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Experience obtained with Structures Executed in France.

Erfahrungen bei ausgeführten Bauwerken in Frankreich.

Observations sur les ouvrages exécutés en France.

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The object of this brief paper is to comment on a number of interesting examples of welded structures carried out in France.

Building in the Rue Jeanne d'Arc at Issy-les-Moulineaux.

This construction is an example of battened columns permitting convenienthy the fixing of beams by welding between the battens. This system enables the beams to be made continuous passing through the columns.

Cold Storage Building at Strasburg Railway Station (Fig. 1).

The skeleton of this structure is composed of light, continuous, welded framework.

Platform Roofing at Le Havre Harbour and Caen Railway Stations.

The platform roofing at the Harbour Station of Le Havre is supported by electric arc welded columns and cantilevering trusses. The trusses, which take the form of brackets, have T-beams as their top and bottom chords. The lattic members are either angles, T-irons or flats welded together.

The principal elements of the platform roofing at Caen Station are [-shaped trusses forming in turn truss, column, and reinforcing of the foundation slab. This construction, like the preceding one, is a lattice work system. The chords are composed of T-sections and the diagonals of double angles welded back to back on to the web of the boom.

Truss system for Motorcoach Garage at Thonon-les Bains.

The truss system of the roof is composed of three bays, one gable and two intermediary with a span of 31.50 and a spacing of 10 m. Height of trusses 6.25 m, covered area 32 m × 30 m.

Factory at Pont-Sainte-Maxence (Oise). (Fig. 2.)

The building measures 70 m × 40 m. This construction is composed of a central bay of 70 m × 19.40 m and two lateral bays 70 m × 10 m, shed-

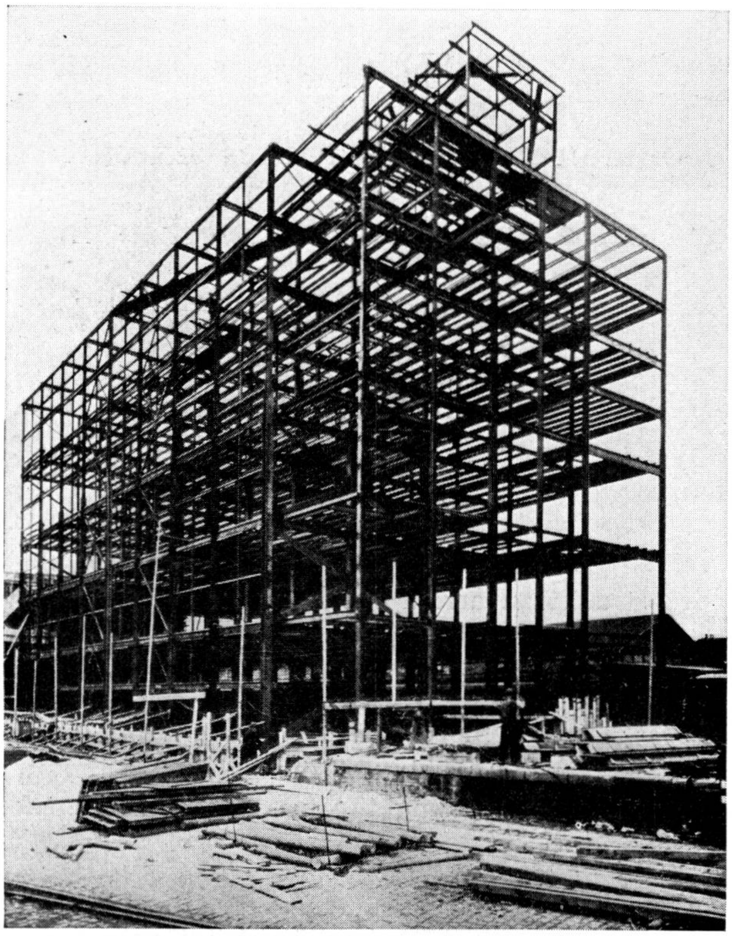

Fig. 1.

Cold storage building at the Railway Station, Strasbourg.

roofed. Height of central bay to tie beam is 11.50 m, that of the shed-roofs 7.65. Maximum height 16 m.

The central bay of the building carries a travelling crane of 25 tons, the shed bays two 5 ton cranes.

Usine des Alouettes (Factory in Lyon).

This factory is constructed in a similar manner to that mentioned above.

Another factory at Pont-Sainte-Maxence (Fig. 3).

This building measures 140 m × 40 m and is entirely shed-roofed. It consists of 12 bays of 9.90 m span. Height to tie beam is 7.80 m, total height 11.50 m.

Workshop at Dunkirk.

This structure has a floor area of 27.33 m × 11.33 m. Its height to tie beam is 10.45 m, total height 14 m. It carries a travelling crane of 10 tons.

Signal cabin overbridges at Mulhouse Station (Fig. 4).

The Vierendeel girders used in this construction have beams and uprights composed of double T-sections. The uprights are butt-welded directly on to the

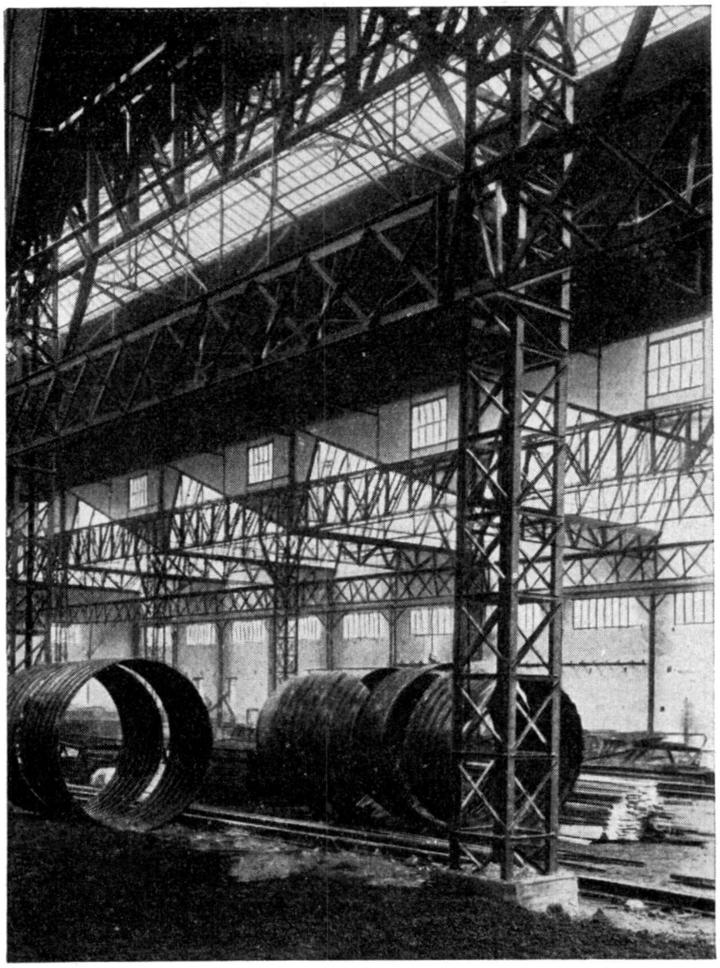

Fig. 2.
Factory building 70 m × 40 m at Pont-Ste-Maxence.

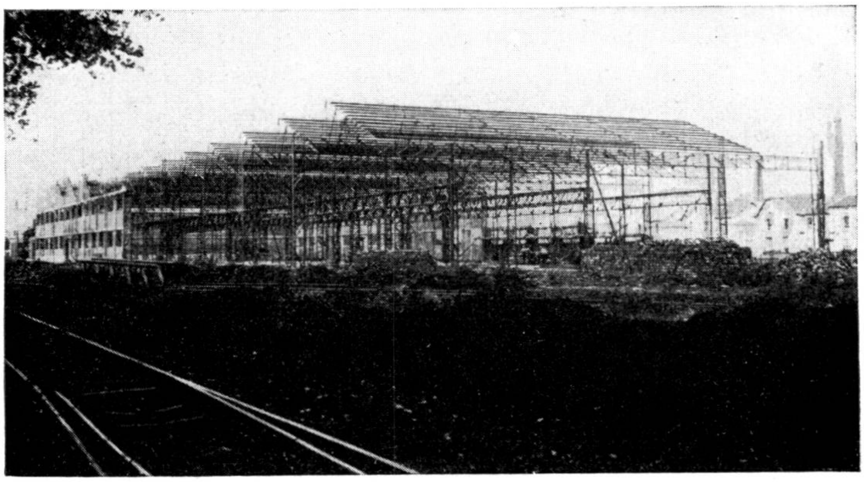

Fig. 3.
Another Factory building at Pont-Ste-Maxence.

booms, the joints being reinforced by simple gusset plates which counteract the moments of restraint. The columns supporting these overbridges were treated on the same principle.

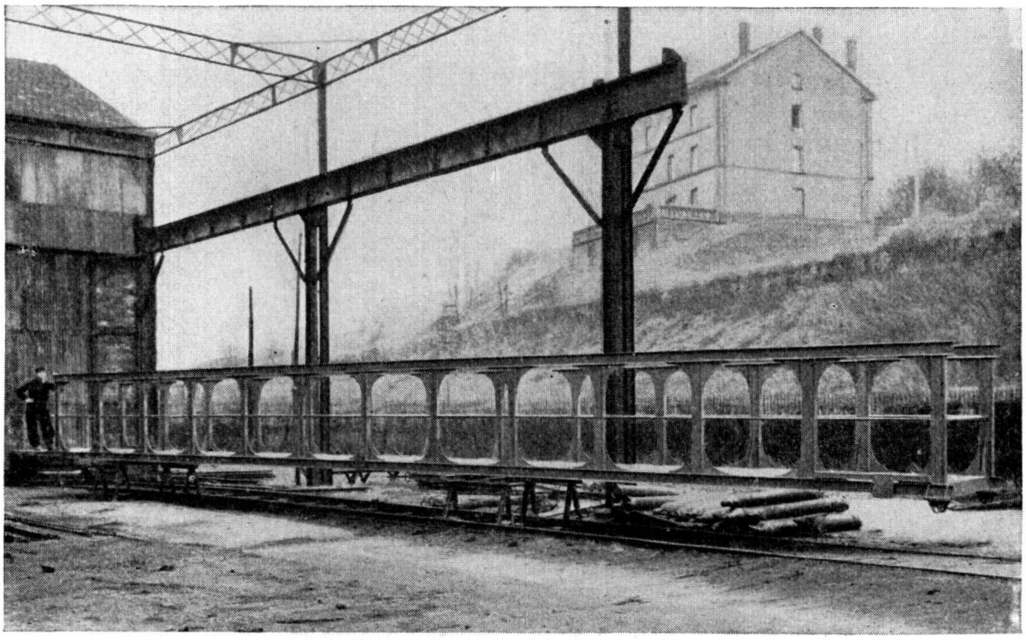

Fig. 4.

Signal Cabin overbridge at Mulhouse Rly. Station Alsace-Lorraine Railways, built by Longroy Ltd. (Dec. 1935). The upper and lower longitudinal beams are standard I-sections Nr. 140.

Cranes.

Reference may be made to the construction of four cranes for the Port of Calais, executed in Steel 54. Their principal features are: carrying capacity 10 tons at swivel hock, span 25 m, height 35 m.

Numerous welded travelling cranes have been constructed. One, for instance, which has a carrying capacity of 25 tons and a span of 20 m, has been in service for seven years. The diagonals are attached to the main girders by means of mitred joints, the girders being heavy T-sections and the diagonals double T's.

Mention might also be made of the revolving locomotive crane used by the Compagnie du Nord at their Joncherolles depot. It has a span of 24 m.

It has been estimated that the use of welding has reduced the weight of crane framework by from 15 to 20%.

Only after sufficient knowledge had been gained as regards the manner of executing bridges and other steel structures with electric arc welding was it possible to start with the actual construction of welded bridges.

Bridge at Ourscamp.

This is a road bridge erected over the canal parallel to the Oise. Its span is 40.47 m. It carries a road 3.50 wide with two sidewalks of 0.75 m. It was the first welded bridge constructed in France for the Department of Bridges and Roads.

The bridge is designed as a bow-string girder. The arches comprise two 3000 mm sections, laid horizontally and connected by a web 15 mm thick and with a height varying between 530 and 580 mm.

The tie members are composed of two 300 mm [-sections, also laid horizontally and connected by a web of 450×15 mm.

The cross girders are 450 mm — section beams to which the longitudinal girders of 300 mm — sections are welded whose continuity is ensured by means of welded cover plated joints at the connection with the cross girders. Deck plating is used, the concrete road being supported on buckled plates. The decking construction is suspended from the arches by means of latticed hangers of T section. The steel work of this bridge was carried out in soft Martin steel of 42 kg/mm². The total sonsumption was 65 tons.

The bridge was constructed under the direction of Monsieur Soleil, Chief Engineer for Roads and Bridges, Compiègne, and M. Alix. Engineer for Roads and Bridges.

Bridge at Vaires (Fig. 5).

The widening of this bridge involved the construction of two new arches which were entirely arc welded. These slender arches have a very pleasing appearance; heavy rectangular sections were used, which were welded on to the flanges of double T sections. The arches were joined up with a main I-section by means of welded lattice work.

Bridge of Saint Denis (Figs. 6 and 7).

The Compagnie du Nord has just had a railway bridge constructed, employing only electric arc welding. It is the first metal railway bridge to be welded in France, and its construction as such was due to the initiative of M. Cambournac, Chief Engineer of the Office of Works.

The bridge was constructed in two portions at the workshop. Each of the principal girders was provided with half pieces of the traverses, and on assembling the two halves were joined in situ.

The structure has a total weight of 165 tons. High resistance steel was used: St. 54 and St. 50. The main girders 63 m long and 2.40 m high, are plate girders.

Bridge over the Boulevard Ney in Paris.

This structure comprises two deckings of mild steel (St. 42), for one-way traffic, resting on blocks and bearings of milled steel.

The bridge consists ob three spans (one central bay of 35.20 m, and two lateral bays of 22.32 m). The distance between the two girders of each decking is 4.05 m. These girders are joined by cross beams, supporting two lines of longitudinal girders, carrying the rails.

The main girders are continuous, with cantilevering ends, of the full-web type. The two flanges and the web were welded directly; the web itself is provided with stiffeners.

This bridge, like the preceding one, was constructed under the direction of M. Cambournac.

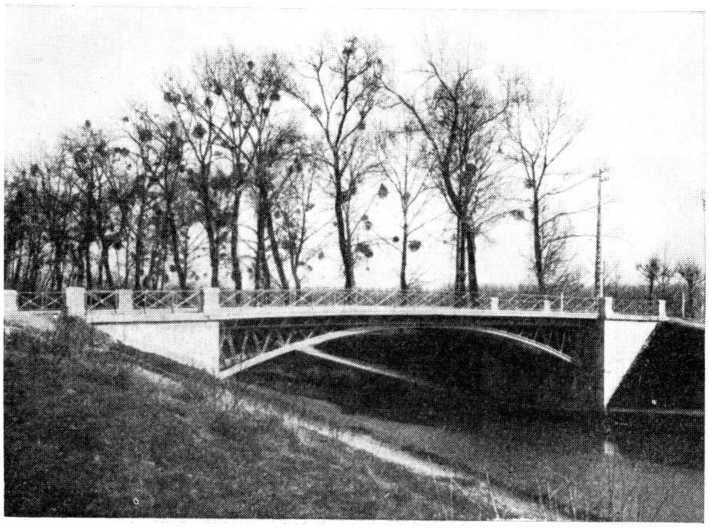

Fig. 5.
Bridge at Vaires.

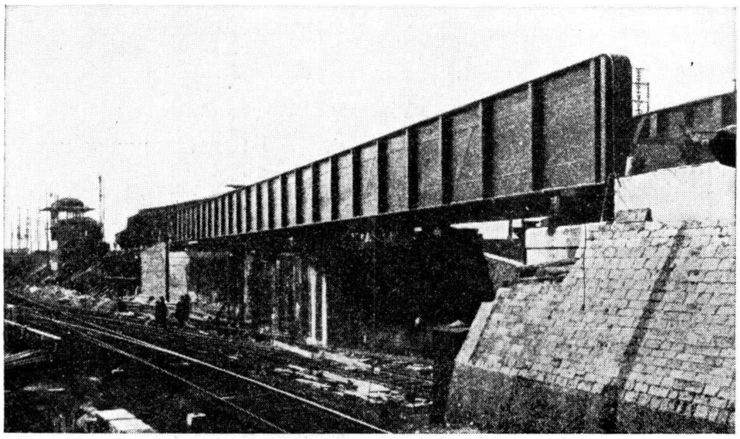

Fig. 6.
Bridge at Saint-Denis.

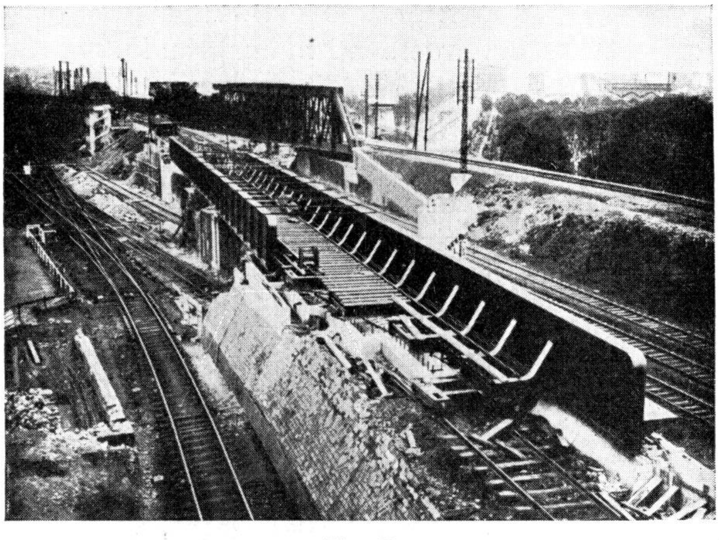

Fig. 7.
Bridge at Saint-Denis.

Strengthening of steel bridges by welding.

The State Railways have had quite a number of bridges strengthened. Among these jobs may be mentioned the strengthening of overbridges on the Versailles-Rennes line, and the reinforcement of the Mainvilliers bridge at Chartres Station.

All this work was carried out by strengthening the bottom flanges of the girders by means of flat bars welded to the lower part with side-fillet welds. As the booms are provided with flanges and consequently with rivets, the reinforcing flanges are also holed for riveting. The hole is then filled with weld metal which thus strengthens the rivets and plate stiffener. This type of reinforcement is also carried out by welding the stiffening plates of the web to the legs of the angles.

An interesting type of construction is the viaduct over the Authion, with a span of 37 m. The principal girders, of the lattice type, are 3.30 m high and were reinforced by the classic system of welding square or rectangular bars on to the booms between the rows of rivets. As to the diagonals, composed of angles and flats joined together, they were strengthened by means of flat irons and square bars combined.

The Eastern Railway Co. has also carried out repairs and strengthening work on railway bridges at different places of their system.

The Alsace-Lorraine Railways have strengthened the main girders of two bridges over the River Ill at Strasburg, with spans of 50 m.

And, finally, the Metropolitan Railway Co. is at present working on the reinforcement of the Austerlitz Viaduct over the Seine. This is a three-hinged arch bridge with a span of 140 m.

Among the reinforcing jobs carried out on road bridges might be mentioned the strengthening of the Jean-François Lépine Bridge and the swing bridge at Brest.

The execution of these various jobs has proved that in France welding is of particular interest in heavy structures. Here a direct saving in tonnage of from 10 to 30% can be attained, involving substantial reductions in the cost of the structure.

In the case of light structure it is the question of labour and organisation that counts most.

It has become evident that the saving in weight permits of better utilisation of the steel, both for the plates and for the sections. Auxiliary pieces become superfluous, the joints are reduced to the utmost simplicity by using butt welds. Thus the layers of superimposed plates that used to necessitate an excessive number of welds have disappeared, for instead of one multiple flange plate of varying thickness we now have a single thick piece composed of various thickness butt welded.

Quite extensive use is also being made of mitred or lapped joints, giving straightforward connections of great strength. The main object of these forms of assembly is to obtain lattice work whose members form a perfectly symmetrical design. It is thus possible to eliminate secondary forces which stress the lattice members to buckling point and substantially reduce the coefficient of safety of the structure.

The use of welding. also allows the structure to be easily protected against corrosion. As we have seen, thin superimposed layers are being discarded, and that the interstices covered over by welds can now be better insulted.

The perfect elasticity of welded structures should also be emphasised; this has been ascertained without difficulty by means of resistance tests carried out with extensometers. The explanation of this great elasticity lies in the fact that welding permits no slipping whatever in the connections.

An examination of welded construction in general and of bridges in particular reveals the fact that welding tends to produce really clean lines in metal structures. Thus it propagates a style of architecture in metal work that harmonises well with our modern conceptions.

These are, in our opinion, the various factors characterising the commencement of an important evolution in steel construction.