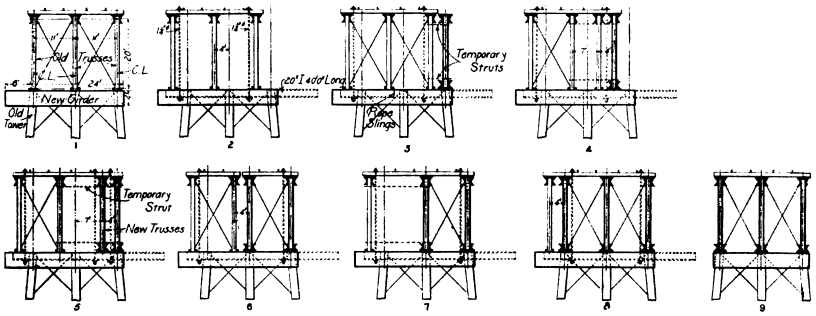
RECONSTRUCTION OF APPROACH SPANS, POUGHKEEPSIE BRIDGE.

The double-track high level bridge across the Hudson River at Poughkeepsie, N. Y., has been in service about 20 years and was originally designed for a train load of 3000 lb. per lineal foot of each track preceded by two locomotives each having four 24,000-lb. axle loads. In order to provide for increased traffic requirements both substructure and superstructure have been reinforced and partly reconstructed to carry 3600-lb. train load and 45,000-lb. locomotive axle loads.

The structure includes five river spans and two anchor spans having a combined length of 3093 ft. 9 in., and two approaches having a length of 2857 ft. 6 in. more. The approaches have seven pin-connected spans 116 to 175 ft. in length and a large number of alternating 30 to 60-ft. plate girder spans all supported on steel towers. The axis of the bridge is on a tangent and the track has a maximum height of about 212 ft. above the water reduced to about 120 ft. above the surface of the ground for the long spans in the west approach and about 160 ft. for the long spans in the east approach.

It was required to maintain traffic during reconstruction and the difficulties of the problem were greatly increased by the construction of all approach spans with three lines of girders or trusses so arranged that both tracks were supported partly by the center line and the latter could not be disturbed without affecting them. All of the old girders and trusses were either entirely replaced by new ones or else were materially strengthened by the addition of new top chords and new eye-bars and the reinforcement of riveted members so that in either event it was necessary to wholly remove each of them and put in their place new or reconstructed old girders.



Successive Operations in Adding New Trusses to East Viaduct.

It is obvious that the work could have been performed in a simple manner by the construction of a complete system of falsework to support the traffic and carry the old and new structures, but this method was rejected on account of the time required and the great cost involved by the height of the track above the ground. A very ingenuous and elaborate method was, however, adopted, which eliminated trestle falsework and provided for both the girder and truss spans and was very successfully carried out. It consisted essentially in providing transverse horizontal supports or tower extensions on which the complete spans could be moved bodily a short distance transversely and the trusses and girders moved successively back and forth so as to constantly support one track while renewals were being made for the other track. This involved the restriction of traffic to one track and the other track successively and required rapid and carefully planned operations with a pair of special derrick cars of large capacity by which the complete trusses and girders were set in position and removed. The reconstruction of the plate girder spans was described and illustrated in The Engineering Record of Aug. 18, 1906. The reconstruction of the other seven long spans in the viaduct will be described in this article.

One 116-ft. 9-in. span adjacent to the anchor arm in the east end of the bridge was for special reasons supported on ordinary falsework trestle bents, while the old trusses were removed and a new center truss and two reinforced old side trusses were put in position. The remaining six spans were supported like the rest of the viaduct entirely from the old towers during reconstruction. At the west end of the bridge each of the two 145-ft. spans had three trusses 20 ft. deep and 11 ft. apart on centers, two of which were reinforced to nearly double their former capacity and were retained for the outside trusses while the center truss was replaced by an entirely new center truss of the same dimensions. The corresponding trusses in both spans were handled together as if they formed single continuous trusses 290 ft. long.

The first step in the reconstruction was to rivet across the tops of the tower bents pairs of transverse horizontal plate girders about 30 ft. long and 4 ft. deep which cantilevered about 6 ft. beyond the centers of the south columns. The old trusses were displaced from their seats on top of the tower columns and were jacked 4 ft. transversely southward, supported on the transverse girders so that they were supported eccentric with the tower columns on the new girders, the south trusses being supported on their cantilever extensions.

This removed the trusses from the center lines and enabled a pair of 25-ton special derrick cars described in The Engineering Record of Aug. 25, 1906, to pick up the old north trusses weighing about 50 tons each, swing them around to the center line of the south track and carry them out to the yard where they were laid horizontally on skids, cut apart, shipped to the Athens bridge shops, rebuilt with entirely new top chords, additional eye-bars, and web reinforcement plates on some of the other members.

Simultaneously the new center trusses were erected in a horizontal plane in the contractor's yard about 1400 ft. beyond the west end of the bridge and when completely riveted were picked up by the two derrick cars on the south or traffic track, carried between them to their positions on the bridge, lowered into place, stayed to the old bridge, and the derrick cars run back out of the way in a 45-minute interval between trains. After the old trusses were returned from the shop they were reassembled as the new ones had been in the yard, carried out on the bridge by the derrick cars and placed in their required position; the transverse bracing between them and the center trusses were assembled and riveted, the floor built, tracks laid on it and traffic transferred from the south to the north side of the bridge.

Derrick cars working on the north track then removed the center and south side old trusses, two of which were cut up for scrap and the other two returned to the shop for rebuilding as the north trusses had been. The reinforced trusses were returned to the site, reassembled in the yard, carried out and lowered to position by the derrick cars, the south side transverse and lateral bracing completed, the floor deck built and the south track laid and put in service, completing this part of the reconstruction. During these operations both spans were handled together so that the track only required shifting once and back.

It is believed that there is no other example on record for handling such long and deep trusses complete, in single pieces, like plate girders, with derrick cars or their equivalents. On account of the length and transverse flexibility of the trusses the top chords were hog chained to stiffen them for handling. A pair of 6 x 6-in. horizontal transverse struts, about 10 ft. long and 60 ft. apart, were notched over the cover plates and clamped in position with bolts and cross pieces bearing on the lower flanges. Their ends were notched to receive ¾-in. wire ropes attached to the ends of the top chord and adjusted by sleeve nuts.

The old trusses weighed about 40 tons each before being reinforced and afterwards weighed about 50 tons, corresponding to the new center trusses. The time required for the execution of this work was considerably prolonged by waiting for the trusses to go to and from the shops, but the actual working days numbered only about 35 for an average force of only about 20 men, except when the second derrick car was in use when the number of men was approximately doubled for a few hours on each occasion when the trusses were being moved.

At the east end of the bridge the first approach span, 116 ft. 9 in. long, was erected on falsework as previously described. The second approach span, 116 ft. 9 in., and the succeeding ones, 175 ft., 115 ft. and 161 ft. long, each of them separated by 30-ft. tower spans, made a total length of 717 ft. 9 in., which were reconstructed by the following method: Double transverse plate girders about 30 ft. long and 4 ft. deep were first riveted across the top of the tower bents as described for the west end of the bridge, making 6-ft. cantilever projections on the south side of the bridge. The seven alternating long and short spans, forming a 717-ft. 9-in. length of continuous superstructure were jacked 4 ft. transversely on the temporary tower girders, displacing the center line from the bridge axis so that the south trusses were carried on the extremities of the cantilevers.

To provide an erection platform 20 in. I-beams 40 ft. long were suspended from the top chord panel points by pairs of 1¼-in. upset rods about 28 ft. long engaging at their lower ends 12 x 12-in. yellow pine saddles under the I-beam flanges and thus affording supports for them which could not be conveniently secured from the lower chord pins of the old trusses. The new center trusses were assembled in temporary positions over the north columns where the old north trusses had previously been. These trusses were erected piecemeal by both derricks to avoid the difficulty and danger of bringing the completed trusses from the yard on the opposite side of the river which was thought to involve too much hazard from the train traffic and to require too long a time.

As soon as these trusses, which weighed from 30 to 80 tons each, were assembled, supported from the old spans at a clear height of 160 ft. above the ground, they were braced to the old center trusses with transverse angles bolted to the top and bottom chords at panel points. Temporary rope slings were then attached to the center trusses to support the transverse 20-in. I-beams while their vertical suspension rods were removed from the north trusses and placed on the new center trusses at the north side of the viaduct. The old north trusses were then moved transversely 4 ft. to the south and stayed to the old center trusses, enabling the new center trusses

also to be moved 4 ft. and again stayed as before described to the old center trusses.

The north track was then relaid, supported by the new center trusses and the old center trusses and the old north trusses removed with the derrick cars. The old north trusses were then reinforced as already described for the work at the west end of the bridge, except that here the work was executed by the contractor at the bridge site with pneumatic hammers and drills made by the Chicago Pneumatic Tool Company, and operated by air from an Ingersoll-Sergeant electrically driven compressor so as to save the large amount of time previously wasted in transportation back and forth from the bridge shop.

The new north trusses were then assembled in their permanent position, being supported on the cantilever ends of the suspended I-beams and were temporarily stayed to the old center trusses with top and bottom chord transverse angles. The new center trusses were then moved transversely 7 ft. south to their permanent position in the bridge axis and the permanent transverse and lateral bracing and floor system was put in between them and the north trusses, the north track replaced and the train service transferred to it.

The old south trusses were braced to the new center trusses with top and bottom chord transverse angles, the lateral and transverse bracing was removed, thus freeing the old center trusses, which were taken apart and removed by the derrick cars, transferred to the contractor's yard and reinforced as had been done for the north trusses, after which the members were brought back on service cars on the north track and re-erected by the derrick cars on the south track, thus re-establishing the south trusses in permanent position, after which the old south trusses were removed by the derrick cars and finally the transverse I-beams were removed and the projecting south ends of the transverse girders were cut off, completing the work.

Notwithstanding its great height and the fact that the work was constantly interrupted by the train service it was executed without any accident to the structure or to the property or persons below, although the spans in the east approach cross over the main tracks of the New York, Central & Hudson River Railroad, and over Duchess Avenue, an important city thoroughfare, and the west approach spans were erected during last winter. The success of the work demonstrated the value and convenience of the special derrick cars by which it was handled throughout and without which it would have been impossible to erect it by this method. It was estimated that if the falsework had been built to carry the old and new work during the process of reconstruction it would have taken much longer than by the method actually employed and would have been very much more expensive.

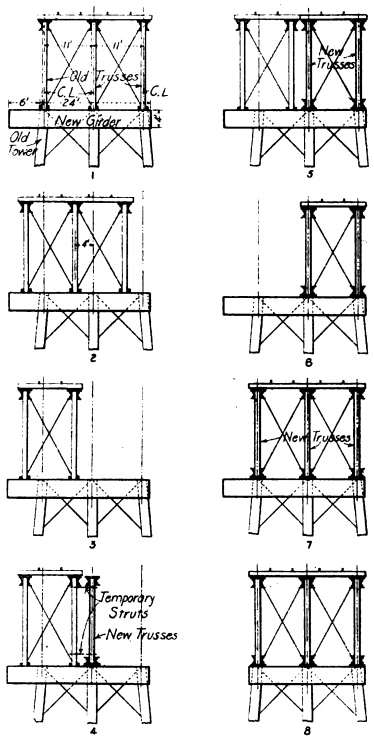
Mr. Mace Moulton was the consulting engineer for the Railway Company and the American Bridge Company, of New York, was the contractor. The general design and details of the methods employed were made and developed by Mr. S. P. Mitchell, who executed the work on a sub-contract from the American Bridge Company, of New York.

Inclined Tunnel Approaches were studied critically by Mr. Maurice Fitzmaurice, chief engineer of the London County Council, in connection with the Rotherhithe Tunnel. He states that the cost of land for long inclined approaches is very expensive in London, and that if any more tunnels should be constructed for vehicular traffic east of the Tower Bridge it might be necessary to dispense with approaches and substitute elevators. The principal objection to elevators he considers to be the necessity of eliminating long loads, which would have to go by way of the bridges or by the tunnels having approaches

THE RECLAMATION OF WET LANDS IN LOUISIANA.

The reclamation of swampy and overflowed lands in Louisiana has progressed at a remarkable rate during the past few years. Much has been printed regarding public and private irrigation projects in the arid and semi-arid regions of the West, while the drainage and protection of great areas of wet lands in the Mississippi Valley have received comparatively little attention except locally. The State of Louisiana alone contains about 5,000,000 acres of low land that is subject to reclamation. Considerable areas of this vast territory already have been rendered available for cultivation by private companies, and many large projects are now under construction or are being financed in the territory adjacent to New Orleans.

The land that is being improved by levees and drainage systems until lately has been considered



Adding New Trusses to West Viaduct.

absolutely worthless. Since the reclamation work was started, however, tracts of these watery wastes have proved to be some of the richest and most productive agricultural lands in the world, capable of growing crops of almost any kind adapted to the climate. From the results thus obtained the feasibility of extending the reclamation over large areas has been demonstrated and the rapidity with which the land is being put under cultivation indicates that much of the territory adjacent to New Orleans will shortly be closely settled.

The reclaimed lands in the several million acres of wet prairies subject to reclamation are in what is known as the "lower delta" of the Mississippi River, most of the projects being located on both sides of the river below that city. This delta consists of alluvial silt brought down from the drainage areas of the river and its tributaries. The silt was deposited on the lands during the annual periods of overflow and extends to great depths in the entire delta. In common with all lands overflowed by silt-bearing streams, the greater bulk of the material settled out within a comparatively short distance of the main channel of the stream. As a result ridges of varying widths parallel the streams closely, with lower ground in the rear of these ridges. The plantations that have been cultivated for two or three centuries in the vicinity of New Orleans are located on the ridges formed in this manner and have demonstrated the fertility of the soil. Directly back of the ridges the vast stretches of prairie lands are covered with a profusion of water grasses of every description and with other semi-tropical vegetation. Most of this land at a distance from the waterways is only a few inches above the normal level of the Gulf of Mexico and much of it is submerged during a considerable portion of the year. It also contains a network of intersecting lakes and bayous which are practically at the level of the Gulf.

When the country was first settled the annual overflow of the river deposited over these lands additional layers of silt. The erection of practically continuous levees along the river has, however, prevented these overflows, with the result that the level of the land remains the same. Since this level is considerably below the maximum stage of the river during flood periods, the prairies are submerged to such extent that cultivation of them is impossible without proper protection and drainage. The conditions are such, nevertheless, that the reclamation of most of this territory is not difficult nor expensive. In fact, it is considered by engineers who have long been engaged in work of this character that practically all of the swamps and marshes in the State can be reclaimed.

The construction work necessary to make these lands available for cultivation is exactly the reverse of the irrigation projects which have been undertaken so extensively in the West. Levees have to be built to prevent overflow from adjacent waterways and pumping plants installed to remove the surplus rainfall. The latter averages about 60 in. per year and the evaporation is practically the same amount. Accordingly, if the rains were equally distributed throughout the year pumping plants would seldom or never have to be operated. On account of the heavy rainfall during certain periods of the year it is necessary, however, to provide means for removing the surplus water.

The drainage districts at present completed or now under construction are each arranged to be served by a single pumping plant and vary in area from 1000 to 3000 acres. A tract comprising four sections and containing approximately 2500 acres has been found to make a district of satisfactory size. A typical arrangement of the ditches, canals, levees and pumping plant for a tract of this size located on a bayou is shown in one of the accompanying illustrations. A dipper dredge excavates material from the bayou to build a levee along that side of the tract. A canal is then dug around the latter and the spoil thrown on the inside with a berm about 12 ft. wide. The tract thus is enclosed by a continuous levee which serves to protect the land from outside overflow. At the same time the canal provides a navigable channel connecting with the bayou, which is connected in turn with other waterways leading eventually to the Mississippi River.

The maximum variation of the water level in the bayous of this section reaches 3 ft. It has been found, however, that the top of the levees should be placed not less than 5 ft. above low tide to insure absolute protection against overflow. With levees provided in this manner no difficulty has been experienced from damage to the property protected and the levees are maintained readily by the luxuriant vegetation that grows on them during the entire year.

The drainage system has a main reservoir canal extending normal to the bayou on the center line of the tract to the rear limits of the latter