EXTENDED PLATFORM

An improvement to a LIRR platform at Penn Station in New York City required the removal of 11 columns

Top: *New columns being jacked into position.*

Above: *Transfer girders, with fireproofing, are in place. Original columns have been removed, but the track is not yet completed.*

By Michael A. Lahti, P.E. and Felix G. Andrews, P.E.

With daily traffic of 786 trains, New York's Penn Station is the country's busiest passenger train station. And although the station is shared by Amtrak and New Jersey Transit, the Long Island Rail Road alone accounts for 66% of the total weekday trains. Unfortunately, this high level of use strains the physical capabilities of LIRR's allotted terminal facilities.

One major constraint has been the inability of Platform 11 (serving tracks 20 and 21) to fully accommodate 12 car trains. As a result of this platform's limited length, disembarkation for 12-car trains has been severely handicapped, since passengers on the last two cars have had to walk forward to reach an open exit door on the platforms. The solution to this problem is to extend the platform 280 ft. In addition to decreasing passenger disembarking time, the extension will provide a direct connection to the West End Concourse, the Eighth Avenue subway and the street level, all of which is now unavailable from Tracks 20 and 21.

However, realignment of track to permit the platform lengthening was a complex issue. The solution included providing a new ladder track between the extended Tracks 20 and 21 to the West Side Yard lead tracks, and creating connections to equipment storage tracks located in the northwest corner of the station. Further complicating the project was the need to remove 11 columns—10 under the JAF Post Office and one under the

33rd Street Viaduct. Due to constraints from the concurrent track construction, the structural work was divided into two phases. Phase 1, which will be discussed in this article, included the five most westerly columns, all under the post office.

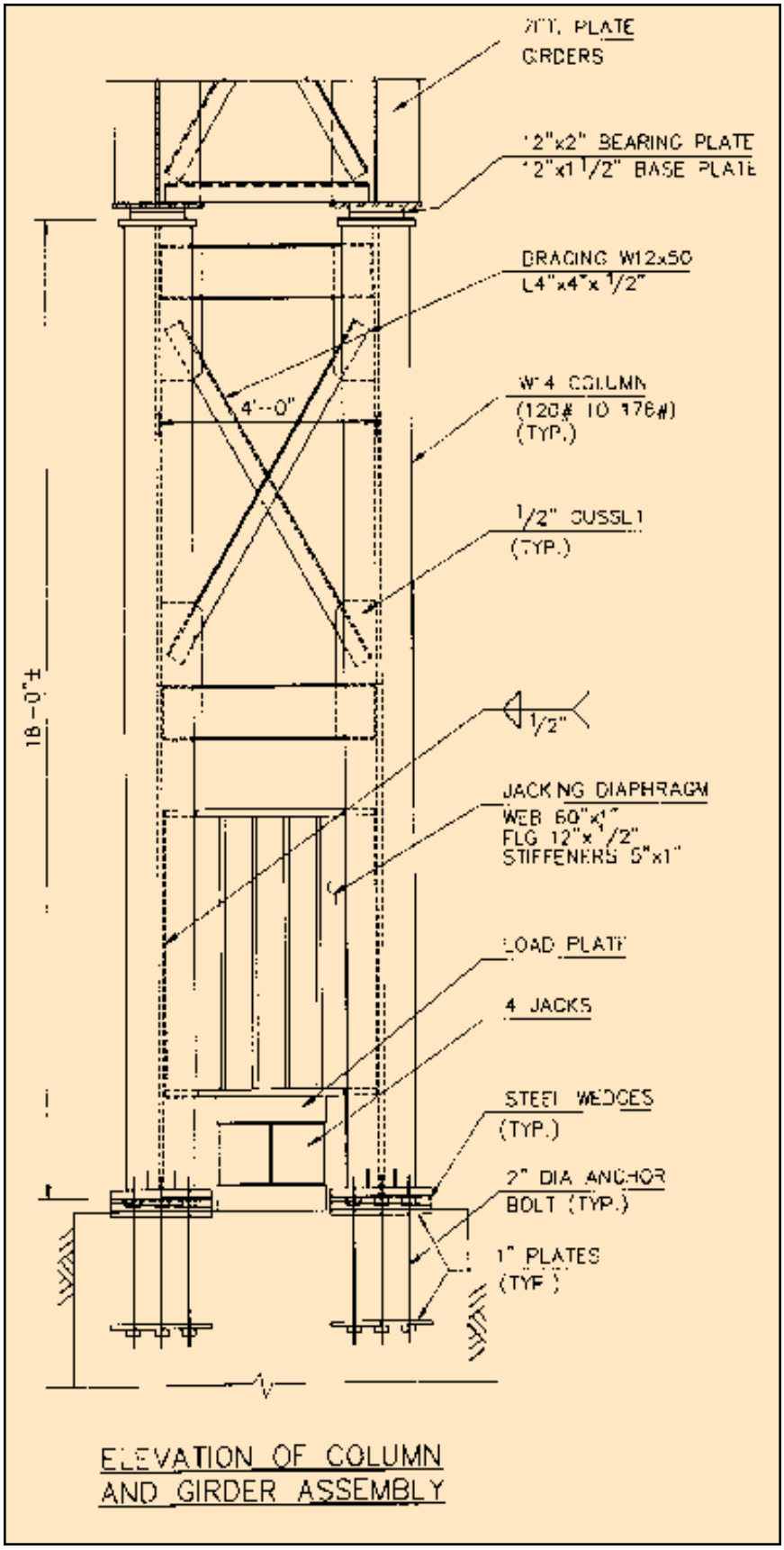
Important considerations in the structural design of Phase 1 was the need to keep both the post office and the adjacent tracks fully operational during construction. In addition, it was desirable to minimize modifications to the existing structure and therefore reduce time-consuming field work in an extremely busy station. As a result, paired A572 Gr. 50 steel transfer girders, supported by column bents, were selected.

Existing Conditions

The JAF Post Office is a four-story building located on Eighth Avenue above the west end of Penn Station. The existing basement level framing consists of concrete encased built-up columns, girders and floor beams, with rolled beam stringers and a reinforced concrete slab. The bottom of the framing is approximately 25-ft. above track level. Footings are I-beam grillages founded on rock.

Fortunately, the existing drawings for the building were available. A load analysis of the affected area was done and the load paths were traced upwards through the structure, assuming simple beam distribution. The design loads determined from the analysis varied from 2,700 to 3,450 kips.

The layout of the new framing was determined by plotting the envelope of required track clearances and placing new column bents in the spaces between the tracks. The new girders were located at 4-ft. on center to envelope the existing columns. Use of paired members eliminated the need for shoring, as well as reducing the required depth and handling weight of the girders. Lengths varied from 18-ft.-10-in.



ELEVATION OF COLUMN AND GIRDER ASSEMBLY

to 30-ft.-3-in. The web plates were a uniform 6-ft.-10-in. by $^{11}/_{16}$-in., minimizing the intermediate stiffeners required. Flanges were 20-in. wide, with thicknesses varying from $1^{1}/_{8}$-in. to $2^{7}/_{8}$-in. There was at most one transition in thickness. Simple end conditions were insured by providing curved bearing shoes. Due to the magnitude of the axial loads, any bending moment transmitted to the columns was undesirable.

Two 6-ft.-deep plate girder diaphragms at 3-ft.-6-in. on center were provided to transmit the column load to the transfer girders. The diaphragms were framed into the top of the existing column with welded H brackets and also receive load by direct bearing from the ends of the girders above. The intent of this arrangement was to equalize the applied loadings to the new members and minimize the effects on the present structure.

The columns also were laid out in pairs, at 4-ft. on center. The paired columns were then connected into bents with cross bracing. Column lengths were approximately 18-ft. and W14 sections between 120 and 170 pounds were used. Heavy anchor bolts and wing plates at the bases were used to provide a degree of fixity in the direction parallel to the girders. The anchor bolts were fastened to plates embedded in the footings. The footings were socketed into rock, which was located only a few feet below grade.

Conventional steel fabrication was utilized, including submerged arc welding with E70 electrodes. Inspection was limited to visual inspection of welds and magnetic particle testing of 10% of the girder flange-to-web welds. The major complication in the fabrication process was verification of field dimensions. Because as-built plans were not available, it was necessary to remove the concrete encasement at the proposed connections to the existing columns to determine detail dimensions. Also, fit of the diaphragm to the girder was checked by trial assembly, as misalignment of this long connection would be difficult to adjust in the field.

The structural steel was delivered by truck and lowered to track level from the street by use of a small crane. Access was through a 20-ft.-by-4-ft. hole in the sidewalk of the street above.

Work within Penn Station entailed numerous difficulties. Railroads enforce very restrictive work rules near active track. For example, any operation that could result in persons or materials being within 15 ft. of track center, even by accident, is considered fouling the track and requires temporary closure. In general, a two week notice was needed for a scheduled closure. Advanced approval was required for operations such as hoisting, removal of structural components and jacking. Railroad personnel were also necessary for piloting rail mounted vehicles into the station from yard areas and for shutting down third rail or catenary power.

The erector's work was facilitated by fencing off the effected location, which happened to be within a yard area adjacent to active ladder tracks. This removed some restrictions of track closures and the requirement for only working during off-peak hours. Several of the construction operations were subject to peak hour restrictions, but normal productivity was generally possible because of the segregation of work areas.

Erection of the steel was accomplished entirely with hand tools, i.e., pulleys and chain hoists. Rail mounted cranes, suitable for use within the confines of the station, are generally not available and would have been subject to the previously mentioned constraints. The structural members were moved from the access hole by fitting them with skid plates or portable rollers and dragging them with a chainfall to their final location.

The columns were placed by lifting with an 8-ton chainfall attached to a lug welded into the framing above. A come-along fastened from the column to an adjacent member controlled the bottom of the member. The column assemblies were plumbed by tightening nuts on the anchor bolts below the baseplates. The lateral cross bracing between column pairs was then hung with erection bolts.

The girders also were hoisted into position with chainfalls; in this case, two 8-ton units were connected to heavy trolley assemblies fastened to the members above. When the girders were hoisted to the correct elevation, come-alongs at both ends were used to pull them toward the diaphragms in between. Lining up the 6-ft. tall connections was difficult and shims were needed to make all plies of the material bear together. Once all the structural steel was plumbed and adjusted, the bearings were tack welded into position and the lateral bracing connected with erection bolts.

The jacking scheme used was to lift the ends of the transfer girders in the correct proportions until the entire load on the existing column was removed. The method originally proposed by the designer was altered at the contractor's request. The original method involved using a set of temporary jacking columns and end diaphragms to lift the girders; once the jacking forces were sufficient, the bearings were to be shimmed into position. The temporary members were then to be moved to the next girder and the permanent bracing installed.

The contractor's scheme was to incorporate the jacking diaphragms into the column assembly and lift the girders and columns simultaneously. Once raised to the necessary elevation, wedges were driven to fix the baseplates and welded into place. This method eliminated shimming and permitted all of the work to be done at grade level. It also reduced the duration of the field work. For the

heavy lifts anticipated, four 565-ton jacks were used at each end. A common hydraulic pump was provided for each set of jacks. The large volume produced a slow and easily controlled lift.

The displacements were monitored with simple telltale pointers attached to the anchor bolts at both column bases and a rod with pointer at the column to be removed. The final end deflections of the transfer girders were approximately $^1/_4$ in.

The specific procedure utilized was to pump each end, in the correct simple beam proportion, while maintaining equal end lifts, until the existing column top was raised $^1/_{16}$ to $^1/_8$ in. At this point, the column was cut and the jacks further pressurized to obtain a minimum upward lift of $^1/_{16}$ in. The actual forces produced by the jacking varied between two thirds and 100 percent of the computed dead loads.

Removing the old columns was time consuming because they were filled with concrete that had to be removed by jackhammer, complicating the flame cutting operation. The new structural steel was protected with spray on fireproofing for a four hour fire rating.

The total duration of work for this structure was approximately six months, including the foundations. The crew for the steel erection consisted of three to five ironworkers. General contractor on the project was A.J. Pegno Construction Corp. of College Point, NY, erector was Budco Enterprises, Inc., of Middle Island, NY, and structural engineer was Lichenstein Engineering Associates of New York City.

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