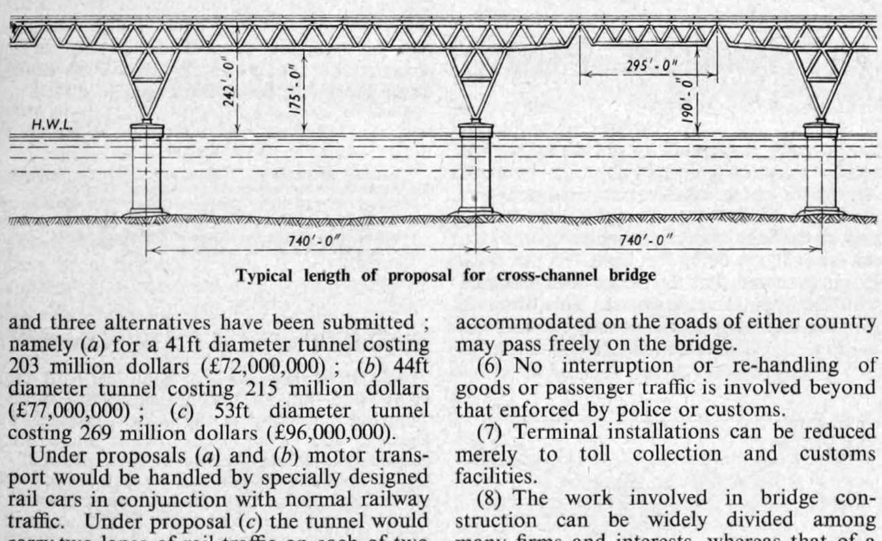
Proposal for a Road and Rail Crossing of the Channel

Much attention has been given in recent months to proposals for a cross-channel tunnel. Within the past week, there have been two important developments, namely the submission of schemes for a tunnel and a bridge respectively to the channel tunnel study group by groups of internationally-known contractors. Here the tunnel scheme is mentioned only briefly, but the bridge scheme is described more fully.

LAST week, two priced proposals for the construction of a channel crossing were submitted to the channel tunnel study group. One of these proposals gave details of a tunnel, and the second was for a bridge. As we go to press only an outline of the tunnel proposal is available, which is given first, followed by a more detailed explanation of the bridge proposal.

Four contracting firms are grouped in the proposal for the tunnel, which, it is stated, will take three-and-a-half years to construct. Richard Costain, Ltd., represents British interests, Hyperion Constructors and Kaiser Engineers and Constructors Inc. represent U.S. interests, and Entreprises Campenon Bernard represents French interests in this group. The proposal is for a submerged tunnel similar to one which is now being successfully constructed in the open waters of the Pacific in depths of 200ft, it is stated, and three alternatives have been submitted; namely (*a*) for a 41ft diameter tunnel costing 203 million dollars (£72,000,000); (*b*) 44ft diameter tunnel costing 215 million dollars (£77,000,000); (*c*) 53ft diameter tunnel costing 269 million dollars (£96,000,000).



Typical length of proposal for cross-channel bridge

Under proposals (*a*) and (*b*) motor transport would be handled by specially designed rail cars in conjunction with normal railway traffic. Under proposal (*c*) the tunnel would carry two lanes of rail traffic on each of two levels, and motor transport would be handled independently of the normal passenger and freight traffic on specially air-conditioned trains operating on the upper level.

Project for a Cross-Channel Bridge

The gist of this article consists of the substance of a statement sent to us by Dorman Long (Bridge and Engineering), Ltd., about the channel bridge proposal. Thus the views expressed about the advantages of the bridge are strictly those of Messrs. Dorman Long. The statement is as follows:

"A project and priced estimate for a channel bridge, prepared under the direction of the Compagnie Francaise d'Entreprises, has been submitted to the channel tunnel study group on behalf of that company, in association with Dorman Long (Bridge and Engineering), Ltd., and the Merritt-Chapman and Scott Corporation of America. The bridge solution to the problem of a channel crossing offers many advantages:

"(1) From the aspect of amenity a bridge has every advantage over a tunnel. An underground journey of 25 miles is not a subject for pleasant anticipation.

(2) The bridge solution obviously provides the greatest safety to its users. The hazards of fire or ventilation failure are inherent in all long tunnels and become of major significance in a tunnel 25 miles long, sloping downwards at both ends.

(3) Road and rail and cycle traffic of all kinds can be accommodated on a bridge structure without any interruption or check to the flow of traffic.

(4) Either steam, diesel or electric propulsion can be used for the railway traffic.

(5) The largest vehicles which can be accommodated on the roads of either country may pass freely on the bridge.

(6) No interruption or re-handling of goods or passenger traffic is involved beyond that enforced by police or customs.

(7) Terminal installations can be reduced merely to toll collection and customs facilities.

(8) The work involved in bridge construction can be widely divided among many firms and interests, whereas that of a bored tunnel is concentrated at the tunnel faces.

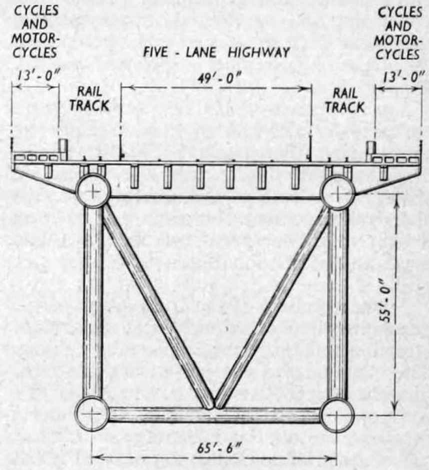
(9) The first cost of a bridge cannot be simply compared with that for a tunnel. The true comparison lies between the unit cost per ton, per passenger car or vehicle crossing the channel, with proper allowance for future developments with either solution, after taking due account of the cost of maintenance.

(10) Since the financing of the project is inevitably subject to the guarantees of the British and French Governments, it would seem that its benefits should be as widely distributed as possible and not confined to the users of rail traffic only to the detriment of commercial and private road users.

(11) Only an open uninterrupted highway can permit the full development of tourist and commercial traffic between England and Continental Europe through France."

Technical Characteristics of the Bridge Proposal

"The proposed line of the bridge crosses the Straits at the narrowest point, a distance of 21 miles from the South Foreland near Dover to a point just south-west of Sangatte near Calais. Rail connections with existing routes can be made within 5 miles of the bridge terminal on the French side and just over 2 miles on the English side. Considerable investigations of the foundation conditions on the sea-bed have already been carried out. If subsequent investigations of the route proposed show any diversion to be advisable, this can readily be accommodated. The level of the land at both ends of the bridge greatly facilitates the bridge approaches. The bridge terminals in both England and France will lie in open country. Design has been based on standardised mass-production methods and use of the heaviest equipment.



Typical cross section of cross-channel bridge proposal

"The bridge is designed to provide: a central five-lane highway 49ft wide; two rail-road tracks, one on each side of the highway directly over the bridge girders; an overhanging 'sidewalk' 13ft wide on each side for cycle and motor-cycle traffic. The design is in accordance with British and French national loading standards and specifications.

"On economic grounds for the conditions prevailing, a span of 740ft between pier centres has been adopted throughout the crossing with the exception of two pairs of wider navigation openings, situated on the sea routes on either side of the Varne Bank. A minimum headroom of 170ft at high water is available under the ordinary spans and 230ft in the navigation openings. The normal spans are of alternate cantilever and suspended span construction. The piers are situated in the following depths of water: eighteen piers in depths between 0ft and 65ft; thirty-five piers in depths between 65ft and 100ft; forty-five piers in depths between 100ft and 130ft; forty-four piers in depths between 130ft and 165ft. Their construction would involve no difficulties greater than those which have already been successfully overcome.

Construction of Piers.—"The successive construction of a very great number of piers of the same design and in increasing depths of water will permit the development and adjustment of the fabrication and placing technique as the work proceeds towards the deeper water.

"The piers are of uniform section,

approximately elliptical in form. They consist of heavy precast rings of reinforced concrete superimposed on one another, with socket joints. The lowest ring which forms the foundation on the channel bed is filled with a grouted rockfill mass after setting in place. The remaining rings are filled with sand or other granular material. The whole pier will be anchored to its base by cables set in conduits formed in the walls of each ring and grouted in place. The upper ring will be covered with a concrete slab some 50ft above sea level upon which the legs of the steel superstructure are supported.

Superstructure.—" The steel superstructure comprises cantilever truss spans, 1180ft long overhanging the standard 740ft openings. Their ends are connected by 295ft suspended spans. The depth of the cantilever spans is sharply accentuated over each pier to form a support. The spans rest upon alternate fixed and expansion bearings on the pier caps.

" The members of the truss spans of the superstructure are of circular tubular construction built up from steel plates by welding. The magnitude of the project and the large amount of repetition involved makes such a form of construction economic. The tubular form has outstanding advantages in efficient use of material and reduction of wind resistance, and greatly simplifies maintenance. The dimensions of the tubes permit ample space for access and maintenance, and for the accommodation of services, if required. The outside diameter proposed for the chord tubes is 11ft 9in and for the web members 6ft 6in.

" The design of the bridge deck is based upon the orthotropic slab principle. The forms of the deck members are proportioned in such a manner as to induce deflection of the wind currents so as to protect vehicles using the bridge. Wind-tunnel experiments with this object in view are proceeding.

Mass Production of Units.—" Prefabrication of the pier ring segments and assembly of the superstructure units would be at yards established on both sides of the channel. This work would be carried out under the best conditions for mass-production. The pier ring segments would be floated out from the yard basin to their permanent sites with the aid of buoyancy tanks or ' camels.' At these sites they would be placed in position by ' De Long ' pontoon platforms fitted with their own generating plant and hoisting, compressed air and maintenance equipment. These platforms consist of large pontoons by which they can be floated from one site to another, with retractable legs or spuds which can be forced down to the sea-bed, thus raising the platforms from the water above the influence of wave action.

" Complete spans of the bridge superstructure would be assembled in the yards, rolled out on slipways, and transported on pontoons to the bridge site, where they would be deposited by the falling tide upon the completed piers. The total weight of structural steelwork is approximately 800,000 tons."

Hydraulic Ram as a Suction Pump

By N. G. CALVERT, B.Eng., Ph.D., A.M.I.Mech.E.*

EYTELWEIN (1803) in his classic work on the Hydraulic Ram[1] proposed a modification (Fig. 1) in order that the ram could be used as a suction instead of a forcing device.

In this proposal water was meant to flow from an upper level *A* to an intermediate level *B*. An impulse valve *E* was fitted at the entrance to a long drive pipe. When sufficient velocity was attained in this drive pipe, the hydro-dynamic drag on the impulse valve was to cause this valve to close. The inertia of the column was then meant to bring about a reduction in pressure at the point *D* which was to be sufficient to open the suction valve and set up a flow from the lower level *C* to the intermediate level *B*. The author has no evidence that Eytelwein, or anyone else, has hitherto attempted to construct such a device although the same effect has been achieved in a different way, in the " clean water " type of ram.

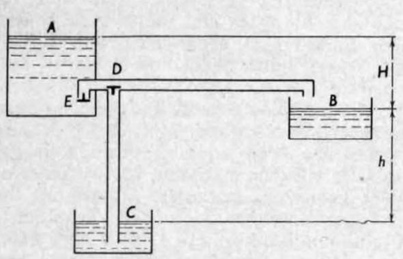


Fig. 1

Recently the author constructed a suction ram of the kind suggested by Eytelwein. The first attempt was based on ½in diameter pipe and both suction and supply heads were about 2ft. After some adjustments this ram was made to work but it was unstable in operation and its capacity and efficiency were very low, the latter figure being less than 1·5 per cent. It was observed that the device always stalled with the impulse valve closed. This observation led ultimately to the construction shown in Fig. 2. The essential modification to Eytelwein's suggestion is the addition of a pipe *AE* between the pipe entrance and the impulse valve. The function of this pipe is to provide the negative surge necessary to re-open the impulse valve and so bring about stable working. A second modification found to be desirable was to shorten the suction pipe by lowering the valve box from the intermediate level *B* to the lower level *C*. In this form the device becomes a workable machine.

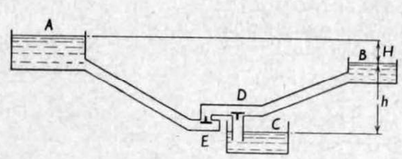


Fig. 2

An experimental model based on a drive pipe (*D*—*B*) 1½in diameter by 20ft long has been tested on supply heads varying from 2ft to 16ft with suction heads varying from 1ft to 14ft.

A typical set of experimental results are shown in Fig. 3. These are characteristic curves for a constant supply head of 4ft with suction head plotted as the independent variable.

The maximum suction capacity which has been observed in other experiments is

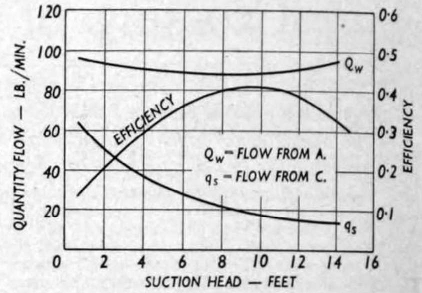


Fig. 3

76 lb/min with an efficiency of 0·35(H=10ft, h=2ft) and the maximum efficiency which has been observed is 0·7 with a delivery of 10 lb/min (H=2·5ft, h=15ft).

For stable working the length of the pipe *DB* is of some significance and it has an optimum value. This is controlled mainly by the beat frequency of the part of the plant *AE* considered as a hydraulic ram working under a head *H*. This in turn is controlled by the length of the pipe and the closing velocity of the valves (Calvert (1957)[2] and (1958)[3]). The adjustments are not critical and stable working continues over a wide range of suction and supply conditions. The device is self priming and can handle a mixture of air and water.

Possible applications might include the drainage of low lying land into an embanked river, the emptying of canal locks, turbine pits or riverside excavations during construction and repair and the use of a low head water supply for cellar drainage.

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REFERENCES

[1] Eytelwein, J. A., 1805, " Bermerkungen uber die Wirkung und Vortheilhafte Anwendung des Stosshebers " (Berlin).

[2] Calvert, N. G., " The Hydraulic Ram," THE ENGINEER, April 9, 1957, page 597.

[3] Calvert, N. G., " The Drive Pipe of a Hydraulic Ram," THE ENGINEER, December 26, 1958, page 1001.

Air Conditioning of T.S.S " Chusan "

As part of the scheme to equip all P. & O. liners with full air conditioning, the T. S. S. " Chusan " has been at the Belfast shipyard of Harland and Wolff, Ltd. While there the accommodation has been improved and additional facilities provided, and a full air conditioning system installed throughout all passenger and crew accommodation and public rooms. A total of thirty-four separate air-conditioning units were supplied by the Carrier Engineering Company, Ltd., and designed to fit into the spaces originally occupied by ventilating fans and motors so that there was practically no loss of passenger space. Twenty-six units serve the passenger accommodation and eight the crew spaces : they are generally connected to existing fans and contain mixing dampers, high-efficiency filters and a brine coil. The latter is supplied either with chilled brine for cooling and dehumidification, or hot brine, by means of a calorifier, for heating. Control of both cooling and heating is fully automatic so that operation of the respective plants is economic. For refrigeration purposes there are two turbine-driven Carrier centrifugal compressors, each of 385 tons capacity. The system supplies about 250,000 cubic feet of air per minute into the air-conditioned accommodation, and at peak outside summer conditions will remove 50 tons of moisture per day from supply air. Emergency fresh air inlets allow the fans to revert to ordinary air supply in the event of a refrigeration shut-down.