

## SOME SPECIAL ASPECTS OF THE HARTFORD PUBLIC LIBRARY \*

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IF you came into Hartford by way of the Whitehead Highway this morning you are probably aware that Hartford is constructing a new library. Within a few weeks you may see strange trusses beginning to span the highway just east of Main Street. To those of us who have been engaged on the project these Vierendeel trusses typify the unusual problems and unconventional solutions involved.

The building is a steel frame structure about 192 ft. by 174 ft. consisting of a basement, first floor, mezzanine floor and second floor with a penthouse for elevator and staff rooms above the second floor level. The building extends over the Whitehead Highway which makes an angle of about 83 degrees with Main Street. The Park River is contained in a double conduit below the highway.

When the proposal for a building to span the Park River conduit and the highway came into the office it was plain that the structural design would be involved and in many aspects unique, out of all proportion to the size of the project. Not only must the heavy building loads be carried over spans exceeding 100 ft. but the elevation of the bottom of the members were fixed to provide a minimum clearance over the highway and the first floor of the structure was set by the sidewalk elevator of Main Street. Moreover a large area was needed for stack rooms. This space should be undivided and convenient to the general reading rooms and the charging desk.

There was a space over the highway and below the first floor of about the volume needed if a means could be found to use it. Conventional trusses with their diagonal members would occupy too much space and of course plate girders would divide the area into long narrow corridors inconsistent with the requirements of a stack room.

At this time Vierendeel trusses were suggested and the dimensions of their component parts approximated. Over these Vierendeel trusses there are no supporting columns between the main floor and the mezzanine.

Without going into the technical aspects of the design it soon became apparent that a lot of research was to be involved. Professors Fife and

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Beggs of Massachusetts Institute of Technology were engaged as consultants and the design started.

The Vierendeel truss is the invention of Prof. Arthur Vierendeel about 1900. The truss is made up of top and bottom chords and vertical web members. The omission of the diagonals introduces moment at all joints making it statically indeterminate to a high degree. Under existing codes some form of elastic analysis is compulsory even though recent developments looking to ultimate design indicate a much higher safety factor than that required for conventional trusses.

As the design of the trusses progressed to analysis of the joints many places were found to be tight. Experiment by varying the moment of inertia of various main members indicated that the high stress in a member or a joint could after be relieved by increasing the stiffness factor of the adjacent members. This has resulted in some members ending up understressed by usual standards. As finally built the trusses consist of top and bottom chords with two flange plates  $20\frac{1}{2}'' \times 2\frac{7}{8}''$  each and a web plate  $12'' \times 1\frac{5}{8}''$ . These are strengthened at the joints by using  $20'' \times 3\frac{7}{8}''$  flange plates in the outside flange and by curved plates. The verticals consist of a web plate  $13\frac{5}{8}'' \times 1''$  with  $18'' \times 1\frac{1}{2}''$  flange plates.

The trusses are 104 feet c-c. cols. and  $9' 4''$  between center lines of chords weighing 72 tons each. These trusses carry the stack room floor framing on the bottom chord and the first floor framing at the upper chord. Above the first floor there is a mezzanine floor and above this the second floor, penthouse and roof. From both the architectural and engineering viewpoints, it did not work well to carry these floors on the Vierendeel trusses. The large reading room was cleared of columns by using conventional trusses above the second floor to support the roof and ceiling—then hanging the second and mezzanine floors from these roof trusses.

The history of the site goes back to the early days in the settlement of the city. We knew that ever since, structure after structure had been built on the site. Exploratory holes were put down to determine the subsoil conditions and to get some idea of the obstructions. These test holes were limited by buildings on part of the site but did indicate shale rock below a heterogeneous fill.

Limited storage space for back fill and obstructions to general excavation led to the use of steel H piles driven into the rock to support the foundations. The walls acting as grade beams extending from pile cap to pile cap. In limited areas where it was not feasible to drive piles, concrete footings on rock were used. As the work proceeded modifications became necessary due to unforeseen obstructions. Piles were driven as close to the design location as possible. Then the increased loads due to eccentricity were computed and additional piles driven where necessary. In some cases where piles could not be driven due to old foundation walls or other ob-

structions excavation was made to rock and concrete footings substituted for piles. This work was done on a very tight schedule. Often redesign of a foundation was made the same day the obstruction was encountered so that as little time was lost as possible. The foundations were ready for structural steel well on schedule.

Meantime the fabricator was having delays. The bent plates for the Vierendeel trusses were slow in delivery. Since the completed half trusses weigh 35 tons each they could not be assembled in the shop and bad weather further delayed fabrication. The joints were assembled and the beam and post sections fabricated. Then the butt joints were milled for Vee welds and the half truss positioned. Welding proceeded on a two shift per day basis.

One interesting feature of the shop work is the testing of the joints by the use of gamma rays. Under this process a radioactive pill is suspended on one side or over the joint to be tested. A strip of film is placed on the opposite side of the joint. It takes about two hours of exposure for a four-inch thickness of steel and shows up inclusions and foreign matter in a manner similar to X-ray, but is much more portable.

All butt weld joints are subjected to this process including those to be made in the field. In the first 60 joints so tested only a small part of one joint showed defects. This was cut out, rewelded and retested. For the purpose of keeping records every joint was a separate designation and a record is kept of the welder and his certification number, the gamma ray exposure and the resulting negative and any remedial work necessary on the joint with the final negative after such work is complete.

Under the procedure followed at the shop welding is carried on over two shifts daily. Gamma ray testing is carried on during the off shift when there are no workmen in the area. A similar procedure will be followed in the field. Of course this brings up special problems. While there are no ill effects from short term exposure to the rays prolonged exposure must be avoided and special safety precautions taken.

Due to the length, weight and unusual site conditions, erection posed a serious problem.

The highway is supported over the bed of the Park River by a twin, rigid frame built in the middle thirties and designed for three lanes. H-20 loading on each side. Under the specifications this loading was not to be exceeded. A series of conferences on erection developed the final scheme. The four conventional trusses supporting the terrace in front of the building are to be erected by means of crawler cranes operating from the area adjacent to the highway and on the highway itself.

Since these trusses weigh only 32 tons each it is possible to perform this operation without exceeding the H-20 loading although there were tight clearances in places.

The Vierendeel trusses have been fabricated with field splices so that each truss will come to the site in two parts. A trestle bent will be erected along the median strip to support the ends of the Vierendeel trusses. The two parts will then be field welded on the trestle bent. Erection will be done with a guyed derrick and it is planned to raise this derrick to the main floor level to erect the remainder of the center portion of the steel. There are four field splices necessary for each Vierendeel each consisting of a full strength field weld. It will take a crew of 8 men about 12 hours to completely field weld one full truss.

Since the welding of the first truss will be in progress while erection is proceeding on the other trusses all trusses should be completely assembled and tested within two days after the placing of the last truss. Filler beams will be erected as the trusses are placed.

After the framework for the stockroom and first floor is in place the derrick will be raised to the main floor level.

Although the roof trusses weigh only 32 tons each, their length and the site conditions make erection in one piece extremely difficult. Therefore they will be brought to the site in two pieces and assembled in place. To erect the mezzanine and second floor framing, the hangers will be temporarily extended to the first floor and erection will proceed as for a convention steel frame.

The roof trusses will also be supported on these struts till their connections are complete and the columns plumbed. The temporary struts will then be removed.

Schutz and Goodwin are the architects on this project, Henri van Zelm, Mechanical Engineer and R. W. Loomis, Structural Engineer. The general contractors are Wadhams and May, steel fabrication and erection by Lehigh Steel Co.