The development and use of the Robinson composite deck in France

Autor(en): **Fauchart, J. / Sfintesco, D.**

Objekttyp: **Article**

Zeitschrift: **IABSE reports of the working commissions = Rapports des commissions de travail AIPC = IVBH Berichte der Arbeitskommissionen**

Band (Jahr): **2 (1968)**

PDF erstellt am: **24.05.2024**

Persistenter Link: https://doi.org/10.5169/seals-3984

THE DEVELOPMENT AND USE OF THE ROBINSON COMPOSITE DECK IN FRANCE

Développement et applications de la dalle Robinson en France

Entwicklung und Anwendung der Robinson-Verbunddecke in Frankreich

J. FAUCHART
Ingénieur des Ponts et Chaussées
Service d'Etudes Techniques des Routes et Autoroutes
Ministère de l'Equipement
Paris

D. SFINTESCO
Directeur des Recherches
C.T.I.C.M., Puteaux 92, France

I - INTRODUCTION

This Symposium is devoted to the examination of the carpets to be applied to the light steel decks of highway, bridges that is to say primarily to orthotropic decks.

As the rapporteur, Dr. W. Henderson, has stated, this type of deck is the latest version of many artifices introduced by bridge engineers in order to :

- reduce the dead weight of the bridge deck,
- employ the decking material as an element capable of resisting the bending induced in the superstructure as a whole,
- reduce the overall depth of the superstructure.

Nonetheless, there are decks other than orthotropic which fulfil all these functions. There is, for example, in France a thin concrete deck, reinforced by a continuous supporting steel plate, which was developed and tested in 1950 by J.R. Robinson (Technical adviser to the IABSE) and J.R. Courbon, and which is known as the "Robinson deck" (1).

This deck has been used since then in dozens of French steel

(1) See especially :
J.R. Robinson, Preliminary publication, 4th Congress, IABSE, Cambridge, 1952
A. Schmid, Platelages légers pour ponts-routes, 7th Congress, IABSE, Rio de Janeiro, 1964.

bridges, including some of the most spectacular and some whose headroom requirements were critical. None of these schemes have caused the slightest trouble from the point of view of surfacing or decking or the system adopted.

By contrast, problems concerning the adherence of the carpet are presented when aluminium decking, which is used in moving bridges in docks, or orthotropic decks are employed, although the latter have been little used in France because the obstacles to be crossed require relatively small spans.

II - DESCRIPTION OF THE ROBINSON DECK

The deck is of composite steel and concreteconstruction, consisting of :

- a continuous steel supporting plate the thickness which is at least 6 mm (2),
- a concrete slab, poured onto this plate, to which it is attached by shear connectors which are either :
  - studs which transfer the shear forces between the steel and the concrete, as in Fig.1, or,
  - strips, bent at 45°, the lower parts of which are welded to the steel plate and the upper presenting horizontal portions, to which the reinforcement rods are welded, thus absorbing the shear forces by bond to the concrete, as in Fig. 2

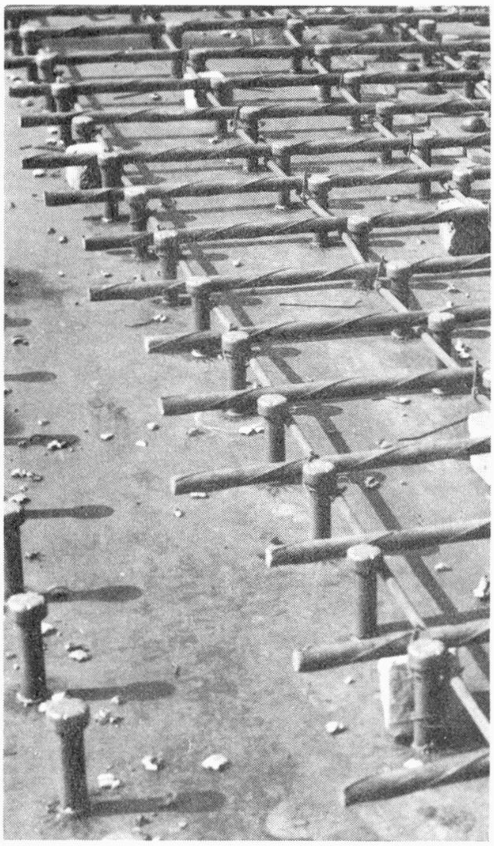


Fig. 1

(2) The French regulations for steel bridges (CPC-61-V) require that every structural element shall have a thickness of at least 8 mm, unless it is protected on one side (as is the case with the Robinson deck, thanks to the concrete slab), when it may be reduced to 6mm. Nevertheless, to limit the deflection in the plate under the load from the concrete and the effect of welding stud connectors, it is unusual to descend below 8 mm.

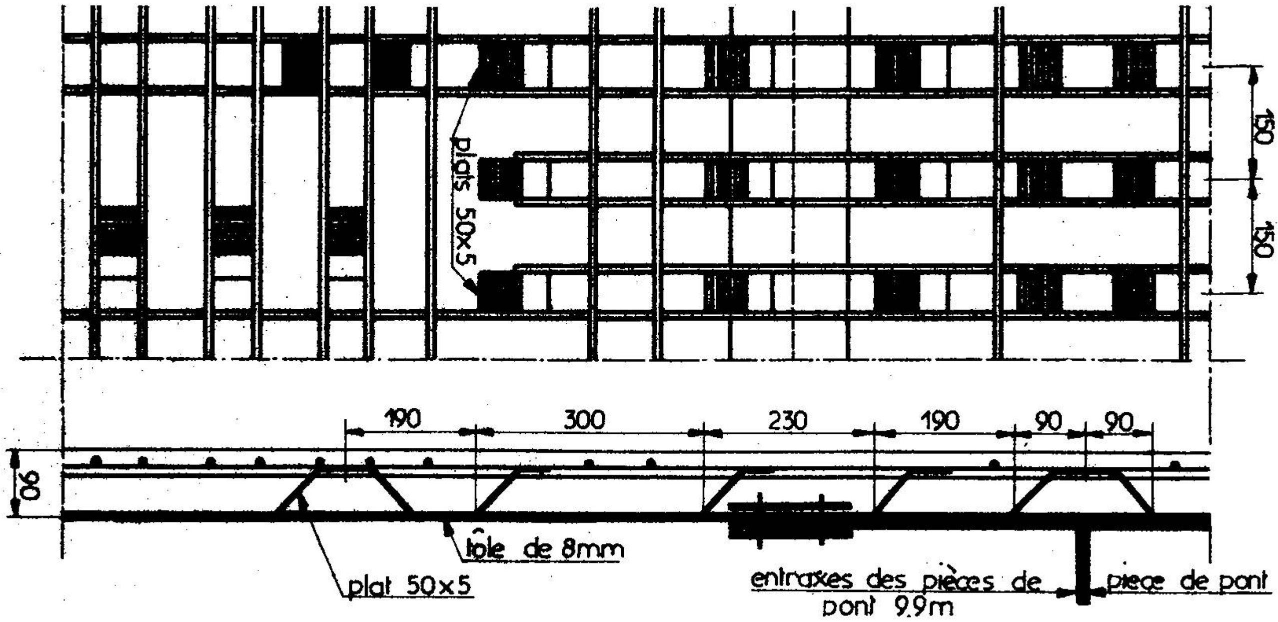


Fig. 2

The thickness of the concrete slab is considerably less than that required for a reinforced concrete slab, which on account of punching shear could scarcely descend below 16 cm.

By contrast, in the case of the Robinson deck, the continuous supporting steel plate, which is connected to the girders, acts as a membrane and avoids any risk of punching shear in the deck.

The minimum thickness of the slab is therefore fixed by the resistance to bending. Under the transverse bending moments between the girders, the compressive stress in the concrete must not exceed $0.6\,\sigma_{28}$ (which in practice limits the stress to between 175 and 200 kg/sq.cm).

As the spacing of the stringers varies from 1.0 to 2.5 m, the thickness of the slab varies from 6 to 10 cm.

The supporting steel plate, like the upper plate of an orthotropic, deck, plays several rôles :

- it resists local transverse bending between the main girders (or the stringers)
- as it is connected to the main girders and to the stringers (if there are any), it acts as the top flange of these members

in resisting bending.

III - SPHERE OF USE

Comparison with other kinds of surfacing

Let us compare the weight per sq.m. of reinforced concrete, Robinson and orthotropic decks. In the first two cases, the wearing surface has a thickness varying from 4 cm (where it is necessary to keep the weight down, as in a swing or lifting bridge) to 6 cm. For orthotropic decks, a thickness of 7 cm is considered necessary. The densities considered are : 2.25 tons/cub.m for bituminous carpets, 2.5 tons/cub.m for concrete and 7.85 tons/cub.m for steel. Finally, the weight of the orthotropic deck is calculated by considering an "equivalent thickness" (12 mm thick plate + stringers and cross girders) of 25 mm.

Weight in kg/sq.m

Deck	Reinforced concrete	Robinson	Orthotropic
Surfacing	(0.04 to 0.06)x2250= ~100	100	0.07x2250= ~150
Concrete	0.18x2500 = 450	0.08x2500=200	-
Steel	-	0.008x7850=65	0.025x7850= ~200
TOTAL	550	365	350

This comparison demonstrates that the Robinson deck and an orthotropic deck are of about the same weight.

It must be said, however, that :

- As far as general bending is concerned,all the steel section of the orthotropic deck acts, equally in tension as in compression, while, by contrast, only the bottom plate (of smaller section) of the Robinson deck can resist tension in the zones subjected to negative moments (and where the concrete is also in tension).

- Although the spacing of the main girders for orthotropic decks may be large, for the Robinson deck it must be limited. Alternatively, intermediate stringers may be used which of course increase the amount of steel employed beyond the figure mentioned above.

From the experience gained in competitions and in the structures erected in France, it is possible to say that at the present time in our country :

a) The Robinson deck is the type of deck to adopt for steel bridges required for spans of about 100 m or less, when the depths are less than 1/30 of the span (a reinforced concrete deck is too thick in comparison with the Robinson deck which allows a reduction in depth of about 10 cm).

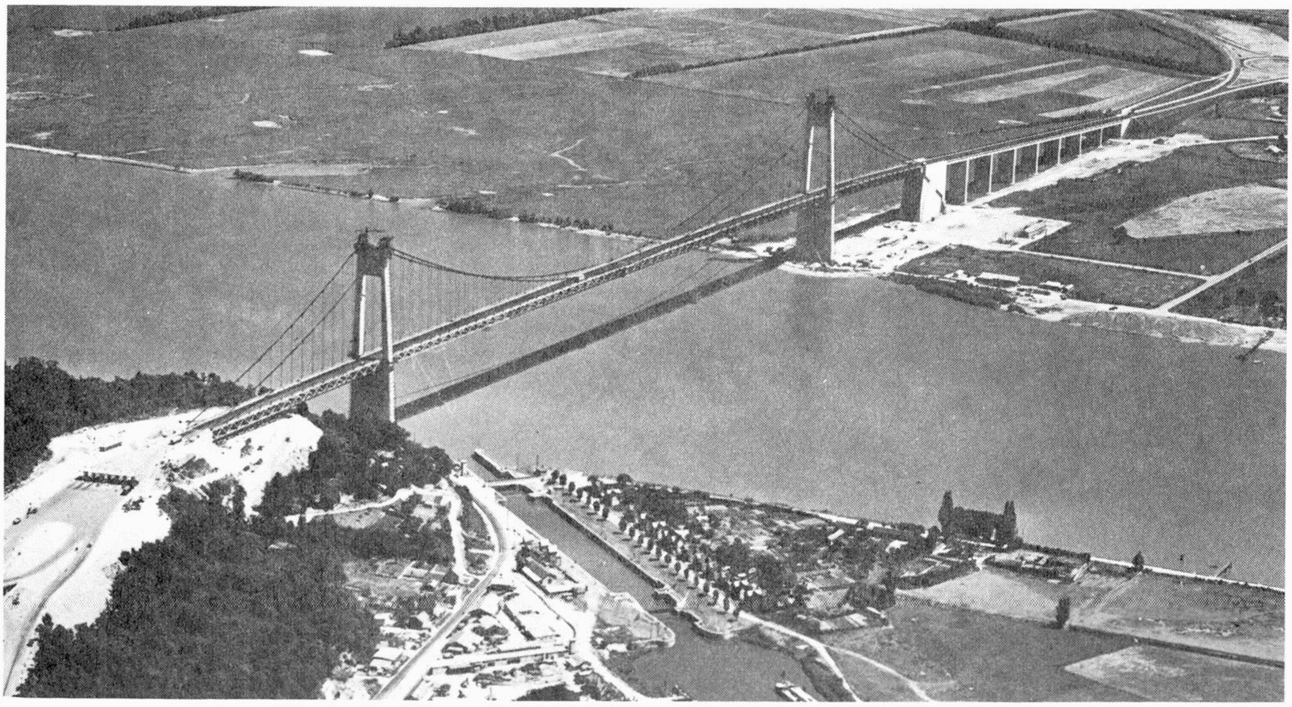
b) The orthotropic deck, intrinsically more expensive because of the price of steel, which is more than that of concrete, and of the expense of fabrication and multiple welds, is considered for structures whose spans are at least 150 m.

IV - PRACTICAL EXAMPLES

IV.1 - Suspension bridges

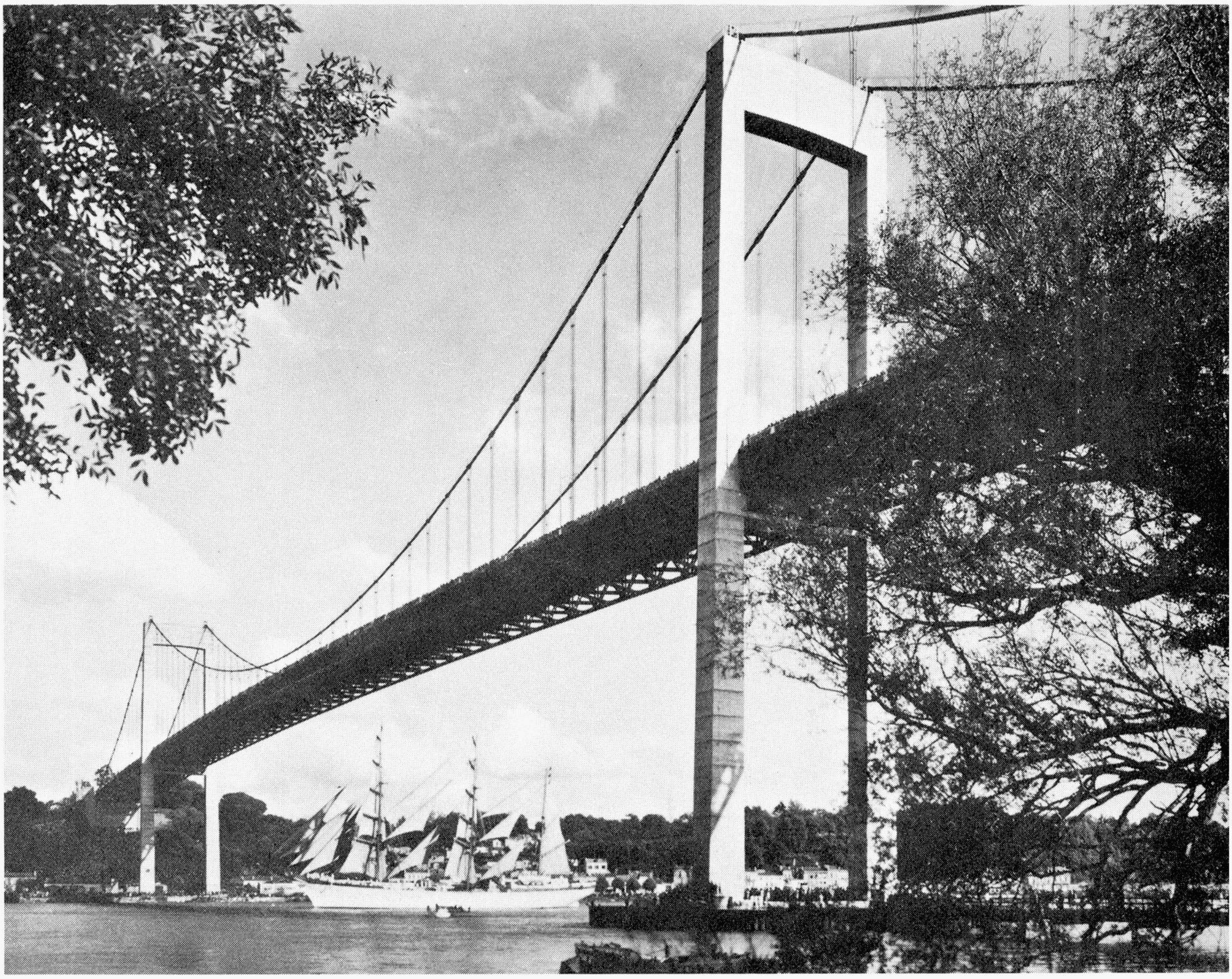
The two latest (and greatest) suspension bridges built in France have a Robinson deck.

Fig. 3



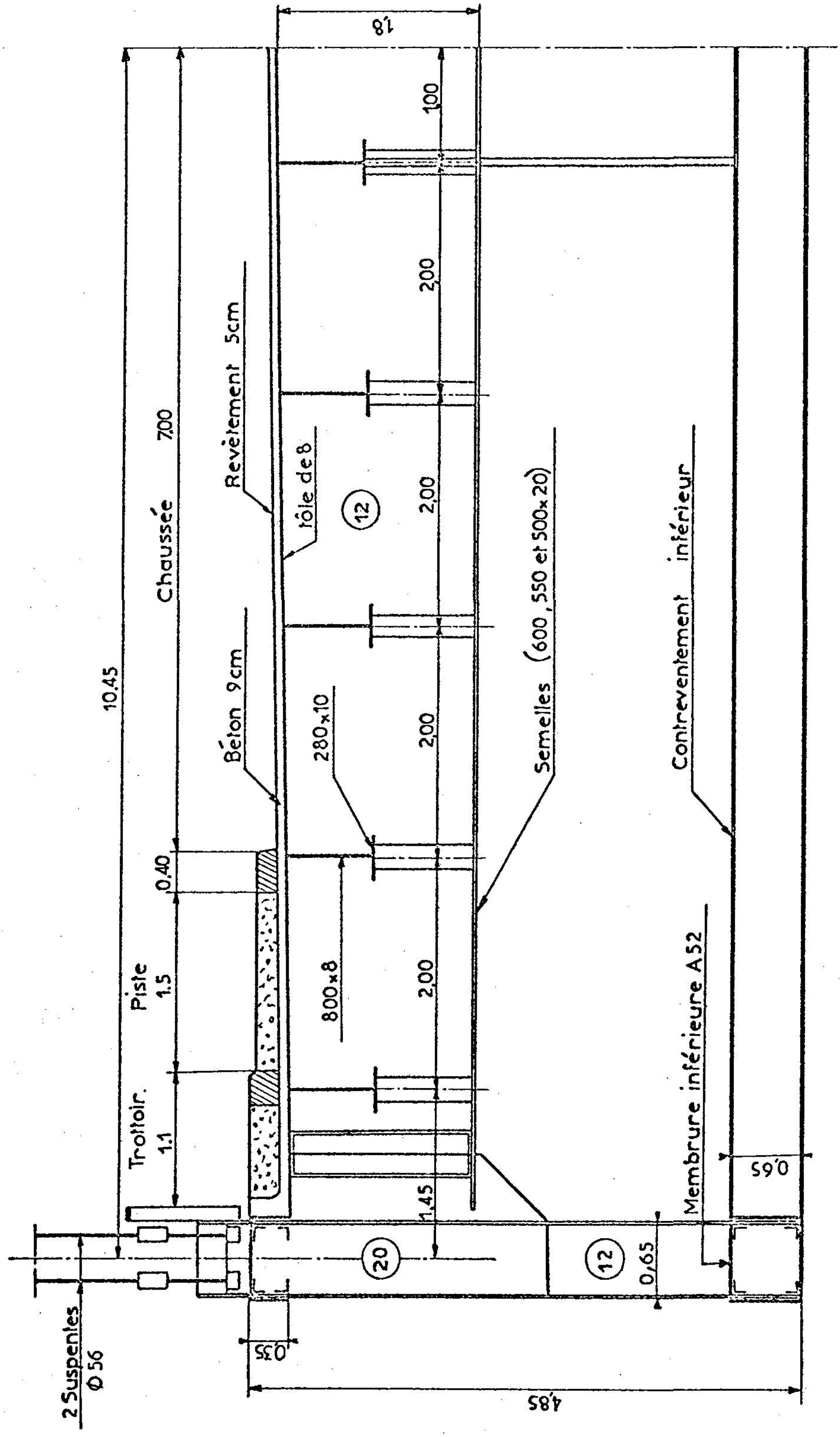
Bridges	Spans m	Spacing of stringers m	Thickness of decking		Connectors
			Plate cm	concrete cm	
Tancarville (Fig.3)	176+608+176	2.0	1.0	9.5	Studs
Bordeaux (Fig.4.5)	150+384+150	2.0	0.8	9.0	Strips at 45°

Fig.4



PONT SUSPENDU DE BORDEAUX

Demi-coupe transversale



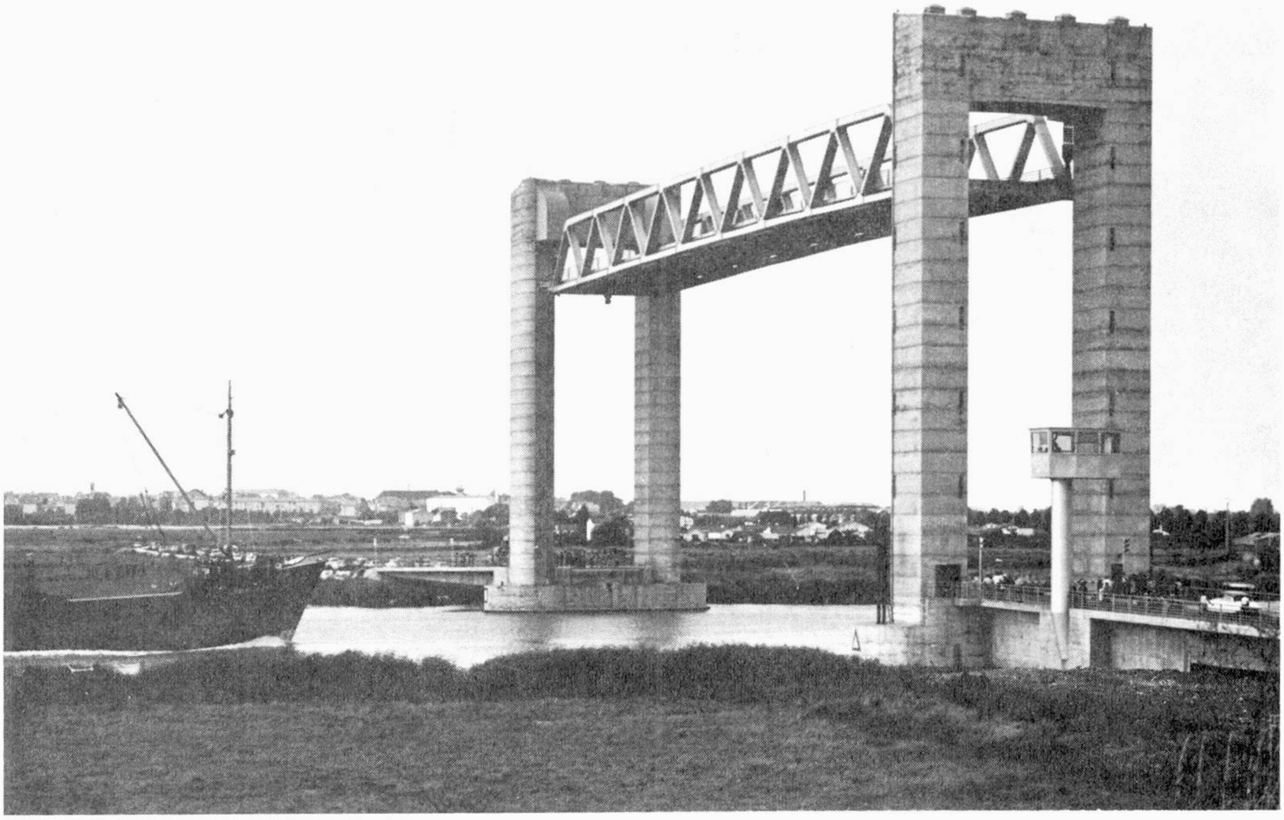


Fig.6

IV.2 - Moving bridges

The last two moving bridges built in France were lifting bridges. They are of the through type with Warren girders and a Robinson deck.

In the case of the bridge at Brest, the slab rests on a curved plate, the minimum thickness being above the girders and the maximum at mid-span.

Bridge	Span m	Spacing of stringers m	Thickness of decking		Total depth of superstructure
			Plate cm	Concrete cm	
Brest	87.50	1.50	0.6	5 to 9 (curved plates)	1.35
Martrou (Fig.6)	92.43	1.10 to 1.60	0.8	6 to 9	1.01

IV.3 - Slender bridges

Kind of bridge	Bridge	Span m	Total depth of superstructure m	Thickness	
				Plate	Concrete
Single span girder bridge	Attigny	21.5	0.575	1.2	5 to 9 (curved plates)
Continuous girders bridge	Lorient	63+95+63	3.70 to 2.18	0.8 to 2.0	6
Portal	Jeumont	32.9	0.69	1.0	5 to 18 (curved plates)
Triangulated through girder bridge	Rangiport	102.52	1.222	0.8	6 to 10 (curved plates

V - CONCLUSION

In the last twenty years many French steel bridges have been built with the Robinson composite steel and concrete deck, scarcely heavier than an orthotropic deck.

The thickness of the bituminous carpet, which is normally 6 cm, could be reduced to about 4 cm for moving or highly trafficked bridges.

There have been no difficulties connected with :

- the adherence of the surfacing (which is the same as that in current use for concrete bridges),

- the resistance of the supporting steel plate to corrosion. It seems that its top surface is protected by the concrete. In addition, as the plates are usually made continuous by welding, no water can pass through them.

SUMMARY

Light bridge decks in composite construction of the Robinson-type have been used in France for nearly 20 years, especially for bridges with spans up to 100 m and/or with relatively small depth, as well as for movable bridges.

A brief description of this type of deck and some examples of such structures are given.

RESUME

La dalle mixte légère, système Robinson, est employée en France depuis près de 20 ans, notamment pour des ponts à portées jusqu'à 100 m ou à hauteur de tablier relativement faible, ainsi que pour des ponts mobiles.

Une description sommaire de ce type de dalle ainsi que des exemples de ponts construits sont donnés.

ZUSAMMENFASSUNG

Die leichte Verbunddecke System Robinson wird in Frankreich seit fast 20 Jahren angewandt, und zwar hauptsächlich für Brücken mit Spannweiten bis zu etwa 100 m, und/oder mit relativ kleiner Bauhöhe sowie für bewegliche Brücken.

Eine kurze Beschreibung dieses Deckensystems und einige Anwendungsbeispiele werden angegeben.

Leere Seite
Blank page
Page vide