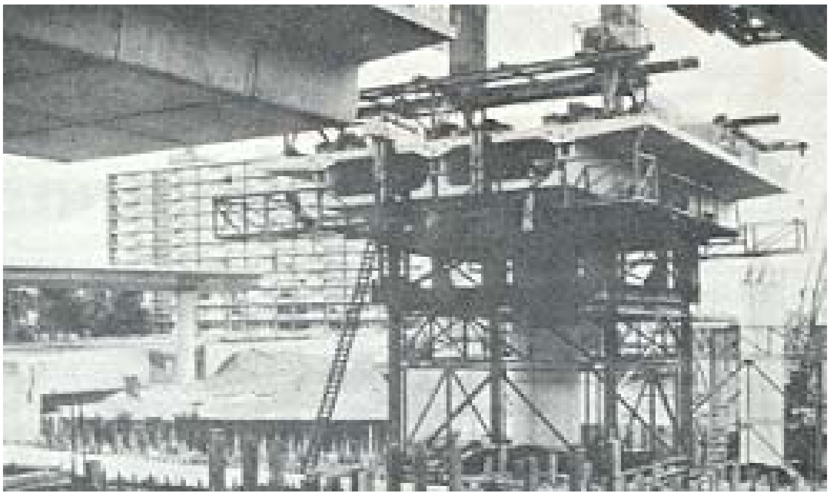
ROTTERDAM MOTORWAY

On the outskirts of Rotterdam, motorist coming from The Hague pass an enormous building site which is going to be the Kleinpolderplein motorway junction. This junction will link Rijkweg 13 to Delft and The Hague, Stadhoudersweg into Rotterdam city centre and the Maastunnel, and the northern section of the planned Rotterdam ring road system, which consists of Rijkweg 3 eastward to Gouda and Utrecht, and Rijksweg 20 westward to Vlaardingen, Hook of Holland and the Benelux Tunnel.
When the construction of the system of roads and fly-over is complete in the spring of 1971, it will have taken three and half years to build and approximately 40.000 cubic metres of concrete and 8.500 tons of steel will have been put into place. The intersection will then have a total of 45.000 square metres of road surface, ready to carry an expected 75.000 to 80.000 vehicles per day.
In addition to the steel and the concrete, special formulated epoxy adhesive paste (P.A 103), based on *Epikote* resins play an integral part in the total construction. They have been used for the jointing of prefabricated concrete sections thus enabling a much greater speed of building than would otherwise have been possible in specific parts of the complex.
The overall design of the junction is quite elaborate, involving roads at four different levels – the main east-west artery is 5 metres below ground level, inter-connecting roads are at ground level, direct north-south traffic lanes are carried on fly-overs 6 metres above ground level, while the fly-overs joining Rijksweg 13 and Rijksweg 3 are 12 metres above the ground.
Several different construction methods are used in a project of this size and importance, and in this case particular attention had to be paid to the choice of design and construction methods for the fly-overs.
In addition to the normal engineering considerations, factors which had to be borne in mind were the limited available space, the time available for building and the high traffic density around the building site. This led to the choice of two different types of construction for the fly-overs – a flat slab design being used for one group and a box girder design for the others.
The flat slab design was adopted when the clearances needed below the fly-over made it essential to limit the thickness of the deck. The fly-overs of this design are supported on large oval pillars cast in place; the spans were also cast in formwork erected on the site. Since the large number of underground cables and lines crossing the site precluded extensive pile driving, the formwork was supported by steel cradles, 52 metres long and weighting 60 tons. As each span was completed, the cradles were rolled to the location for the next span.
In this way, three of the fly-overs were built each consisting of about 40 spans varying in length from 25 to 35 metres.

The gantry in position for building a span.

For the other three fly-overs, however, it would have been impossible to use such a method of building because of the interference this would have caused to the heavy traffic using the existing main roads crossing the site from north to south. Moreover, the large supporting pillars needed would have restricted lines of sight for traffic moving on the ground level roads of the completed junction. Hence for these three fly-overs, a box-girder type of construction has been used; in effect the concrete deck is carried by two conjoined concrete cylinders which give great rigidity to the structure. The supporting pillars can then be centrally placed circular columns of relatively small diameters, which will interfere, as little as possible with a driver's view.



A supportino pillar with staging, the hammerhead section and the first two sections of the span are in place.

In situ casting using mobile shuttering was considered originally as a construction method, but it was decided that there were many objections to this both in the time required and the traffic congestion it would have caused. Building from pre-fabricated sections, jointed and prestressed, was therefore decided on, despite the close tolerances to which the pre-fabricated sections would have to be made. Co-operation between the Survey Department of the Rijkswaterstaat and the contractors, Van Haltum en Blankevoot N.V. who have considerable experience and know-how in this field, solved the design and practical casting problems involved in copying with different lengths of span varying in shape and curvature.

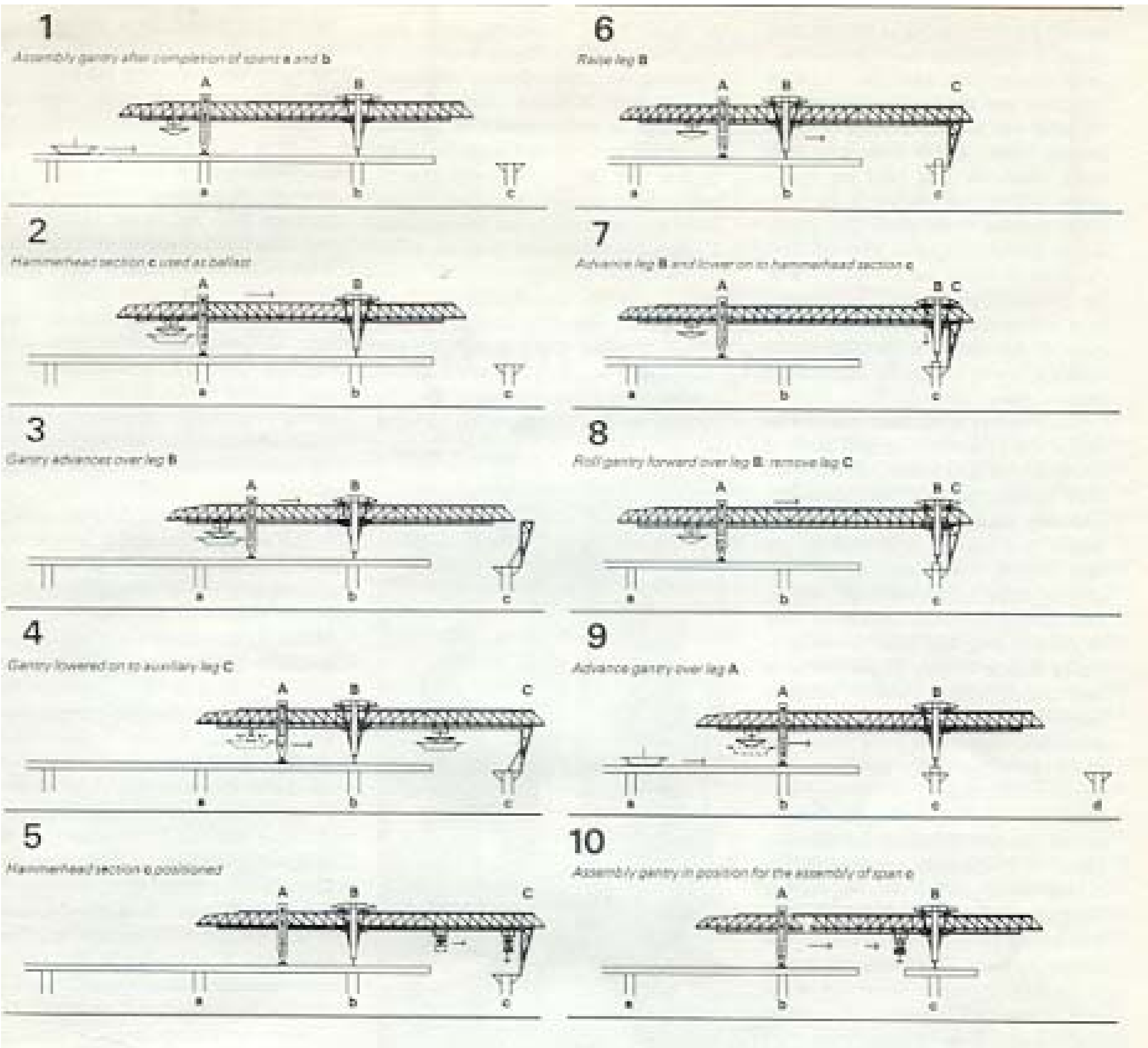
The major restriction of this design is that the thickness of the box sections is substantial, almost 1.5 metres. This would have presented great difficulties in the other three fly-overs, therefore two different designs and methods of construction are being used on the site to provide a structure that has been 'tailored in concrete'.

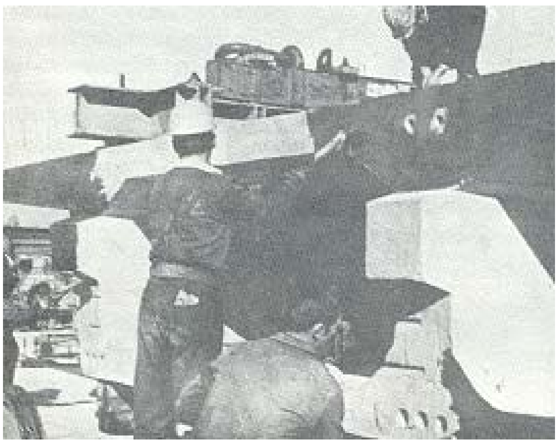
The three box girder fly-overs are made up of spans which vary in lengths from 26 to 35 metres; the pre-fabricated sections are each about 3 metres long and weigh on average some 40 tons.

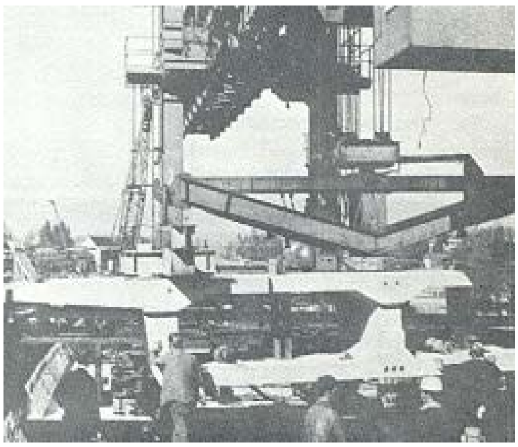
Several places were examined as possible sites where the sections could be made without obstructing other construction work on the site – or the traffic; the site eventually chosen was at Kats in Zeeland, a considerable distance from Rotterdam but allowing easy transport by ship up the Rhine-Shie Canal to the Kleinpolderplein. At the building site the sections are unloaded on to trolleys to travel the last few metres to the points at which they are wanted.

The method of assembly of the fly-overs from the pre-fabricated sections is rapid and, since the only places where work is carried out at ground level are immediately around the supporting columns, there is a maximum of obstruction to the existing traffic flow of about 50.000 vehicles per day. The first step in the construction of a span is the construction around the column of staging, the upper section of which is an adjustable cradle; the staging also carries the auxiliary leg that is a temporary support for the main girder of the assembly gantry. The further steps are shown schematically in the diagrams; it should be noted that is method of construction a span consists of the centre piece mounted on the support pillar and the two half spans each side of it. Using the hammerhead section which will be the centre piece of the new span as ballast, the gantry is moved forward to rest on the auxiliary leg. The hammerhead section is then placed on the cradle and secured with wedges; the whole is then adjusted into the correct position. The top of the column carries steel Kreutz adapters and, after the hammerhead section has been located on top of the column, some clearance remains between the upper surface of the Kreutz adapter and the circular cut-out in the concrete Kreutz plate on the underside of the section. This is filled with a specially formulated grouting compound formed by E/2 epoxy binder and quartz aggregate.

The rapid setting rate and development of strength of the E/2 epoxy compound play an essential part in achieving the required speed of building, since after a few hours it is strong enough for the front leg of the assembly gantry to be lowered onto the hammerhead section. This takes the weight of the girder and the auxiliary leg so that the latter can be disconnected from the jacking frame; at the same time rails along which the rear fixed leg of the gantry will run are laid along the completed portion of the deck. The gantry is then moved forward to give sufficient clearance to lower the auxiliary leg to the ground, from where it is removed by a mobile crane. The forward movement of the gantry is then continued until is in position for the assembly of the new span.







Coating the face of a section with the epoxy adhesive P.A. 103 based adhesive and (right) bringing a closing section between two spans into place.

The assembly of the span can now be carried by positioning deck sections alternately on each side of the hammerhead section; the firs two, those immediately adjacent to the hammerhead section, are initially supported by the steel staging, the remainder are assembled using launch-out construction.

Each section is lowered into place after its contact area and that of the preceding section already in position have been coated with the epoxy adhesive P.A 103 based on *Epikote* resins. This is a compound supplied as two components which are thoroughly mixed shortly before application to the contact surfaces; placing the section must then be carried out rapidly within the adhesive pot-life expire, while preliminary prestressing is carried out also rapidly before the adhesive hardens. Preliminary prestressing is carried out as soon as possible, tension being applied by means of four Dywidag rods acting on steel beams against the contact surfaces. This forces any excess of P.A. 103 adhesive out of the joint and ensures that the joint is under a pressure of 3 to 4 kgf/cm^2 while the resin based adhesive hardens. The design of the sections includes centring ribs which facilitate rapid placement and also help to prevent displacement during this hardening period of a few hours.

The permanent presstressing load obtained with six 12 ø ½´´ Freyssinet cables is applied from auxiliary staging, the jacks being suspended from the upper trolleys. This staging is also used in coating the contract faces of the outer sections with P.A. 103 adhesive. Towards the final stage in the assembly of a span, four or five sections each weighing up to 40 tons are attached to the central hammerhead section; the P.A. 103 epoxy adhesive ensures the efficient transmission of stresses between these sections. Since the maximum strength is higher then that of concrete and is reached much more quickly then that of concrete cast *in situ*, the time required between the fitting into place of successive sections is reduced by a factor of eight. Despite the time needed to centre the forward leg before placing each prefabricated section, once the assembly gantry is in place, a span containing ten sections is completed in three days using the epoxy based P.A. 103 adhesive.

The last few inches as a section is moved into position.

Joining the new span to the previously completed span is done by inserting a closing section secured with a temporary pre-load into the space between the two. The residual gap of about 20 cm is fitted with reinforcement into which concrete is poured after the span has been aligned vertically and horizontally. The continuity cables, nine 12 ø ½´´ and four 12 ø 7.5 Freyssinet system, are then stressed to join the two portions of the fly-over. While the assembly gantry is moved forward to start the next span, the completed span is finished – the cable slots are filled, the edged and guardrails fitted and the deck coated.

This method of assembly is rapid and has, in fact, proved so effective that construction has proceeded well ahead of the dead-lines for each stage – a tribute to the many skills which have gone into this major project. The overall plan to relieve traffic congestion was drawn up by the Highways Department and the General Services Department of the Rijkswaterstaat in co-operation with the Town Planning Authority of Rotterdam Municipality – detailed project planning was the responsibility of the Bridges Department of Rijkswaterstaat.

The contractors are N.V. tot Aanneming van Werken v/h H.J. Nederhorst of Gouda and Van Hattum en Blankevoort N.V. of Beverwijk. Epoxy compounds E/2 and P.A.103 were manufactured by Sinmast Nederland.

When the Kleinpolderplein project is completed, few of the 500.000 motorists who will be using the road junction each week will be aware of the skill and care of the designers and contractors – or of the epoxy compounds used.

Yet these resin composition will be playing their part with the other engineering materials in ensuring a rapid and safe journey for them.