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Short communication

Effect of steel hanger height on its members' internal forces due to wind loads: comparison between standards EN1991-1-4 and NV65

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ABSTRACT

This paper presents a comparison between two standards, namely NF EN 1991-1-4/A1 (October 2010) of Eurocode 1 and NV65 (DTU P06-002) (February 2009), that estimate wind loads on steel structures. For that purpose, a typical steel hanger was designed and analysed using both standards. Five different heights for the designed hanger were considered going from five to 25 m with an increment of 5 m. The paper shows all obtained curves for the calculated internal forces (axial, shear, and bending moment) on the hanger elements for all studied cases when using both standards.

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1. Introduction

All European Community countries adopted in June 2010 to use EN1991-1-4 standard instead of NV65 for calculating wind loads when designing steel structures. For instance, in France, NF EN 1991-1-4 (November 2005) standard of Eurocode 1 - Actions on structures - Part 1-4: General actions - Wind actions, modified by Amendment A1 (October 2010) with index: P06-114-1, came out to cancel NV65 standard (DTU P06-002) (February 2009). However, France's "national application document" NF EN 1991-1-4/NA (March 2008), which defines the wind regions map for metropolitan France, amended by: Amendment A1 (July 2011); Amendment A2 (September 2012), is identical to the wind map as defined by NV65: 2009.

This paper provides the impact of this change on the calculated internal forces of the elements of a typical steel hanger. The first part of the paper presents the effect of varying the hanger height on the calculated internal forces induced by wind loads on the structural elements. The second part of the paper gives a comparison of the calculated internal forces when the wind load is determined using the two selected standards.

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2. GENERAL assuMptions

2.1. Selected wind region

Fig. 1 gives the value of the wind speed for the different adopted regions in metropolitan France when using both standards (NV65 and EN 1991-1-4). The difference between the speed values comes mainly from the differences in the basic definitions adopted by both standards [1]. The reference used by the NV 65 standard corresponds to the maximum observed speed whereas that of the EN 1991-1-4 corresponds to an average speed over a10-minute-period. For this study, Region 2 was selected since it the most representative region in France.

2.2. Choice of site and terrain categories

Fig. 2 gives the design wind pressure according to both standards for different construction heights. With the NV65 standard, the wind pressure depends on the site type, while with the EN 1991-1-4, it depends on the selected terrain category. In order to evaluate differences attributed to the two codes, comparables terrain category and site type should be used. For that reason, differences in wind pressure using both codes for all site types and terrain categories were calculated for several construction heights. Fig. 3 shows the cumulative variation in calculated wind presssure (using all considered heights) for each combination of site type and terrain category. It is clear that the two closest cases are “terrain category II and exposed site” and “terrain category IIIb and normal site”. Since, 66% of the geographical map of France lies within “category II”, the case “terrain category II and exposed site” was selected for this comapartive study.

2.3. Choice of the designed hanger geometry and location

For the purpose of this study, a typical steel hanger was used (Fig. 4). The hanger is composed of one steel frame with a height H, a width of 24 m, and a length of 60 m. The height (H) was varied from 5 m to 25 m with an increment of 5 m. The roof has a slope of 10% (angle of about 5.7°). Pinned connections were assumed for the columns. The hanger is assumed to be a closed building, located at an altitude of 200 m over a flat terrain. Table 1 summarizes the general assumptions of the study as well as the engineering characteristics of the building.

3. Effect of the variation of the height on the internal forces

3.1. Study approach

After determining the general assumptions, the calculation of the wind pressures for the various load cases (wind on end frames, wind on sidewall under over-pressure and under-pressure) was performed. The internal forces (FX: axial force, FZ: Shear and MY: bending Moment) in the columns and beams were determined in order to obtain the envelope diagrams.

3.2. Internal forces in the columns

Figs. 5–7 show the envelope curves for the axial force, shear force, and bending moment in the columns as a function of the hanger height (H), respectively. The following findings were noted:

- The axial force increases in the same rate when using both standards. In fact, when H increased from 5 m to 15 m, the maximum axial force increased from 40.4 kN to 84.4 kN (an increase of approximately 109%) when using EN1991-1-4

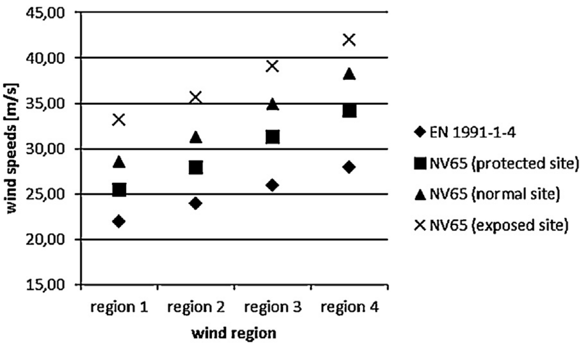

Fig. 1. Design wind speed according to the regions.

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