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7. Structural Features of Stations

Both the Tohoku Shinkansen and the Joetsu Shinkansen have connection with the conventional lines at several stations. As there was not sufficient space for the enlargement of some of the station buildings for the construction of the Shinkansen, the new platforms had to be situated directly over or under the conventional tracks in operation, thus necessitating special structures.

In the case of a station bestriding the conventional lines, usually there are highways which pass over them by bridges in the neighbourhood of the station. Accordingly, the Shinkansen line must go over the highway bridges and as a result the platforms for the Shinkansen are situated in a very high position up to 15 m.

In the case of an underground station, there are subways and public utility tunnels already constructed in the neighbourhood of the station. The platforms for the Shinkansen, therefore, have to be situated in a very deep position, for instance, 30 m deep in the case of Ueno (refer to chapter 6).

The materials to be used differ according to the constructional conditions; for instance, steel, reinforced concrete or steel-concrete composition.

As an example of a station building constructed over existing lines, the structure of Sendai Station, the Tohoku Shinkansen, will be explained below.

At Sendai Station, a steel-frame-concrete composite structure, in which the two elements work together, was adopted for the following reasons;

- a lighter structure is preferable to a concrete structure, because it is important to reduce the mass force due to earthquakes as much as possible, especially in such a tall structure
- at a station it is necessary to secure an effective space to the utmost. For this purpose, shallow and long beams supported by columns of a small diameter are required
- it is desirable to minimize the amount and period of the constructional work done directly over the tracks in operation from a safety view-point
- considering the above conditions, a steel structure is suitable, but is undesirable because of its greater noise and vibrations due to train passage and of its lower resistance against fire (see Photo 1 and Fig. 2).

In the Shinkansen including the Sanyo Shinkansen, there are already several examples of stations of composite structure other than Sendai Station because of this form's superior structural behaviour and economy.

The outline of the cross section of the station building is shown in Fig. 1 of chapter 8. The spaces between the columns both in the directions along and across the line are about 13 m.

It was designed according to a code specifically prepared for the composite railway structures with steel frames encased in concrete. The allowable strength of the steel frame element comprising a composite member and that of reinforced concrete element are calculated separately and the sum of the both strengths is considered to be the allowable strength of the member. This concept is similar to the ultimate design method. The safety of structures designed according to this method was already proved by many tests and actual buildings.

The distribution of temperature difference was assumed in such a manner as to be 0 °C on the ground level and ± 10 °C at the top of the building, with a linear variation in between. The effect of temperature difference was calculated to account for 15 % of the total stress at maximum.

The building was provided with aseismic walls in the basement and the first storey in order that the amount of seismic force acting upon the frames might be effectively reduced. In the design of the members which support the tracks on the fourth floor, the fatigue effect was taken into account. Also special consideration was paid to the torsion of the composite members.

Steel frame members were fabricated in bridge fabricators. A total of 25 spans were erected, divided into several blocks. The concrete was laid over a two-year period in a chequer pattern, not in continuation from one end to the other, so as to reduce the residual stress due to drying shrinkage and to avoid the drying shrinkage cracks. Also, care had to be taken, so that no air might be entrapped by the steel frame components.

Fig. 1 and Photo 3 show the section of Shin-Shirakawa Station and Takasaki Station under construction, respectively, both of which are made of reinforced concrete. Fig. 3 shows the section of Morioka Station, a structure of combination of steel and composite members. Photo 2 shows its steel structural portion being built.

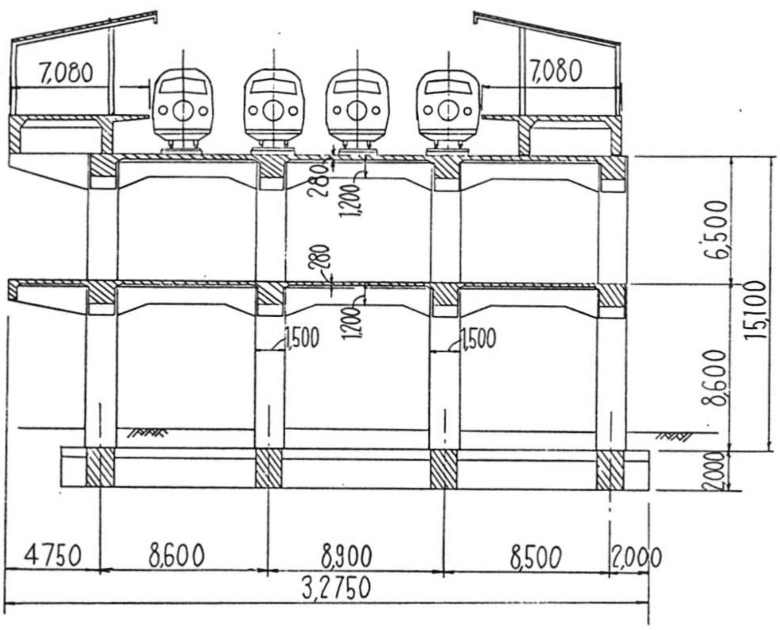

Fig. 1 Shinshirakawa station of reinforced concrete structure

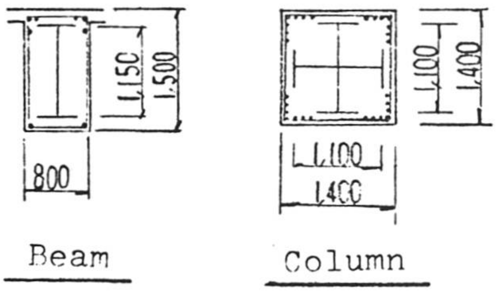

Fig. 2 Typical cross section of steel concrete composite structure

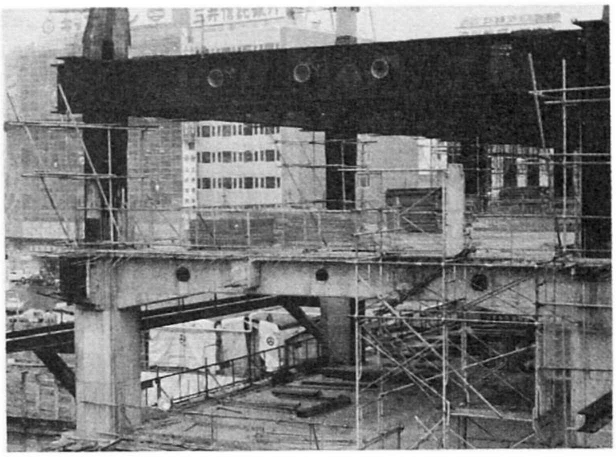

Photo 1 Sendai station

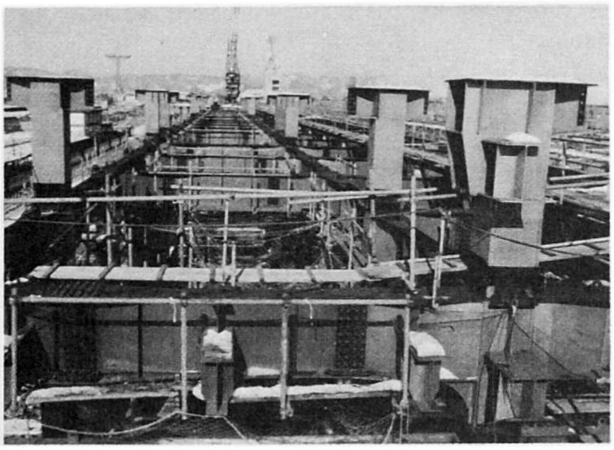

Photo 2 Morioka station

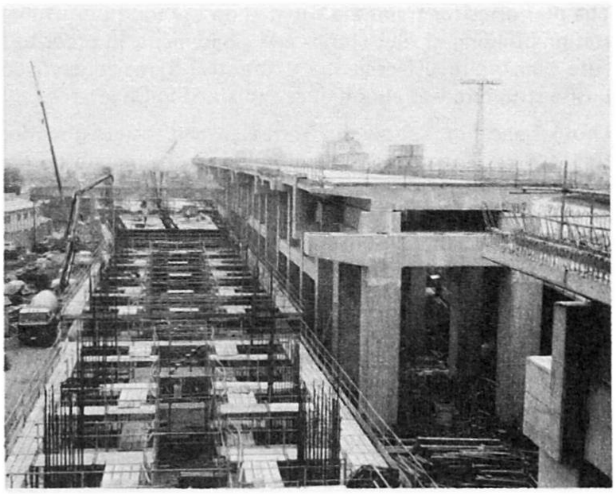

Photo 3 Takasaki station

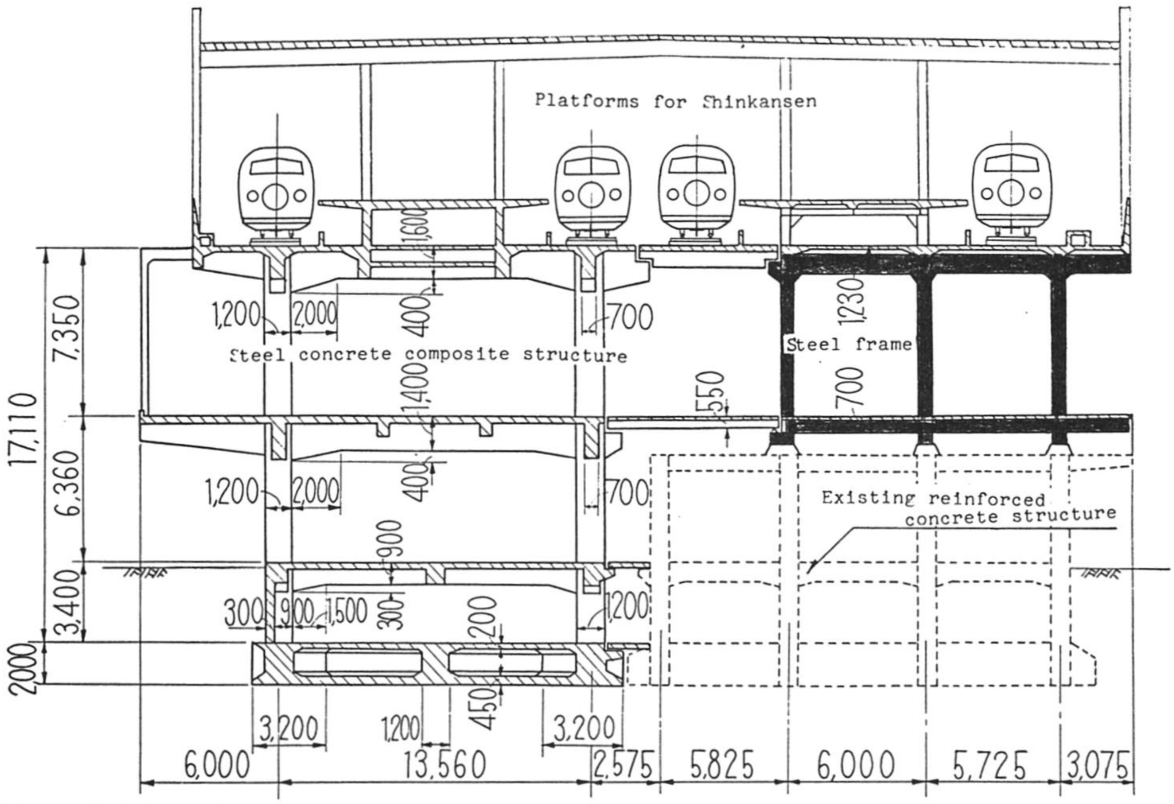

Fig. 3 Morioka station