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Performance of wall-stud cold-formed shear panels under monotonic and cyclic loading Part II: Numerical modelling and performance analysis

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Abstract

The main components to provide earthquake performance of a light-gauge steel house are the shear walls. Understanding shear wall behaviour and finding suitable hysteretic models is important in order to be able to build realistic finite element models and assess structural performance in case of earthquake. As for any building structure expected to exceed its elastic behaviour-range in case of earthquake, the interaction of design capacity, load bearing capacity and structural ductility will influence the performance.

In this paper alternative design methods and hysteretic modeling techniques are presented. Based on tests described in Part I, a numerical equivalent model for hysteretic behavior of wall panels working in shear was built and used in 3D dynamic nonlinear analysis of cold-formed steel framed buildings. Preliminary conclusions refer to the effect of over-strength and ductility upon possible earthquake load reduction in case of light-gauge shear wall structures.

Keywords: Light-gauge steel shear walls; Hysteretic modelling; Time history analysis; Incremental dynamic analysis; Earthquake load reduction factor

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1. Introduction

Earthquake performance of a structure depends on large number of parameters. Even if we do not consider the high uncertainties related to the evaluation of earthquake motion characteristics at a given site, the overall behaviour of a structure is influenced by numerous factors related to the behaviour of its structural components, interaction with the soil and interaction with non-structural elements that are usually neglected in design calculations.

Undoubtedly, one of the most important parameters to consider for a structure is the actual behaviour characteristics of its structural components. In the case of light-gauge steel houses the primary elements to resist lateral forces (i.e. wind and earthquake) are the wall panels, so the steps towards understanding global response are through assessing wall panel behaviour and then integrating it into the structure. As a first step it is important to find suitable modelling tools for a panel, which is easily integrated into a global structural scheme. Also, it is unavoidable to define the objectives that we are trying to fulfil through design and how it is possible to avoid collapse and limit damage.

2. Possible design calculation methodologies

During experiments two distinct failure mechanisms were identified for wall panels sheeted with corrugated sheeting and OSB. The lateral deformation of a panel is dependent on: (1) shear deformation of the sheeting material, (2) deformation due to corner uplift and most significantly on (3) nonlinear deformation of the connections between shear panel and skeleton.

In case of wall panels sheeted with corrugated sheeting placed horizontally (Fig. 1a) most of the nonlinear deformation was due to the inelastic deformation of seam fasteners. Seam connectors will be the ones to deform excessively, later load being redistributed to the vertical screw lines connecting the sheeting to the skeleton.

In case of wall panels sheeted with OSB, as the skeleton deforms into a parallelogram, the OSB panels have ‘rigid body’ rotation (Fig. 1b). As a consequence connec-

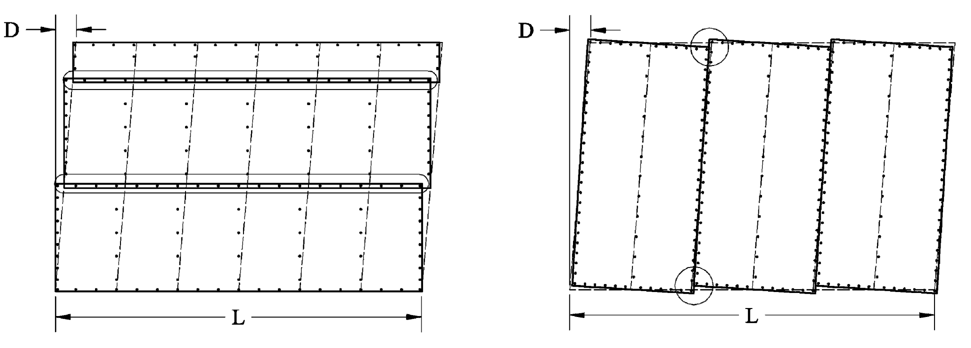

Fig. 1. Deformation pattern of corrugated sheet (Series I & II) and OSB (Series OSB I) specimens.