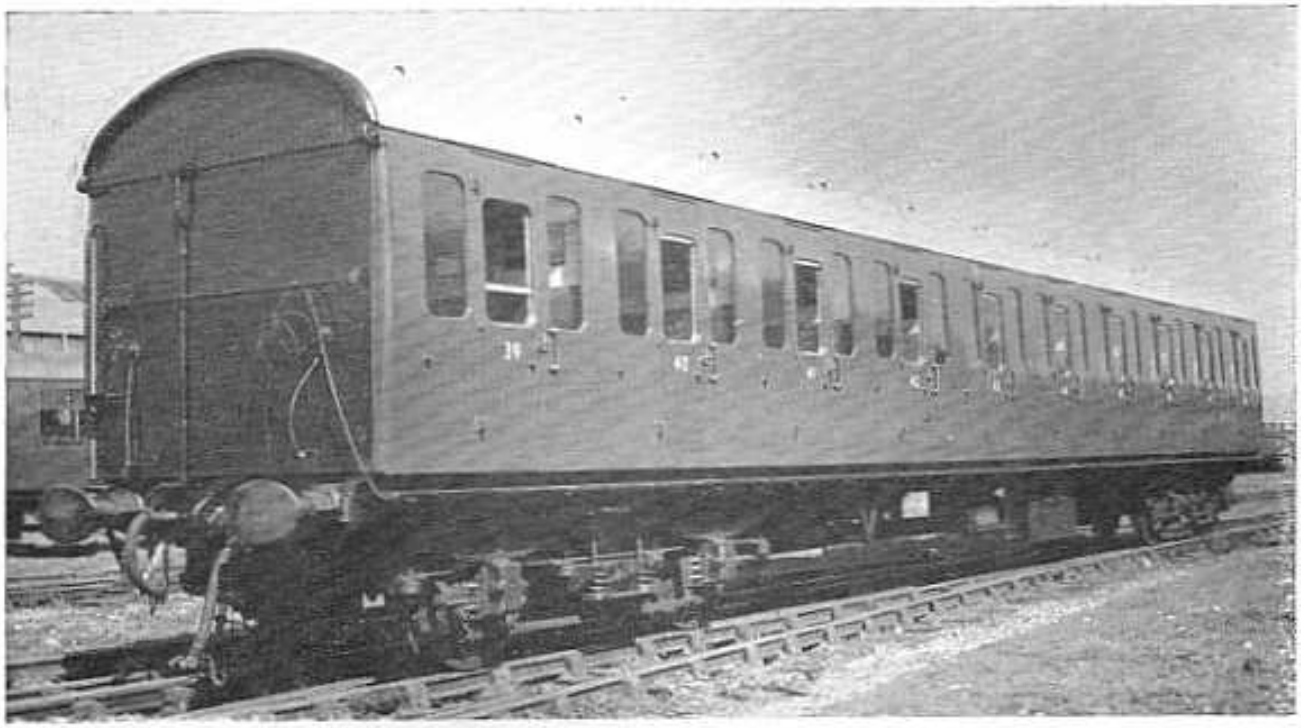


Southern Region experimental second-class suburban coach (No. DS 70200) with body of reinforced plastic

Coach bodies of PLASTIC

IMPROVEMENTS in production techniques, and in the structural properties of moulded reinforced plastics, have now reached the stage where this material can be considered as a replacement for traditional materials for railway equipment subject to stress and vibration.

Considerable investigation and development in the field of coachbuilding by using unconventional material has been undertaken in both the carriage works and the locomotive works of British Railways at Eastleigh, in the Southern Region. The plastic material is immune to corrosion, the interior and exterior colour required is incorporated in the material and no further finishing is required. Maintenance costs are reduced by eliminating exterior repainting and the reconditioning of interior panelling.

To provide a full-scale assessment of the design and manufacturing problems involved in producing a moulded reinforced plastic coach body, a conventional type second-class suburban coach has been built at Eastleigh Works. The body of this coach has no traditional framework and the required rigidity has been obtained by using a sandwich construction of rigid foam-core material, with an inner and outer skin of glass-resin laminate. A series of stiffening webs, bonded to the core blocks and to the inner and outer skin, are incorporated.

The coach has ten door openings in each side and to provide the required longitudinal stiffness the roof is constructed as a single-piece moulding 64 ft. long and 8 ft. 7 in. wide. The sandwich roof construction, which conforms to the standard B.R. contour on the outside, is 4 in. thick in the centre, reducing to 2¾ in. thick at the sides.

To provide a measure of crash protection in the event of overriding, the moulded coach ends are reinforced by a steel framework of four pillars, welded to the underframe end plates and bolted to a steel arch rail incorporated in the roof moulding. The complete assembly of roof, sides, and ends are bonded and bolted to form a single-piece structure, which is then bonded and bolted to the underframe.

The degree of weight saving achieved on the first coach was not as much as expected and this aspect is under investigation. It is

appreciable enough to effect a substantial reduction in haulage costs. This coach is now running in a restricted daily service where it is being kept under observation, and a second coach is being produced for static and impact testing.

The core material used in the sandwich construction is expanded polyurethane foam which can be moulded readily and has good insulating properties. The coach side is an assembly of preformed bodyside quarters, each with two light openings. The mould incorporates a framing to form the bodyside light openings.

To form the core blocks, the inner and outer mould panels are closed within $\frac{1}{4}$-in. and the liquid polyurethane poured into the cavity. After it has set, the core is removed and cut into eight sections, and a layer of glass fibre and resin applied to the edges of each block. When the blocks are reassembled into the mould these layers of fibre and resin form webs joining the inner and outer skins. The glass fibre overlaps at the edges to provide a good anchorage to the skin.

A gel coat of resin, pigmented to match the standard green livery, is applied to the outer mould, and successive layers of chopped-glass roving and resin are then sprayed on and rolled to form an outer skin of $\frac{1}{8}$-in. nominal thickness. While the resin is still wet, the core blocks are assembled on top of the outer skin and a layer of glass and resin, pigmented to the interior décor, is sprayed on and rolled. The inner skin mould is placed in position and the complete mould clamped for curing, metal plates for the door fittings and roof anchorage bolts being moulded in.

Along the top inner face of the mould, a half-round bead is formed to conceal the roof joint, and at the bottom of the quarter is a boot section for attachment to the underframe outrigger plate and to support the floor. A communication chain-pull shield is incorporated, and in the centre of the quarter is a vertical web for partition panel attachment.

The roof is the most important structural member and as a single-piece wet lay-up moulding is the most difficult section to produce. The fixed part of the mould, which forms the inner contour of the roof, consists of a series of steel panels, each representing a compartment ceiling, mounted on a rigid steel structure. Along the edge of the mould is a machined surface for moulding the roof gutter and joint face to match the bodyside. The roof is built up in sections using two teams, each working progressively outwards from the centre of the mould. The outside roof contour is obtained by building an even thickness of glass laminate and preformed core blocks on to the fixed inner mould.

The prefabricated compartment partition headboards are inserted in slots in the mould and a gel coat of pigmented resin applied. Along the gutter sides, 5 in.-wide strips of continuous rove mat are laid to provide a tensile load member at each side. Glass-resin laminate is then sprayed on to cover a 12-ft. central section of the inner mould and the laminated box section and foam-core blocks placed in position. This assembly is covered with a laminate of glass and resin and consolidated with rollers.

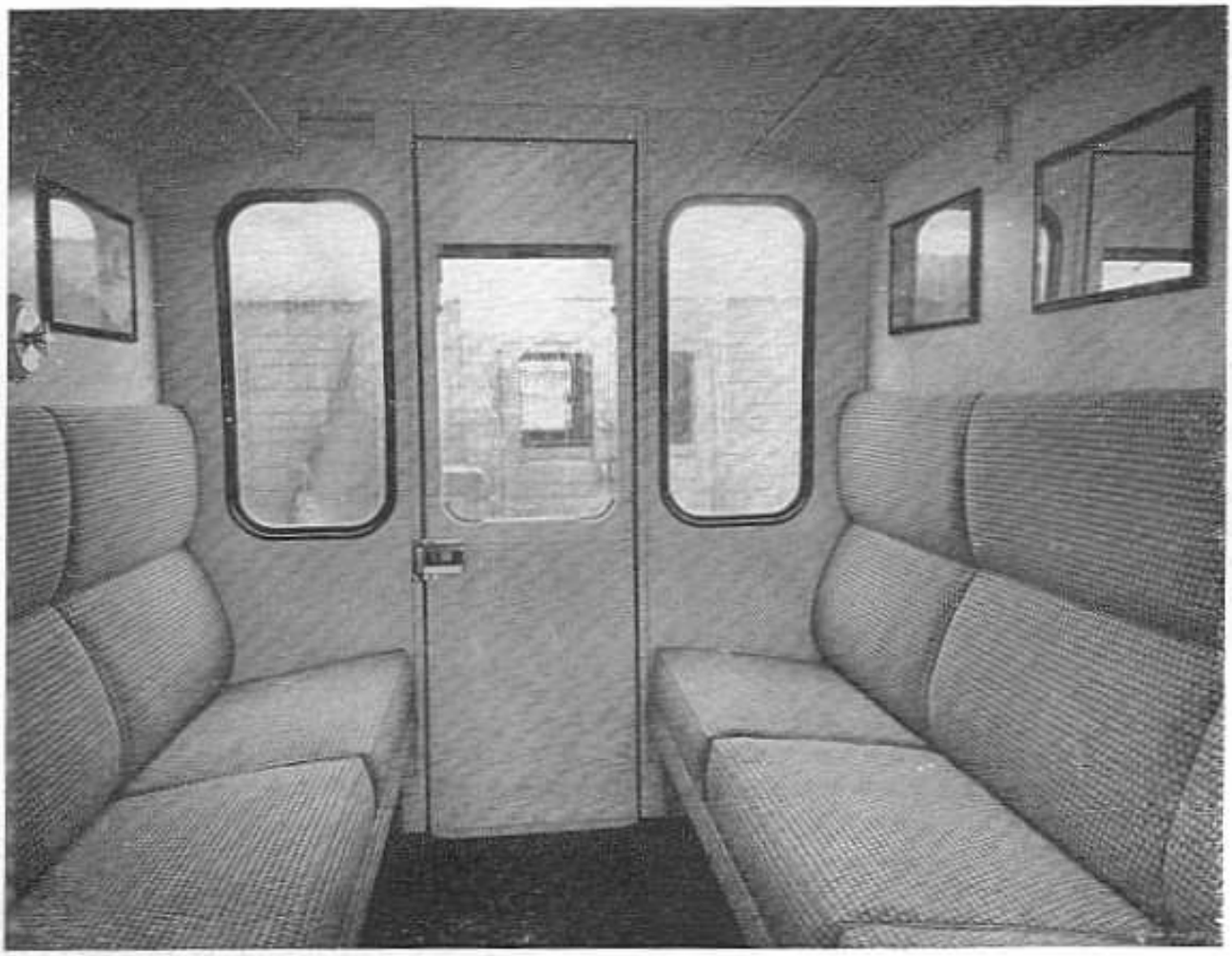
The outer moulding panel, mounted on a trolley and prepared with gel coat and glass-resin laminate, is wheeled into position and clamped down before gelation occurs. Each section is treated similarly, working outwards from the centre to achieve a continuous wet follow-up. For the attachment of the flat ends of the coach to the roof, a flat steel plate shaped to the roof contour is bonded into each end of the roof.

The completed moulding is cured by holding at a temperature of 80 deg. F. for four days, using steam heating on the underside and electrically heated hoods above the mould. The flat coach ends are a sandwich construction consisting of a Plasticell rigid p.v.c. core, $\frac{1}{2}$ in. thick, enclosed in glass-resin laminate.

On the first coach the rubber gasket holding the bodyside light is laid in a flanged recess and retained by brass angle strips, which in turn are covered by a reinforced resin moulding. This method can be revised to permit the use of wider manufacturing tolerances. The coach floor is a sandwich of plywood and rigid foam, sealed on the underside with a light galvanised steel sheet.

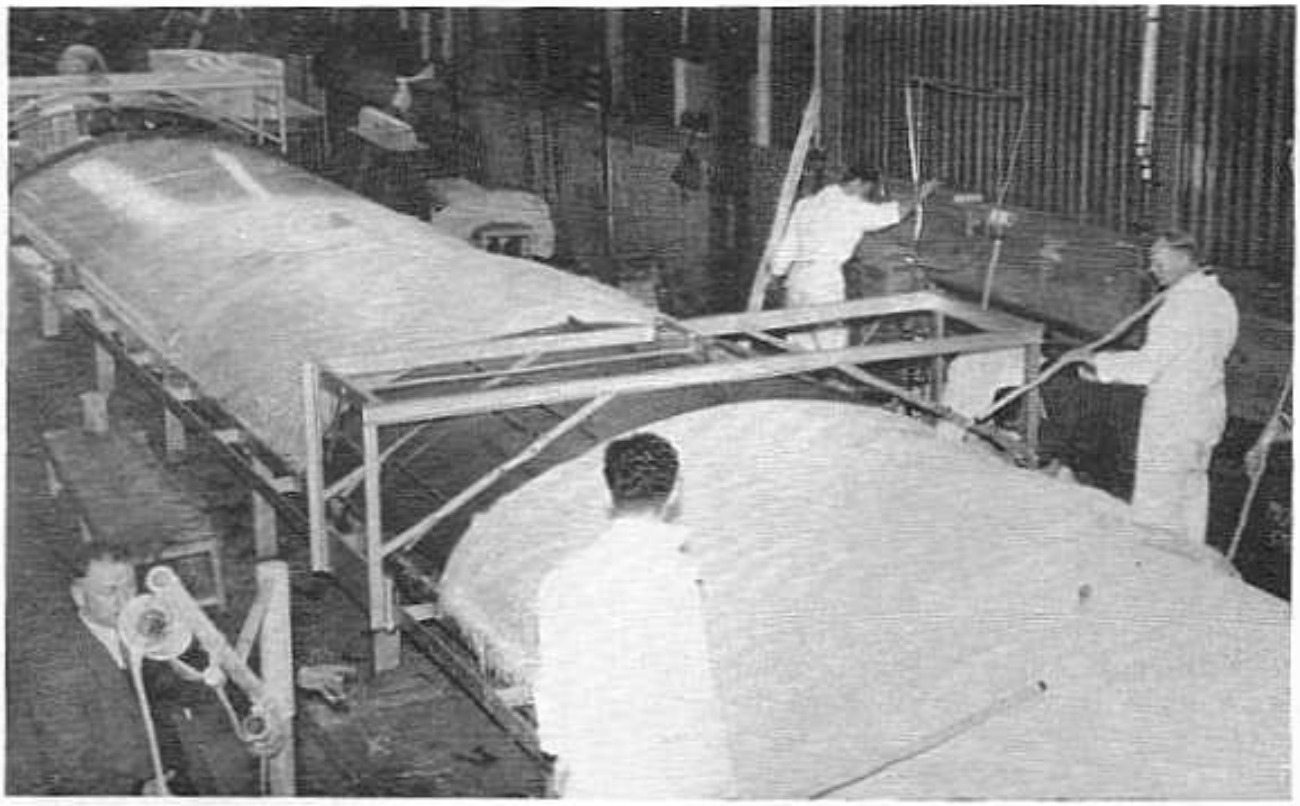
In addition to the complete coach, the reinforced plastic technique has been adopted by British Railways for a number of applications. Cab roofs for the electro-diesel locomotives were produced by this method and the use of plastic coach doors is now firmly established. Comparative testing of these doors on a slam-test rig showed rapid failure with the conventional door and no failure with the reinforced plastic door.

Service testing of a pilot batch of small wheeled containers indicates that this is a particularly suitable application for reinforced plastics, and a solution to the problem



Compartment of plastic coach built at Eastleigh

Placing outer moulding panel in position. The inner roof mould (far left) had not yet been sprayed with pigmented gel coat



of the extensive damage sustained by wooden containers. The smooth inner and outer surface facilitates cleaning, painting is not required, and the Plasticell core provides a degree of insulation for foodstuffs.

A further project undertaken was the production of a batch of restyled cab fronts for the Oxted diesel-electric multiple-unit stock. These were not of sandwich construction, but consist of a welded steel framework covered with a $\frac{3}{16}$-in. thick panel of glass fibre reinforced polyester resin.

In the locomotive works, plastic component production is carried out in the pattern shop. Here equipment was initially installed for the production of patterns in epoxy resin. These patterns are widely used to bridge the gap between the cheap timber pattern for "one-off" castings and the expensive metal pattern for large quantity production. The department now undertakes the batch production of a variety of components in resin-base materials.

The material has good weather resistant and electrical insulating properties and typical examples in production are apparatus cases and track connecting boxes for signal and telegraph use. These are glass fibre resin laminate mouldings.

In the Locomotive Maintenance Department, leaking fuel tanks have been repaired *in situ* by applying a pad of glass fibre which has been impregnated with epoxy resin. The repair is rapidly effected and the tank does not require to be drained lower than the point of fracture.