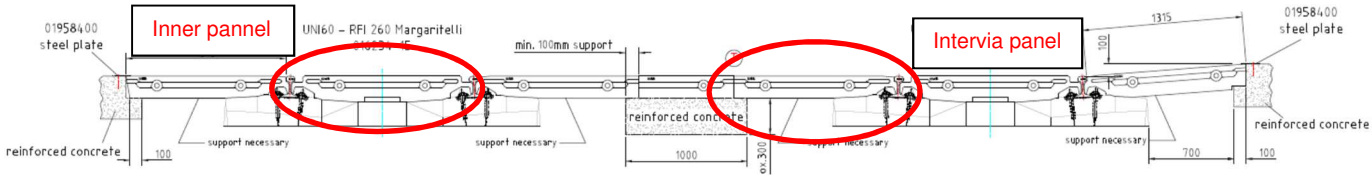
Project “Galleria Rondissone” - Calculation of aerodynamic impact on innoSTRAIL panels at high speed lines

Parameters:
According a study of DB regarding impact on crossing panels at normal track and in tunnels, following forces were measured:

Normal track, ICE1, 280 km/h: pressure: 2,3 kPa; suction: -3,9 kPa; impact pressure: 3,6 kPa
Tunnel, two ICE3 encounter, both 300 km/h: pressure: 6,8 kPa; suction: -7,1 kPa

Facts:



Weight of innoSTRAIL inner panels (UIC60 rail, RFI260 V Margaritelli sleeper) 268,0 kg
Surface area inner panel 1,337 m x 0,9 m

Weight of the lightest used innoSTRAIL intervia panel (UIC60 rail, flat surface) 231,7 kg
Surface area intervia panel 1,320 m x 0,9 m

Weight of tie rod 3,92 kg

Target: ***p > q***

Calculation with tie rods and without end restraints:

Load innoSTRAIL inner panel: $$p1.1 = \frac{(268kg+2*3{,}92kg)*9{,}81\frac{m}{s^2}*10^{-3}}{1{,}337m*0{,}90m} = 2{,}25\ \frac{kN}{m^2}$$

Load innoSTRAIL intervia panel: $$p1.2 = \frac{(231{,}7kg+3{,}92kg)*9{,}81\frac{m}{s^2}*10^{-3}}{1{,}32m*0{,}90m} = 1{,}95\ \frac{kN}{m^2}$$

Resistance of clamped inner panels against vertical load until the panel end slips out of the railhead (with lubricade):

$$p2 = \frac{(103kg)*9{,}81\frac{m}{s^2}*10^{-3}}{1{,}337m*0{,}90m} = 0{,}84\ \frac{kN}{m^2}$$

Normal track:

Force caused of wind suction at 280km/h: $$q = 3{,}90\ \frac{kN}{m^2}$$

Force caused of wind suction at 385km/h: $$q = 3{,}90\ \frac{kN}{m^2} * 2{,}0 = 7{,}80\ \frac{kN}{m^2}$$ > p

Note: Assumption that force of wind suction from 280km/h to 385km/h increases by factor 2,0. Weight of panel/system can be increased easily by changed design.

Calculation of end restraints:

Force applied to one end restraint: $F = \frac{q*l}{2}$

Normal track, 385km/h:

$$F = \frac{(7{,}80kN - 2{,}25kN)*19{,}8m*1{,}337m}{2\ m^2} = 73{,}46\ kN$$

According to break test carried out at LGA Nuermberg/Germany the weakest part of end restraint will break at a force of 100 kN.

Conclusion:

- Weight of one innoSTRAIL panel without any additional fixing will not provide position stability at 385 km/h.
- A minimum of four connected innoSTRAIL inner panels can provide position stability at 385 km/h
- A minimum of five connected innoSTRAIL intervia panel can provide position stability at 385 km/h
- All panels have to be fixed with end restraints.
- If during construction the installation is not finished and trains pass the level crossing the panels have to be fixed with tie rods and end restrains due to safety reasons.