Description of the experiment: Damage detection of steel splice-type connections by Coaxial Correlation Method in 6-D space

The steel beam specimens with splice connection were considered as the object of study (initial stage of specimens is shown in Figure 1). The investigated steel specimens consisted of S355 strength class parallel flange I section IPE 80 steel beam elements with dimensions according EN 10365, where the height is 80 mm, the width is 46 mm, the web thickness is 3.8 mm, the flange thickness is 5.2 mm, and the root fillet radius is 5.0 mm. A total length of the specimen is 600 mm that had been halved and joined using two metal plates with dimensions of 46 mm × 300 mm and three different thicknesses – 4 mm (N1, N4), 8 mm (N2, N5) and 12 mm (N3, N6). One metal connector plate is positioned on the top face and the other on the bottom face of the specimen. The connection between the steel beam and steel plates was established using 8.8-grade M8 bolts in amount of 12 (N1, N2, and N3) or 16 bolts (N4, N5, and N6). The positioning of holes for bolts is adopted following the requirements of the Eurocode EN 1993-1-8 of minimum and maximum spacing and end and edge distances for bolts.

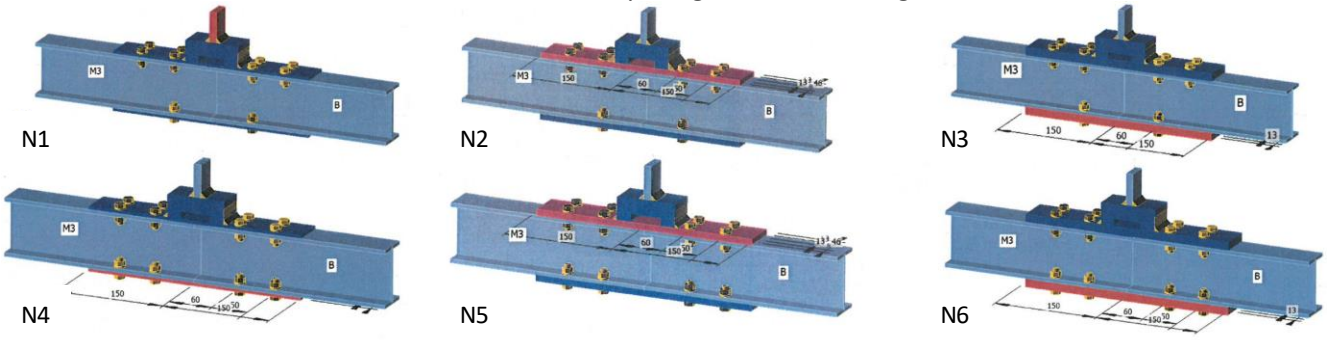

Figure 1. Steel beam specimens with splice connection with maximum value of the bending moment that the specimen can absorb: N1 – 2.250 kNm, N4 – 3.625 kNm, N2 – 2.625 kNm, N5 – 4.750 kNm, N3 – 3.125 kNm, and N6 – 5.500 kNm.

The vibration load on the specimen was generated by electrodynamic actuator placed at the right end of the beam as it can be seen on the Figure 2. Two 6D sensors were coaxially placed on the beams on either side of the investigated joint. 6D sensors are implemented by MPU-9250, which contains a 3-axis gyroscope and a 3-axis accelerometer. The specimen axes in accordance with the sensor's axes are shown on Figure 2, where vertical axis is X, the longitudinal axis of the specimen is Y, and the transversal axis of the specimen is Y. During the experiment, constant support conditions for the specimens are provided: simply supported (roller-roller) on vibration-absorbing supports with a span of 500 mm.

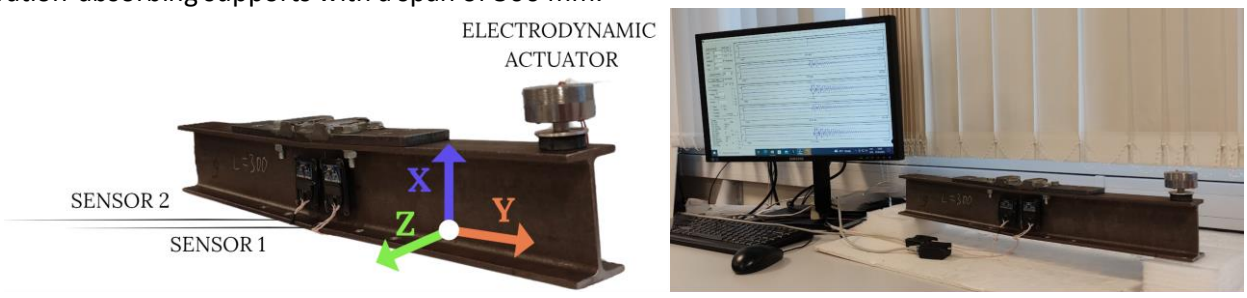

Figure 2. Placement of sensors and electrodynamic actuator, the axis of the specimen and the process of the data collection.

The data set consists of measurements for each of the six specimens during splice connection degradation. The degradation of a connection during operation has been artificially characterized by unbolting the bolts and removing the metal connector plate. For the specimens with initial number of bolts equal to 12 (N1, N2, and N3), measurements were taken with 12, 8 and 4 bolts. For the specimens with initial number of bolts equal to 16 (N4, N5, and N6), measurements were carried out with 16, 12, 8 and 4 bolts. The order of unbolting is shown in Figure 3 and was as follows: first, the 4 bottom bolts were unbolted, 2 edge bolts on each side of the joint; second, the

4 top bolts were unbolted, and 2 edge bolts on each side of the joint; finally, the last 4 bottom bolts were unbolted, and the bottom metal plate was removed. For each specimen state, two types of impact load were used – sweep with duration of 0.5 seconds and short pulse.

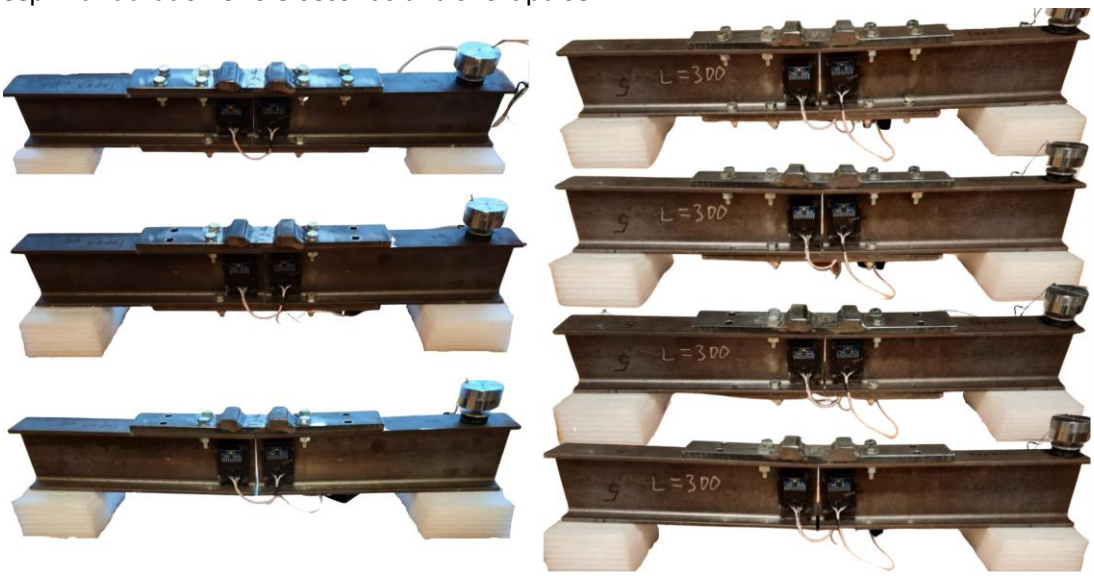

Figure 3. The order of unbolting for specimens N1, N2, and N3 (left), and for specimens N4, N5, and N6 (right).

The name of each measurement **.csv** file in the database has format **IMP_NX_BXX.csv**, where:

- **IMP** indicates on the type of impact ("P" – short impulse, or "S" – sweep type signal with duration 0.5 s);

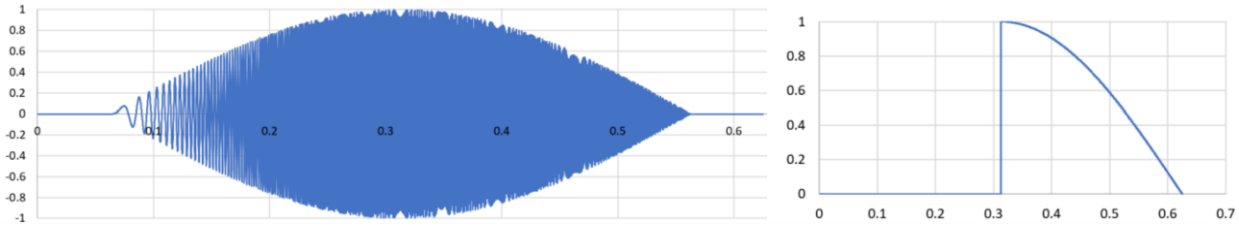

Figure 4. Types of impact: wave action (left) and short impulse (right).

- **NX** – indicates the specimen number in accordance with Figure 1;
- **BXX** is the number of the bolts in the investigated splice connection (B16, B12, B08 and B04 corresponds accordingly to 16, 12, 8 and 4 bolts).

For example, the measurement designation P_N4_B08.csv indicates that the measurement was carried out for the specimen N4 in the state of connection with 8 bolts, under impulse action.

Each file has the following **structure**:

Columns														
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Time, s	Pulse or sweep impact	–	Measurements of the sensor 1 on axes:						Measurements of the sensor 2 on axes:					
			X	Y	Z	GX	GY	GZ	X	Y	Z	GX	GY	GZ

The structure's response was measured in three directions, namely, X, Y, and Z (see Figure 2), using two 3D accelerometers and around three axes, namely, GX, GY, and GZ, using two 3D gyroscopes, thus providing 6D space measurements.