

tenor of their recommendation may be seen from Plate XV., which shows the proposed new streets, the widening of existing streets, and the city railway scheme and subway.

One cannot fail to be impressed with the fact that the city railway is urgently required, and must be underground, and that such being the case the only economical and practical solution of the problem of communication between North Sydney and the City is by subway also, since only in that way could a satisfactory linking up of the systems be effected.

Many of the works recommended by the Commissioners are now in progress, some are completed, but the most important items are not yet authorised, notably the City Railway scheme. Plate XVI. shows the City tramways as they are now. For many years past the traffic upon the City trams has been vastly in excess of their proper capacity, with the result that travelling in them has become a discomfort, accidents numerous, and owing to the great number of trams that have to be run at busy periods of the day, ordinary vehicular traffic is very seriously interfered with. The trams are a public convenience, and their permanence is assured, but it is generally agreed that the congestion of traffic in many of the streets is almost entirely due to the tramways. The traffic as measured in passengers carried, is steadily increasing, to an extent of from 8 to 10% per annum. In 1901 the number of passengers carried was 74½ million, in 1907 it was 134 million, at present the rate exceeds 200,000,000 per annum. The mileage of trams is steadily growing, but not in proportion to the increasing number of passengers carried. The output of power from the Ultimo Power Station for the operation of the trams has now reached the enormous figure of 70 million k.w. hours per annum, and now five additional 7,500 k.w. steam Turbo Alternators are on order, two of which are to be installed at the present power station, and three at the new station at White Bay.

Closely associated with the question of tram traffic is that of ferry traffic between the City and various Suburbs on the North Shore Line and others adjacent to the harbour waterways. At present these ferries carry over fifteen million passengers per annum, and the two vehicle ferries transport approximately half-a-million vehicles per annum.

The railway passengers to and from Milson's Point now exceed five millions per annum, and the North Sydney tramway system conveys over fourteen million passengers per annum. The rate of increase per year in the numbers carried on the North Sydney trams and railways exceeds that ruling on the City and South Suburban systems, and it is becoming increasingly apparent that some more direct means of communication must be established between North Sydney and the city, either by means of a bridge or subways, and that whatever scheme may be installed must provide for railway, tramway, and vehicular traffic as well as for pedestrians.

The present disposition of Sydney's tramways, railways, and ferry traffic, clearly emphasises the absolute necessity for direct communication between the North and South shores of the harbour in the vicinity of Circular Quay.

So far as the upper parts of the harbour are concerned, this transport is fairly well met by bridges, since at these points it is not necessary to consider the passage of sea-going ships, and although certain of these bridges are fitted with draw spans, it is only in two, viz., those at Pyrmont and at Glebe Island, that such spans are in frequent use. And before dismissing these bridges from our minds one must not fail to mention the totally unsatisfactory nature of the Pyrmont Bridge from the traffic point of view. This bridge lies in the main thoroughfare between the City and Pyrmont, Glebe, Balmain, and the thickly populated suburbs in that direction, and the traffic to be dealt with is

exceptionally heavy, the through traffic is daily obstructed to a very serious extent, and frequently for considerable periods resulting in a stoppage not only on the approaches of the bridge itself, but also in Sussex Street, Market Street, and Bridge Road. There can be no doubt that before long some other solution to this particular traffic problem must be found either by the reclamation of the upper part of Darling Harbour, as has been frequently suggested, or by the diversion of traffic through subways to link up with the main subway scheme. The leading problem, however, in harbour transport lies in the crossing of the harbour from the South to the North Shores in the vicinity of Dawes' and Milson's Points. For many years past this problem has exercised the minds of the public, and as far back as 1878 a bridge between the two shores was first seriously proposed.

It is interesting to note that in the year 1880 a proposition made to the Government of the day by Mr. J. L. Garbett, to build a bridge costing £850,000 was agreed to by the Ministry, and Mr. Garbett deposited the sum of £5000 as security, but a change of Government led to a rejection of the proposition, and the return of Mr. Garbett's deposit in the following year.

Various Bills were considered by Parliament from that date, some for bridges, others for subways, and in the year 1900 competitive designs for a bridge were invited with the result that many designs and tenders were submitted, some of which are shewn on Plates XVII. and XVIII. Of these designs that by "Sublazo" was awarded first place, and that marked "In Suspense" the second. None of the tenders were considered satisfactory, however, and all were ultimately rejected. Again in 1903 fresh tenders were called for under amended conditions, and finally that submitted by Messrs. Stewart and Co., with whom Mr. Norman Selfe was associated, was recommended for acceptance. This design, with which you all must be familiar, is shewn on Plates XIX. and XX.,

and with the necessary approaches was estimated to cost £1,940,000, and to be completed in five years. Temporary financial depression, however, prevented further action from being taken, and nothing further was done until the appointment of a Royal Commission in May, 1908, to further inquire into the question of communication between Sydney and North Sydney.

The conditions had by this time materially altered. The Central Railway Station was complete, city railways were under consideration, tramway conditions had changed, and this Commission reported strongly in favour of several independent subways in place of a bridge, their reasons for so doing being as follows:—

1. The fairway of the harbour would not be obstructed in any way by subways, whereas any practicable bridge must have a pier standing in, or projecting into, the harbour.
2. The combined capital cost of the necessary subways for all classes of traffic would be considerably less than that of a suitable bridge.
3. Railway, tramway, and vehicular subways could be separately undertaken, and completed independently of each other. With a bridge, embracing similar facilities, the whole structure must be completed before any of the respective services would be available.
4. Subways would be convenient and comfortable, and enable railway and tramway passengers to reach the different parts of the city with greater ease than by bridge.
5. The railway and tramway systems of Sydney and North Sydney can be more satisfactorily connected up for through traffic by subway than by bridge.

6. The costly section of the Milson's Point-Hornsby railway between Bay Road station and Milson's Point would be retained as portion of the through line which could not be done with a bridge.
7. Increased accommodation, when required, could be provided more economically by additional subways than by bridge.

Plate XXI. shows the recommendation of the 1908 Commission.

Since that date, the height of the masts of steamers, in which previously there had been a marked tendency toward reduction, is now on the increase again, due partly to the installation of Wireless Apparatus, and it is quite probable that the clear head room of 170 feet proposed for the bridge would not now be sufficient, a matter of considerable importance, since the difficulties encountered in constructing approaches and the cost of same would very rapidly increase with higher levels.

No doubt the bridge would be picturesque, but one cannot, I think, fail to agree with the Commissioners that apart from all sentiment, the subway system provides by far the most suitable and economical solution of the question.

Not being versed in military matters, I feel somewhat diffident in suggesting that, in war time, a bridge would be exposed to far greater risk of destruction than any subway or tunnel. One well directed shot might destroy the whole structure. There have been considerable discussions in military and engineering circles at Home over the selection of the site for the naval base at Rosyth, which is above the Forth Bridge, it being argued that in the event of the destruction of that structure, boats lying at Rosyth would be blocked in. A similar situation is possible at Cockatoo Island. The tunnel is much less likely to be destroyed, and even if so destroyed would not block the fairway.

The subway proposals are clearly shown on this diagram which was issued by and summarised the recommendation of the Commission of 1908-1909. It is to be noted that this subway scheme fits in with the Chief Commissioner of Railways proposals to the City Improvement Commission for a City Railway.

These subways were estimated to cost £1,715,000, as against £1,940,000 for the bridge proposal, and in addition to this saving, the subways would accommodate a great volume of traffic.

At the present time the Public Works Committee is again taking evidence upon the bridge question, and it is to be sincerely hoped that something definite will be decided upon shortly, whether bridge or subway, as the need for either the one or the other is imperative.

LIGHTING.

The Lighting of Sydney is effected chiefly from four sources, from the City Council's Electrical Generating Plant in Pymont, from the Electric Light and Power Supply Corporation, Ltd., Generating Plant in Balmain, from the Australian Gas Light Co.'s Gas Works on Darling Harbour and at Mortlake, and from the North Shore Gas Works in North Sydney. The three last named sources are Company-owned undertakings, and it is somewhat difficult to obtain reliable data concerning their progress and operations.

The first named undertaking has been developed and organised by the Sydney Municipal Council, and its progress has been somewhat remarkable. Starting operations in the year 1904 with a plant of 1500 K.W. capacity, it delivered during the year approximately 157,500 units, of which 140,800 units were utilised for lighting purposes, and the balance of 6,700 units for power. In the following year, the total had gone up to over two million units, of which $1\frac{3}{4}$ million units were utilised for lighting. To-day the plant

has a total capacity of 14,700 K.W. together with a storage battery having a capacity of 3,000 K.W. hours. In 1911 the total output was $17\frac{3}{4}$ million units, which were nearly equally divided between Lighting and Power, this output being delivered to a total of 4600 consumers.

The Balmain Co.'s business is also extending very rapidly, and almost the whole of the suburbs adjacent to the city have now completed arrangements with either the one or the other of the two Generating Stations for the supply of Electricity.

The Western Suburbs are still yet untouched, and so also the North Shore, with the exception of Manly, in which a small private company is operated. So rapidly is the electric light supply spreading throughout the city and suburbs, and so many are the advantages it possesses over gas, that it cannot be long before the electric current will be available throughout the whole of Sydney and its suburbs.

The diagram shown on Plate XXII., and kindly supplied by Mr. Forbes Mackay, the City Electrical Engineer, shows clearly the present scope of the two electric supply undertakings.

SHIPPING ACCOMMODATION.

In July, 1908, members had the pleasure of listening to a paper read by the late Mr. Norman Selfe, on the Quays, Wharves, and Shipping of Port Jackson, in which Mr. Selfe described the development of the shipping facilities in this port, and illustrated his paper with a series of most interesting views of the progress and development during the past century.

Mr. Selfe also prepared diagrams shewing graphically the annual increase of shipping up to the year 1907 in the port, and the probable future growth. In his prediction

as to future growth, he was, through unforeseen events such as strikes, entirely out, as the tonnage to-day is little in excess of what it was in 1907, viz., 7,170,000 tons. Mr. Selge's estimated tonnage for 1911 was 9,600,000 tons, where actually it was 7,606,000 tons. This, however, should be only a temporary set back, and there can be little doubt that a large expansion has to be faced in the future.

To meet this the Harbour Trust are undoubtedly making great alterations, although there has yet to be dealt with the question of wharves on the North Shore.

Sydney is but little over 100 years old, yet it is now the fifth port in the British Empire, in so far as its trade and tonnage are concerned. The first jetty was erected in the year 1788 at the outlet of the old Tank Stream. To-day Sydney's wharves have a length of berthing space of practically 50,000 feet, exclusive of ferry wharves, jetties, and privately owned wharves.

The diagram illustrated on Plate XXIII., will shew the improvements effected since Mr. Selge read his paper in 1907. These include eight new wharves and jetties giving an increased berthing space of 8,720 feet, ten old jetties materially altered and improved, and fifty new wharf buildings. In addition to this, further new wharves are in process of construction, notably those at Miller's and Dawes' Points, and that in Woolloomooloo Bay. This latter wharf is of particular interest, and through the kindness of Mr. Walsh I am able to shew illustrations of the work which will be seen on Plates XXIV. and XXV.

The jetty will have a total length of 1200 feet with a width of 208 feet. A centre roadway 53 feet wide and four feet below the wharf level runs the full length of the jetty. The wharves at each side are divided into two lengths of approximately 600 feet each, thus providing four extra over-sea berths. Double-decked sheds equipped with three-ton

overhead electric travelling cranes are being erected for the full length of each side of the roadway, and travelling platforms with electric traversing cranes of peculiar design are being provided at each berth.

The wharf work is of the usual construction on "turpentine" piles, but the roadway is carried on ironbark piles, each of which is sheathed in a cylinder of reinforced concrete. This is well shown in the above views. These cylinders are built up of short lengths especially jointed together, which, after jointing, are dropped over the top of the piles, and forced down into the clay bottom by means of hydraulic jacks for a distance of about two feet. The space between piles and sheathing is then cleaned out, pumped dry, and filled with concrete. The concrete bed of the roadway is then laid upon the necessary cross girders, and upon this again is laid the wood blocking, which forms the wearing surface. The whole wharf should, when finished, prove a particularly durable structure and afford excellent working facilities.

It may be seen, therefore, that great improvements have been recently completed, and others are in progress, which will greatly relieve the present congestion, but one cannot fail to notice that when the present schemes are complete, there will then be little room for expansion in the vicinity of Woolloomooloo Bay, Circular Quay, and Darling Harbour, and it will be necessary to consider the construction of wharves farther away, either up the Harbour or on the North Shore.

CONCLUSION.

I have but briefly touched upon each branch of the works, setting out the magnitude of the city's requirements, and what is being done to meet them.

The last illustration, viz., that on Plate XXVI., shews graphically the annual growth of some of the leading items, and emphasises the absolute necessity for immediate

action in certain departments. At present Sydney' roads are disgraceful, and her tram service hopelessly congested, and daily becoming an increasing menace to street traffic. Her wharves are overcrowded, the bulk without railway communication, and only served by streets with gradients so steep as to be unfit for horse traffic. There are no direct means of communication with the North Shore other than by ferry, and the ferry service available for vehicular traffic between the Shores is almost ludicrously inadequate and inefficient. She claims to be modern and up-to-date, yet at present, in the year 1912, it is impossible for people living in the majority of the suburbs to have the use of the electric current in their homes for lighting and other purposes. Her water supply, whilst at present fairly adequate, yet is far from satisfactory, since only a few months back residents in numbers of the suburbs were unable to obtain an adequate supply of water for domestic purposes, and their gardens perforce had to exist without water for some time. Such a state of affairs in a city of so great importance as ours surely cannot be allowed to continue long. We are all so wrapped up in our own little affairs that we allow important public matters to drift along at the mercy, frequently, of opposing political and municipal factions. Surely it is time that the public as a body, and we particularly as engineers, should wake to the sense of our responsibilities, and work unitedly to ensure the early start and completion of the many great city works now so urgently required.