Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 999 (1997)

Artikel: Monotonic behaviour of fastening systems for sandwich panels
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DOI: https://doi.org/10.5169/seals-1078

Monotonic Behaviour of Fastening Systems for Sandwich Panels

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Summary

The influence of connecting system on the structural behaviour of sandwich diaphragms in pin-jointed steel frames is investigated in this paper. The importance of connections on the global response of the whole system has been evidenced through experimental as well as numerical analyses. Detailed tests on different sandwich panel connection typologies allow to set up an analytical model able to predict their monotonic performance. Such a model is useful to characterise the behaviour of connection when accurate global non-linear analyses are required.

1. Introduction

Light-weight curtain wall systems are more and more used in both industrial and civil buildings, where they can cooperate with the steel skeleton, giving rise to a composite action like a diaphragm action. Nowadays, the interest is therefore concentrated in the evaluation of their contributing effect on the structural behaviour of the building. Depending on the adopted connecting system, such panels may, in fact, provide a remarkable increasing of both lateral stiffness and ultimate strength of bearing steel frames subjected to horizontal loads. The linear analysis for infilled frames, as it is suggested in the present code (EC3-Part 1.3), allows to take account for the skin effect in terms of both strength and initial stiffness. Nevertheless, it does not allow to assess the actual ductility resources of the system as well as itsdissipative capacities. The interaction between steel cladding panels and structural framing system has been analysed within a general research project, sponsored by ECSC and developed through thecooperation between University of Naples and Italian Consortium CREA. With regards to the sandwich panels, experimental, theoretical and numerical activities have been performed [1].

2. The influence of connecting systems

Numerical as well as full-scale experimental analyses on different sandwich panel typologies connected each other and to the external frame by means of different kinds of connecting systems have emphasised that the contribution of the connections to shear flexibility of the panel is generally prevalent and plays a fundamental rule on the overall behaviour of infilled frames [1,2]. In addition, it has been shown that the actual behaviour of shear diaphragms, as the shear load increases, is more and more non-linear, depending on the behaviour of the adopted connecting system, being the major source of non-linearity just concentrated in connection elements. In order to develop an accurate analysis, the complete shear load-lateral displacement relationship should be therefore determined. The aim can be pursued by means of adequate non linear numerical tools. The proper structural characterisation of connections becomes therefore the starting point for the correct interpretation of the response of steel shear walls.

3. The behaviour of connections

The actual behaviour of connecting systems has been investigated by means of experimental tests [3,4]. Sandwich panels with trapezoidal, embossed as well as plane external sheets has been tested. Besides, a special panel with an internal steel reinforcing profile has been considered. The analysis have concerned both panel-to-panel connections and panel-to-external frame connections With reference to the former, screwed connections and bonded connections, using glue and biadhesive bands has been analysed. Riveted and welded connections have not been taken into account. The *riveted connections*, in fact, have not a good behaviour under cyclic loads because they present a brittle mechanism of fracture, while the*welded* ones are not applicable owing to the very thin thickness of panel sheets.
The collapse mechanisms have found obviously to be strictly related to the connection typology. As regard to *screwed connections*, the sheeting resistance is demonstrated as the weak point of the joint, being the collapse always characterised by a large holeovalisation. The connection for corrugated sheets have shown a bad performance due the impossibility to connect both sheets on the two sides. On the contrary it is to emphasise the good behaviour of reinforced panel connections which allow to rely on both strong resistance and stiffness.
As far as *bonded connections* are concerned, the collapse phenomenon has been characterised by the slipping between the two opposite parts of the specimens, which follows a more or less sudden disjunction. In particular the connections with*biadhesive band* has provided a too low ultimate load, which makes the good ductility qualities useless. The*glued* bonded connections has instead shown a good ultimate strength value, joined to a very high brittle behaviour.
Based on the previous experimental results, two panel typologies have been selected for testing panel-to-external frame connecting system: the embossed sheet one and the flat sheet with reinforcing cold-formed profile. As far as connecting system typologies are concerned, only screwed connections using self-tapping screws have been considered.
The collapse of connection was characterised by a large holeovalisation, with bearing and tearing of the sheets. The maximum load value is found to be strictly depended on the number of resisting sheets, as well as on their thickness. The corresponding load-slip curves are typical for this failure mechanism, showing the great displacement capacity as consequence of sheet holeovalisation.

4. Further development

In order to develop accurate global non-linear analyses contemplating the diaphragm effect of sandwich claddings, a mechanical model able to predict the monotonic behaviour of connection typologies should be set up. Such a model could be based upon mechanical properties of connections as pointed out from experimental test results and generalised by using a simple appropriate analytical formulations.

References

[1] Mazzolani, G. De Matteis, R. Landolfo: *"The stiffning effect of cladding panels on steel buildings: the ECSC research project in progress "*, in Proceedings of European Workshop on Thin-Walled Structures, Krzyzowa, Poland, September 1996.

[2] Mazzolani, G. De Matteis, R. Landolfo: *"On the shear flexibility of corrugated shear panels"* STEEL STRUCTURES, Journal of Singapore Structural Steel Society, December 1995.

[3] F.M Mazzolani, G. De Matteis, R. Landolfo: *"Shear tests on sandwich panel connections"* - Cost C.1 Workshop, Praga, October, 1994.

[4] Mazzolani, R. Delponte, G. De Matteis, R. Landolfo: *"Experimental analysis on sandwich panel-to-external frame connecting systems"*, 4th Cost - C1 Seismic Working Group Meeting , Anacapri (NA), 5-6 ottobre 1995.