The Force of Wind on a Simple Frame Structure

As part of my year working with Wood Group PSN, I was involved in a project, on the Talisman contract, involving pipes on a support bridge over a road. My role was to ensure the integrity of the structure (see Fig. 1) by considering the loads acting on it such as the self weight of the structure, the vertical loads from the pipes and the wind loading. To do this I calculated all the loads on the structure and input the data into structural analysis software (STAADPro V8i)

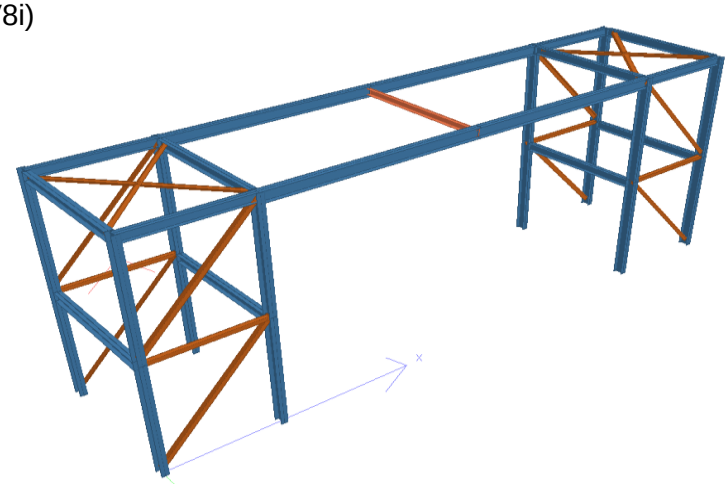

Fig 1. Support Structure for Pipes model from STAADPro V8i

As mentioned, one of the loads considered was wind loading. Wind loadings are applied as a Uniformly Distributed Load (UDL) in the analysis software. An example of a simply supported beam with a UDL is shown below.

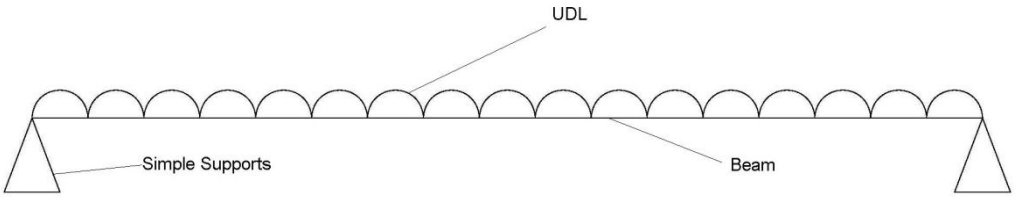

Fig 2. Simply Supported Beam with a Uniformly Distributed Load

To find the values for the UDLs, I started with the average wind speed for the area.

$$Maximum\ Extreme\ Wind\ Speed \quad V = 27.5 m/s$$

The wind speed is then converted into pressure.

$$Wind\ Pressure \quad p = 0.5 p_a V^2 \qquad Where\ the\ density\ of\ air\ is\ p_a = 1.225 \frac{kg}{m^3}$$

$$p = 463.20 \frac{N}{m^2}$$

$$p = 0.463 \frac{kN}{m^2}$$

The UDL for each beam type the wind is acting on will be different even though the pressure is the same; this is due to the change in area of the face the wind is acting on. This is shown by the equation:

$$P = \frac{F}{A}$$

As the lengths of similar sized beams in the structure differ, the UDL for the force per length is used to represent the wind loading for each size of beam. This is calculated using:

$$UDL = hpC_f$$

$$Where\ h = height\ of\ beam\ (m)$$

$$p = pressure\ (\frac{kN}{m^2})$$

$$C_f = force\ coefficient$$

The beam highlighted in blue below is a 254x146x37 UB (Universal Beam). It has a height of 254mm and a force coefficient of 1.68. The force coefficient is dimensionless and depends on the shape of beam and length to height ratio of the beam.

$$UDL = hpC_f$$

$$UDL = 0.254 * 0.463 * 1.68$$

$$UDL = 0.198\frac{kN}{m}$$

Therefore the force per length applied by the wind to the 254x146x37 UB is 0.198kN/m.

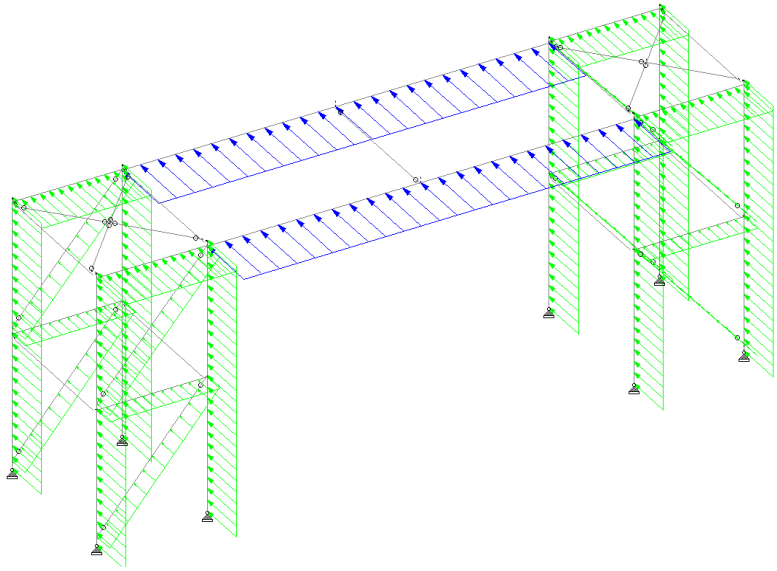

Fig 3. Wind Loadings on Support Structure model from STAADPro V8i

The same process is used to find the UDLs for the other sizes of beam.