DIAPHRAGM ACTION AT THE ROOF LEVEL: USE OF STEEL DECK IN LATERAL LOAD RESISTING SYSTEM AND THE ROLE OF DIAPHRAGM

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CANAM BUILDINGS

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SUMMARY

When the steel deck is used as a roof diaphragm, one must also involve other framing members to ensure the load path of lateral loads to the foundations.

DIAPHRAGM ACTION AT THE ROOF LEVEL

The steel deck sheets used for roofs and floors provide support for gravity loads between the joists and/or beams. Once installed, these sheets can also be used as a horizontal brace and therefore the steel deck acts as a diaphragm.

The fluted deck is equivalent to the web of a horizontal beam of which the flanges are the perimeter structural members connected to the deck. The span of that horizontal beam is defined by the distance between the vertical lateral load resisting systems connected to the deck. The secondary elements form stiffeners for the web produced by the fluted deck. As for normal beams, the deck (web of horizontal beam) must be attached to the perimeter members (flange of horizontal beam) to ensure transfer of the shear forces.

In order to use steel deck as bracing, further design elements must be considered in addition to the installation and attachment of the sheets to the supports and each other. These other elements are the flanges and the end bearings. The flanges are formed by an alignment of structural members that can be tied together and to the deck to resist the calculated flange force. The web must also be tied to members that act as beam end bearings, which are usually located perpendicular to the plane of the diaphragm.

Special example
Figure 1 shows a building with a special geometry in that it includes a setback of the facade along gridline 6 with an isolated vertical bracing system along gridline 6 below the setback between gridlines D and E.

Figures 2 (resisting N-S forces) and 3 (resisting E-W forces) represent a roof diaphragm with the beams and their continuous flanges resisting the forces perpendicular to their span. The heavy black lines are the flange elements of the beam and the grey surface is its web. The ends of the beam are in alignment with a vertical bracing system to transfer the shear force of the diaphragm to the ground.

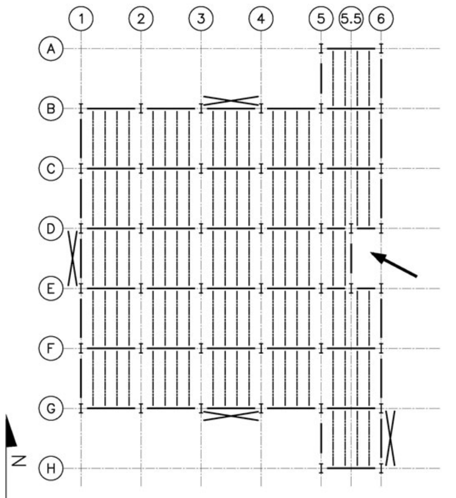

FIGURE 1

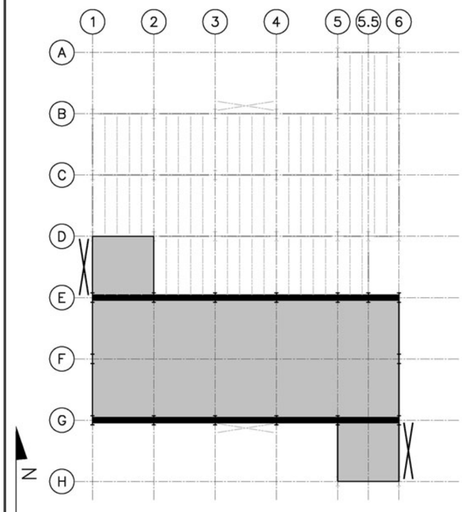

FIGURE 2

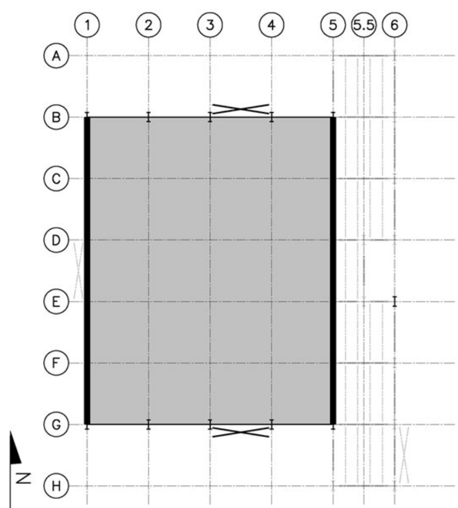

FIGURE 3

The sizes of the diaphragm beam flanges and their attachments to the steel deck must be calculated and spaced properly. The continuity of the flange elements must be maintained by providing field-welded or field-bolted assemblies.

The shear forces accumulated in the roof diaphragm must be transferred to the bracing in a perpendicular plane and subsequently to the ground. This transfer will occur along continuous members aligned with a vertical bracing.

Alternative example

The beam concept in Figure 2 could also be as shown in Figure 4 since this would decrease the flange force. A coped beam would then have to be considered with only the lower part of the web capable of transferring the shear from the diaphragm to the vertical bracing. This would significantly increase the shear flow due to the reduced web section. Similarly, the required attachments to the support and between the sheets of steel deck would increase in the area defined by gridlines 5.5 to 6 and E to H in Figure 4.

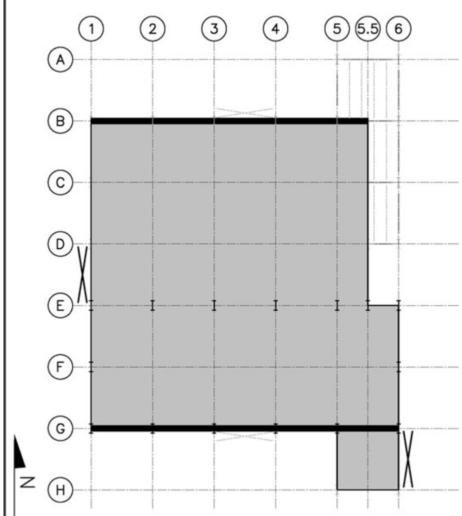

FIGURE 4

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