

Verification of the patch-load method for the determination of the response of guyed masts exposed to gusty wind loads

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With guyed masts, wind is the most important force. In Eurocode 1993-3-1, the loads affecting such structures when exposed to wind action are calculated with a method that is based on the assumption of section-wise gusty wind loads and the 10-minute mean of the wind load. This method is known as the patch-load method, and it is to consider the gusty-wind induced dynamic load in an empirical approach. In EC 1993-3-1, this method is limited to masts with a defined ratio between stiffness, mass, wind resistance, and slenderness, and with a protruding length that is shorter than half of the adjacent section. There are plans to include this method in the draft DIN 4131 Standard (steel radio towers and masts), which is currently under discussion. However, in order not to restrict the field of application of this standard too much, it is not intended to also adopt the above-mentioned limitation of the protruding length. The effects of gusts on the protruding length are to be accounted for with the gust reaction factor stated in DIN 10555-4, Annex C.

As part of this small-scale project, guyed structures that are typical of Germany and that are normally designed on the basis of the rules and regulations set forth in DIN 4131 and DIN 4133 were calculated with the aid of these standards, and the loads thus determined were then compared with a more exact reference solution, in order to be able to assess the quality of results achieved with the patch-load method.

Since the guy cables tend to sag, the load-induced deformation behaviour of guyed structures is a non-linear behaviour. This non-linearity and its effect on the dynamic response of a structure that is exposed to gusty wind loads can be completely considered only with time domain calculations. The response of a structure exposed to spatially correlated, turbulent wind fields was dynamically calculated for the time domain, and the results thus produced were compared with those obtained with the patch-load method.

Structures calculated for the project were three laterally supported smoke stacks and four guyed masts. It is evident from the results produced with the laterally supported smoke stacks that it is necessary to consider the gust reaction factor for the patch-load case "protruding length", as otherwise the forces will be underestimated in comparison with the more exact calculation. With guyed masts with a protruding length which is by more than 50 % longer than the adjacent section, the approach which is to be included in the draft DIN 4131 - consideration of the gust reaction factor for the protruding section - can safely be used for forecasting the forces acting on the protruding length and the uppermost guyed level. However, with highly elastic intermediate supports for the mast shaft, relevant forces can occur, which the patch-load method does not adequately consider, even if these structures still come within the criteria of the patch-load method - both on the basis of the draft DIN 4131 and of Eurocode 1993-3-1. The forces which the patch-load method forecasts for such structures can remain by up to 25 % below the forces resulting from dynamic time-history calculations.