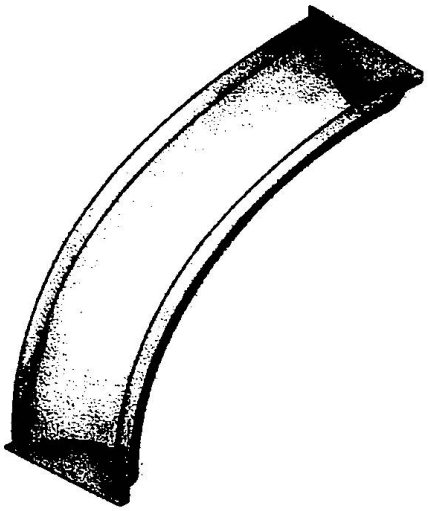

Fig.2 The unit of arch type element

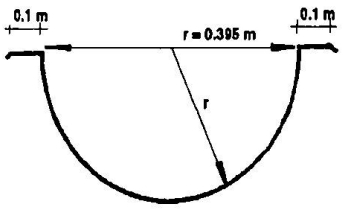

Fig.3 The cross section of unit