3.3. Identified loads and the associated displacements

In order to compare the accuracy of identified wind loads, the actual forces are transformed to the TAM level, that is, $\mathbf{F}_{tr/act} = \mathbf{T}_{IRS}^{T}\mathbf{F}_{act}$. The best and the worst identified TAM wind loads at 1% and 5% noise level together with their corresponding actual transformed forces i.e. $\mathbf{F}_{tr/act}$ are plotted in Fig. 2.

The back calculated displacements of TAM from the identified wind loads are expanded to the intermediate model level. Table 2 provides the second norm vector error of the expanded retrieved displacements. It is also possible to obtain all degrees of freedom responses for FE model with a good quality from the displacement response of intermediate model, since this transformation acts very exactly up to the first eight natural vibration modes.

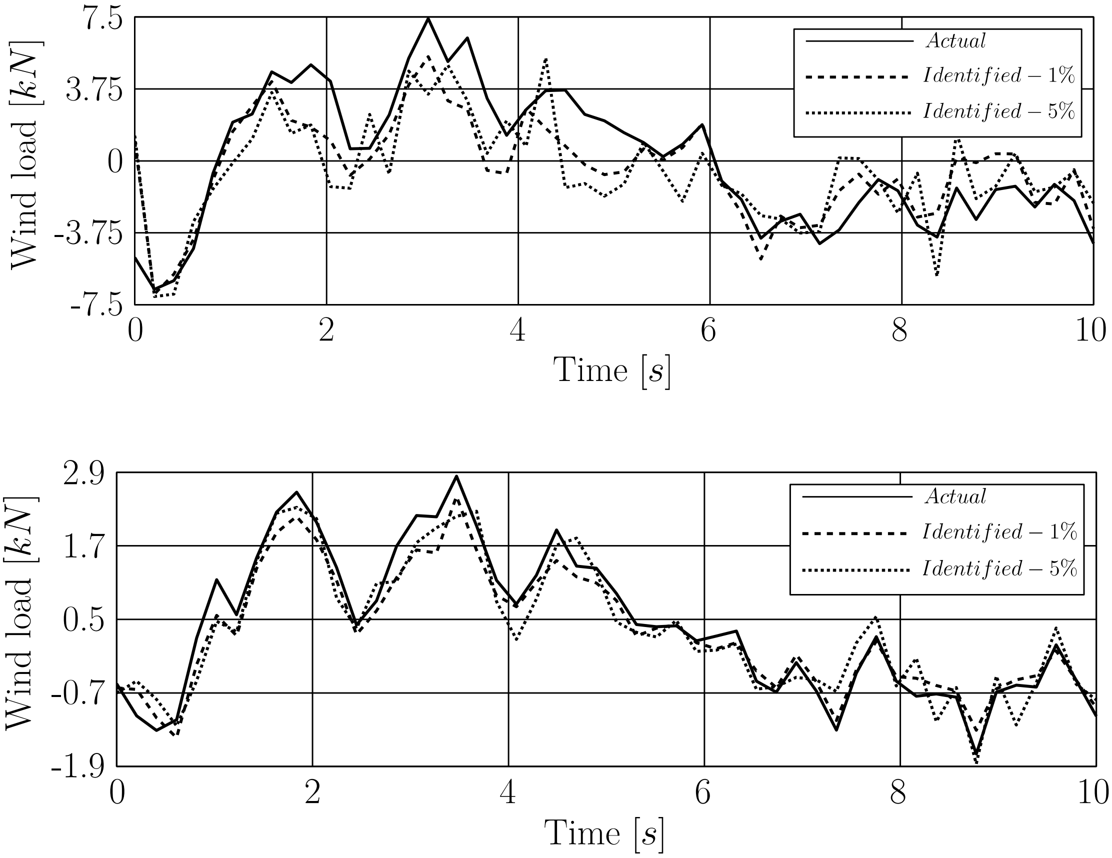

Figure 2. Comparison of identified wind loads at 4th (up) and 5th (down) degree of freedom of the TAM

Table 2. Error of displacements from identified wind loads for 36 degrees of freedom of the intermediate model

Noise level	1%	5%
Error (%)	4.4	1.9

4. CONCLUSION

This study proposes a strategy to identify the distribution of the wind loads inversely from the measured responses of few locations along an instrumented guyed mast. The identified wind load is an equivalent load pattern at the TAM level, corresponding to the measurement locations on the main structure. The load is identified from the Tikhonov regularization solution while the regularization parameter was found by means of L-curve method. This strategy uses the common methods of field measurement and works independent of the loading nature.

The idea of identifying the equivalent load is applied to circumvent the incompleteness of displacements data since just a limited number of degrees of freedom can be measured. On the other hand the order reduction method can influence the quality of the identified wind load. As given in Table. 1, the natural frequencies of 5^{th} and sixth modes of the TAM are not well retained. Therefore these differences in natural frequencies and mode shapes could cause deviations in the identified loads.

However it is possible to apply more powerful methods to generate better TAM parameters. In this regard caution should be made so that the transformation matrix does not substantially change the rank features of the TAM parameters. Otherwise the regularization will be dramatically affected later.

Another source of error in identified load is the noise level in the measurement data. It can be observed from Fig. 2 that up to 5% noise level the identified wind loads still have acceptable accuracy. For higher than these noise levels a preprocessing of measurements data might be useful.

Finally it should be pointed out that identification of wind load acting on a structure under service could be very useful. Firstly due to the serious restrictions in direct wind load measurement in large scales and secondly the dynamics of wind loading can be used for different purposes in structural dynamics.

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REFERENCES

Bucher, C. (2009). Computational analysis of randomness in structural mechanics. Leiden, The Netherlands: CRC Press.

C. Bucher and S. Wolff. “slangTNG - Scriptable software for stochastic structural analysis”. In: Reliability and Optimization of Structural Systems. Ed. by A. DerKiureghian and A. Hajian. American University of Armenia Press, 2013, pp. 49–56..

Di Paola, M. (1998). Digital simulation of wind field velocity. Wind engineering and industrial aerodynamics , 91-109.

Hansen, P. C. (1993). The use of L-crve in the regularization of discret ill-posed problems. SIAM j. Sci. Comput. , 14 (6), 1487-1503.

Holmes, J. D. (2007). Wnd loading of structures (Second ed.). New York: Taylor and Francis.

Kaimal, J. W. (1972). Spectral characteristics of surface-layyer turbulence. Royal Meteorology Society , 98:563-89.

Kazemi Amiri, A., & Bucher, C. (2014). New formulations for derivation of parametric impulse response matrix utilized in deconvolution problem for wind load identification assisted by response measurement. Submitted to Sound and vibration .

Law, S. B. (2005). Time-varying wind load identification from structural response. Engineering structures , 1586-1598.

O'Callahan, J. (1989). A procedure for an improved reduced system (IRS) model. 7th International Modal Analysis Conference (pp. 17-21). Las Vegas, Nevada: Union college.

Tikhonov, A. N. (1997). Solution of ill-posed problems. New York: Weily.