Appendix 4

Stochastic Wind Analysis

Table of Contents

Appendix 4: Stochastic Wind analyses 2

1 Stochastic Wind 2

2 Linearization 4

3 ASCII Input 5

4 Defing wind spectras 6

5 Calculated results 7

Appendix 4: Stochastic Wind analyses

This appendix describes the analysis option of stochastic wind.

1 Stochastic Wind

NovaFrame includes a stochastic wind analysis for determining the dynamic response of the unsteady flow of the wind.

The response of the wind is divided into two parts, one static response (calculated in an ordinary static analysis) and dynamic response calculated by means of a stochastic wind analysis.

The input for a stochastic wind analysis is :

- The loadcase number where results are to be saved.
- The modes which are to be calculated (First mode, Last mode, step is 1)
- Mean wind 10 min. average. The following wind speeds are usually applicable, /3/-NS3479:
  Curve A, Not rough climate: v_{10} = 27 m/s
  Curve B, Rough climate: v_{10} = 31 m/s
- Horizontal wind direction, positive angle from X-axis towards Y, [deg.].
- Terrain roughness;
  z_0 = 0.70, mountain terrain.
  z_0 = 0.10, low terrain.
  z_0 = 0.01, sea.
- Damping, (relative to critical dampening);
  β = 0.08 steel structures and non-cracked concrete
  β = 0.16 cracked concrete

In addition to the parameters above wind areas must be defined for the elements. An eigenvalue analysis calculating the selected modes must have been performed prior to starting a stochastic wind analysis. The mean response is calculated based on the wind mean speed (10 min. average) in a static analysis. The contribution from each mode is added with the use of the RMS (root mean square) method.

Background
The maximum expected dynamic part of the response is estimated by;

$$\Delta w = \gamma \cdot \sigma_w$$

where:

$$\gamma = u + \frac{0.5572}{u}$$

$$u = \sqrt{2 \cdot \ln(n_v \cdot T)}$$

T – duration of period (10 minutes)
n_v – frequncy (~ n_o)

The variance σ_w of the displacement can be expressed by;

$$\sigma_w = \int_0^\infty \left(\frac{1}{K_g} \right)^2 \cdot \chi^2 \cdot \frac{S}{V_m^2} \cdot J^2 \cdot dn$$

K_g - Generalised stiffness
χ - Dynamic amplification
S - Wind spectra
n - Frequency

$$J^2 = \sum_{i=1}^{m}\sum_{j=1}^{m} 4 \cdot P_i \cdot P_j \cdot \phi_i \cdot \phi_j \cdot \sqrt{Coh} \cdot dA_i \cdot dA_j$$

$$P = \frac{1}{2} \cdot \rho \cdot C \cdot V_m^2$$

ϕ = *modal shape of vibration*

C = wind areas and factors

The root coherence function is equal to:

$$\sqrt{Coh} = e^{-8 \cdot n \cdot \frac{\Delta s}{\overline{V}}}$$

where Δs is the distance between the points i and j.

NovaFrame uses as default von Karman's windspectra for horizontal and vertical wind fluctuations. The parameters such as length scales and turbulence intensities are calculated at a reference height. This height is automatically selected as the highest z-ordinate of the structure/model.

The default spectra may be overridden by defining your own spectra. If the user selects a value for the reference height then this value will used for calculating wind field parameters. If the user specify wind parameters explicitly then these will be used instead of being calculated based on the (given or default) reference height.

Defining own spectra is achieved by selecting: **Preprocess- Spectras- Wind** from ***Frame window*** menu.

2 Linearization

Wind areas and shape factors of elements are defined in NovaFrame, please see section 3.6 of the manual. These properties are used in a static wind loadcase and in a stochastic wind analysis. For static wind loadcases, see chapter 4.1 of the manual.

The wind speed at the element location is decomposed in the element local directions, one component in the L-direction and one component in the N-direction. The wind component; V_L gives a drag- and a lift component as shown in fig. 3.6.1. in the manual.
In a stochastic wind analysis the term $(CA)_{L1}$, in the expression for the lift force, is omitted due to linearisation.

3 ASCII Input

Dynamic load syntax: Stochastic Wind

DYNWIND No FromMode ToMode SpectraNo Speed Dir Roughness Dampening

DYNWIND defines a loadcase where results from a stochastic wind analysis is to be saved.

No:	Loadcase no.
FromMode ToMode:	Actual eigen modes, step = 1.
SpectraNo:	Spectra number.
Speed:	Wind speed at 10m height [m/s].
Dir:	Wind direction [deg] relative to global X-Axis (in the horizontal plane XY).
Roughness:	Terrain roughness.
Dampening:	Mechanical damping.
Name:	Optional name. All characters allowed including space.

NovaFrame includes a stochastic wind analysis for determining the dynamic response of the unsteady flow of the wind.

4 Defing wind spectras

It is possible to include user defined spectras in NovaFrame.

5 Calculated results

Detailed results for each mode is calculated. In the List results dialog you choose the type of results you want. Select sort by loadcase. Then a summary of the paramerters used in the calculations are found.