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AD 267

Notional Horizontal Forces and Industrial Platform Floors

Questions have arisen about the guidance in BRE Digest 437 *Industrial Platform Floors: Mezzanine and Raised Storage*, and in particular the application of the notional horizontal forces mentioned in the section covering stability. In BRE Digest 437, it is stated that “lateral stability checks should be carried out based on a notional horizontal force (NHF) of 2% of the sum of the dead and vertical imposed loads assumed to act at decking level”. For structures designed to BS 5950-1, the Digest states that the NHF should be increased by the relevant partial load factors. Additionally, the Digest offers effective length factors for the columns for various restraint conditions, which are repeated in Table D1 of BS 5950.

Firstly, it should be noted that Industrial Platform Floors (often known as mezzanine floors or raised storage), are different from the orthodox building construction that BS 5950-1 covers. Often, Industrial Platform Floors are internal (so have no wind load applied), are lightweight (often constructed of cold-formed joists and chipboard decking), support high imposed loads and are constructed with connections quite different to beam-column connections between hot-rolled steelwork as seen in orthodox building construction. For these reasons, Industrial Platform Floors are seen as a special case.

In common with all structures, minimum levels of lateral load and sway stability must both be addressed.

Minimum level of lateral load

In orthodox structures designed to BS 5950-1: 2000, NHFs are included in any loadcase that would otherwise have no lateral load. Thus BS 5950-1: 2000 Clause 2.4.2.3 specifies that the NHFs should be applied in load combination 1 (defined in Clause 2.4.1.2). In orthodox structures the NHFs are 0.5% of the factored vertical loads. In accordance with Digest 437, when designing Industrial Platform Floors, the NHFs are increased to 2% of the factored vertical loads. These NHFs should be applied together with the factored vertical loads as load combination 1 of BS 5950-1: 2000. Clause

2.4.2.4 (e), states that the NHFs should not be taken to contribute to the net reactions at the foundations. This is because the NHFs are internal to the frame (i.e. no external load is applied) and therefore there can be no net contribution overall – although note that individual foundations may be affected by the NHFs.

BS 5950-1: 2000 Clause 2.4.2.3 explains that, to provide “a practical level of robustness against the effects of incidental loading”, structures should be designed not only to resist NHFs in load combination 1, but also a minimum wind load in load combinations 2 and 3. The minimum wind load is used as a method to define a minimum load that must be transmitted into the foundations, contributing to the net reactions. Since Industrial Platform Floors have a low dead load and a high imposed load, the usual BS 5950-1: 2000 provision in Clause 2.4.2.3 of taking a minimum wind load as 1% of the factored **dead** load is considered to be insufficient. It is recommended that in the case of Industrial Platform Floors, the minimum lateral load in each loadcase is taken as 2% of the factored vertical loads, and that this load is carried through to the foundations. This minimum level of lateral load should also be used when considering SLS deflections.

Sway Stability

Digest 437 refers to braced and unbraced frames, and provides effective lengths for the columns in both cases. It would appear that Digest 437 assumes that braced platform floors are always non-sway, but this cannot be safely assumed. For braced Industrial Platform Floors, the sway stability should always be checked using the rules in BS 5950-1: 2000. Sway stability is assessed by calculating λ_{cr} in exactly the same way as for orthodox structures. The NHFs should be applied to the bare frame and the lateral deflection determined. λ_{cr} is taken as $h/200\delta$, where h is the storey height and δ is the storey drift under the NHFs. Note that to assess sway stability, the NHFs should be taken as 0.5% of the factored imposed loads, and **not** the 2% used as a minimum level of lateral load. The calculation of λ_{cr} in BS 5950-1 is inextricably linked to taking the NHFs as 0.5% of the factored loads – use of any other value of NHFs will invalidate the relationship. If a braced Industrial Platform Floor is found to be sway-sensitive, then either the sway effects can be amplified using the amplification factor k_{amp} for unclad frames, or the column effective lengths should be taken as if the frame were unbraced.

If the Industrial Platform Floor is unbraced,

no explicit check of sway stability is required, as second-order effects are accounted for by using the effective length factors for an unbraced frame as presented in Digest 437 and Table D1 of BS 5950-1.

Where the structure of the surrounding building is both strong enough and stiff enough to stabilise the mezzanine, the most economic solution is usually to connect the mezzanine to the surrounding structure. However, the stability of the surrounding structure must be checked for the effects of its own loads in addition to the loads supported by the mezzanine. Typically, the checks will be made using NHFs, so these must be taken as the sum of the NHFs from the surrounding building plus the NHFs from the entire mezzanine.

Summary

Braced Industrial Platform Floors.

- Assess sway-stability using the BS 5950-1:2000 rules, and taking NHFs as 0.5% factored vertical loads for the calculation of λ_{cr}
- For Sway-sensitive braced frames, there are two options. The first is to amplify the sway effects using the “unclad” amplifier, which will increase the forces in the members of the bracing system (beams, columns, connections, bracing and base). Column effective lengths should be taken from Table D1 for braced frames. The second option is to design all the columns with the effective lengths taken from Table D1 for unbraced frames.
- Non-sway frames should use the braced effective lengths from Table D1
- The minimum level of lateral load should be 2% of the factored vertical load, and this should be taken through to the foundations.

Unbraced Industrial Platform Floors.

- Unbraced frames should use the unbraced effective lengths from Table D1.
- The minimum level of lateral load should be 2% of the factored vertical load, and this should be taken through to the foundations.

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