Seismic loading of the Industrial Zone Triangle

The "Triangle" industrial zone is situated at the border of three districts of the Czech Republic: Chomutov, Most and Louny. From the traffic point of view the zone is very well accessible since it is situated at former military airport Žatec.

Natural seismicity in the Czech Republic

Czech Republic is one of the areas with low seismicity (for illustrative image see map in Enclosure 1). There are six seismic zones on its territory, where earthquake effects reach the macro-seismic intensity 6° at least, i.e. where the effects of earthquake shaking can be observed on buildings. Macroseismic intensity scale is defined by the document European Macroseismic Scale 1998 (Centre European de Géodynamique et de Seismology, Luxembourg, ISBN No2-87977-008-4), see summary table in Enclosure 2. These areas can be briefly described as follows:

a) Český les – In this area, several weak local earthquakes of the intensity 4° - 5° have been observed. The epicenter of the strongest earthquake laid at Přimda (6°, 1902) and was shallow, and therefore the area affected by the shaking has a small size.

b) Krušné hory a Smrčiny – Western area (with adjacent Vogtland in Germany) is known to frequent occurrence of earthquake swarms since the end of the 12th century. There is no regularity in their occurrence (1897, 1900, 1901, 1903, 1904, 1908, 1911, 1936, 1962, 1985-86, 1991, 1997, 2000, 2008, 2011), an increased occurrence at the end of 19th and 20th century is noticeable. The maximum intensity reached 7° only twice, in 1908 and 1985. During the swarm 1985-86 construction damages were reported from a large area. Several old and some new buildings as well were damaged. Earthquake with intensity 6° was reported at Duchcov in 1784. Other earthquakes have occurred in Loket (5.5°, 1850) and Sv. Kateřina Mount (5°, 1896).

c) Sudety – Earthquakes in Trutnov and Náchod areas (1799, 1883, 1901, 1949, 1957, 1962, 1979, 1984, 1992) are associated to tectonic activity of Hronov-Poříčí zone. The strongest events are located between Trutnov and Náchod (7°, 1901) and in the valley of Úpa river (6.5°, 1883). Hrubý Jeseník belongs also to the important focal areas (5°, 1883; 5.5°, 1935; 5.5°, 1986).

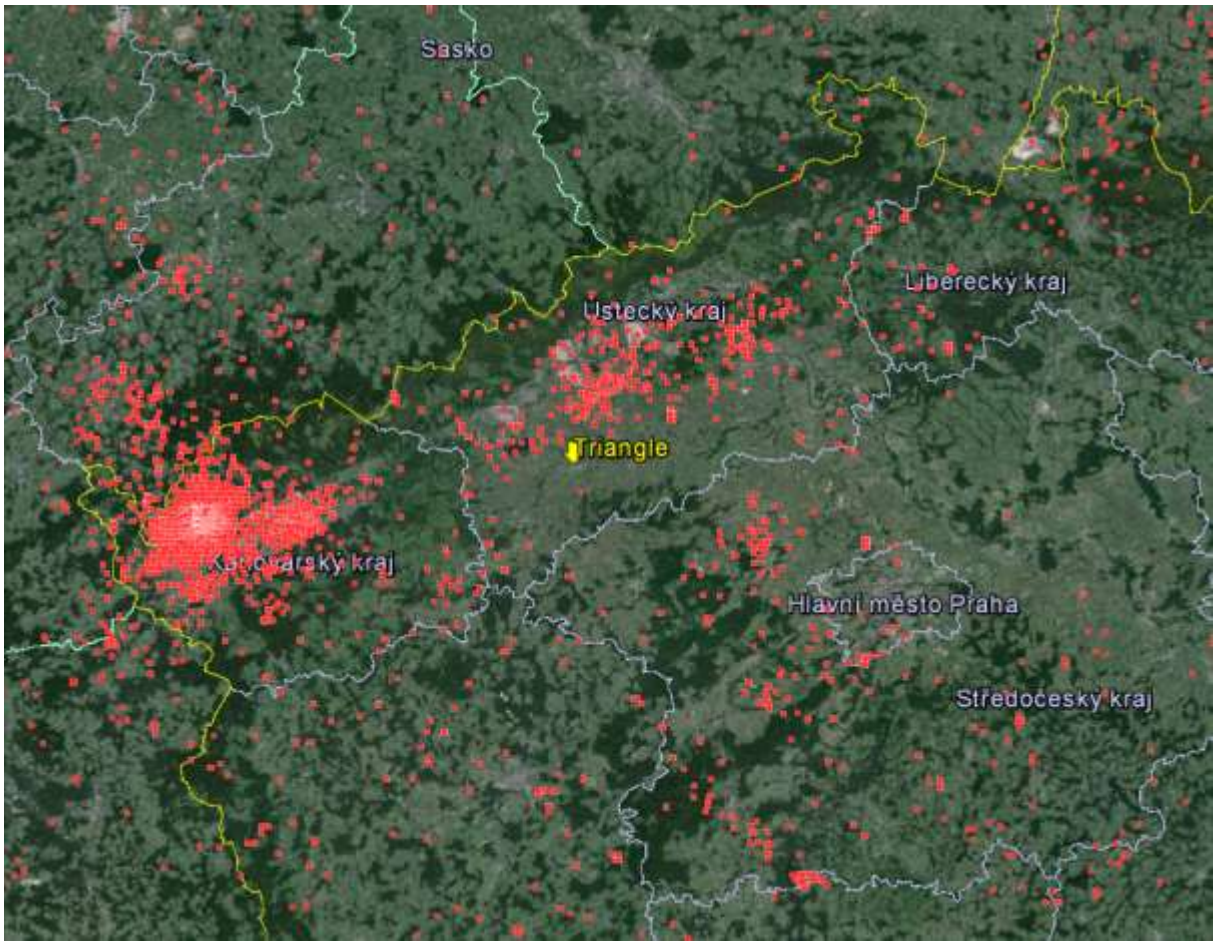
d) Western Carpathians and the Carpathian foredeep – The activity of this area is pronounced by the strong earthquake 7° - 8°, which occurred in 1786 near Český Těšín. The size of area affected by the shaking indicates a greater depth of the hypocenter (30-35 km). Significant earthquake effects reaching the intensity 7° were observed scattered over an area among Cieszyn, Ostrava, Všechovice and reached even to Opava. Macroseismic observations indicate two main directions of damage: the Carpathian (Frýdek - Všechovice) and the Sudeten (Cieszyn - Opava), suggesting probably two major fault systems on the intersection of which the earthquake originated. From the vicinity of Opava a series of 48 earthquakes (1931) is reported with the strongest intensity 6°, and earthquake (5°, 1993) associated with tectonic

directions of Sudeten tectonic unit. Earthquakes located on the Polish territory may cause effects 6° - 7° within the border areas (1785, 1786).

e) South Bohemia – The observed effects of the earthquakes have maximum intensity 6° (1590, 1876) and they are associated both with young tectonics of the Budějovice and Třeboň Basin and the earthquake foci in the Austrian Alps.

f) South Moravia –The effects of the earthquakes of the Austrian (1963, 1964) and the northern Italian Alps (1976) are observed up to intensity 6°.

To define the regions, all available data on observed macroseismic effects over a period of about 500 years were used. If a thick layer of unpaved surface sedimentary deposits (eluvial eroded mantle or alluvial river sediments) occurs in specific areas, an increase of the forecasted effects of earthquakes can be expected there up to one degree of the macroseismic intensity.
Triangle industrial zone is not within any of the areas listed. Locations of the earthquakes from the last 100 years are plotted on the following map. Almost all of these earthquakes have a magnitude less than 3, i.e. they are detectable only by instruments.



Seismic loading

Seismic hazard is usually described by a single parameter, namely the value of the reference peak ground acceleration on soil type A (rock mass or geological formation of rocks overlaid with a softer material in maximum thickness up to 5m). Other types of subsoil are taken into account by the subsoil coefficient S, which for extreme sedimentary cover takes the value 1.4. Additional parameters for certain types of structures are given in the relevant building standards.

The reference peak ground acceleration, estimated for each seismic region, corresponds to the return period of the seismic load which requests to exclude a collapse within 50 years. This return period is defined as a reference and is assigned with a factor of importance equal to 1.0. For other periods different from the reference one, the acceleration on soil type A is equal to the reference peak acceleration multiplied by a factor of importance, see Czech Technical Standard ČSN EN 1998 (73 0036) Eurocode 8.

In the case of a low seismicity, limited or simplified methods of seismic design may be used for certain types or categories of buildings. In cases of very low seismicity, requests of the building code which takes account of seismic loading need not be complied.

The industrial zone Triangle lies in a region with very low seismicity, where the value of the reference peak ground acceleration a_{gR} corresponding to soil type A reaches the maximum value of 0.04 g, i.e. 0.39 m/s^2. For the buildings planned within the Triangle zone - "ground buildings, whose seismic resistance is important in terms of the consequences associated with their collapse (e.g., schools, halls, cultural institutions, etc.)" – the coefficient of significance γ is 1.2 according to Eurocode 8. The corrected value of the reference peak acceleration corresponding to soil type A (subsoil coefficient S = 1) is equal to the product of $a_{gR} * \gamma * S = 0.04g * 1.2 * 1 = 0.048g = 0.47$ m/s^2. According to the standards, " In Czech Republic, the cases of very low seismicity, when it is not necessary to comply with the provisions of ČSN EN 1998, are considered those when the value of the product $a_{gR} * \gamma * S$ used to calculate the seismic load is not greater than 0.05 g".

Conclusion:

Seismicity of the zone comprising the locality of the Industrial Zone Triangle was assessed as small, the reference peak ground acceleration for supposed soil type A remains below the threshold value which would require to comply with the provisions of the building code taking into account a seismic loading.

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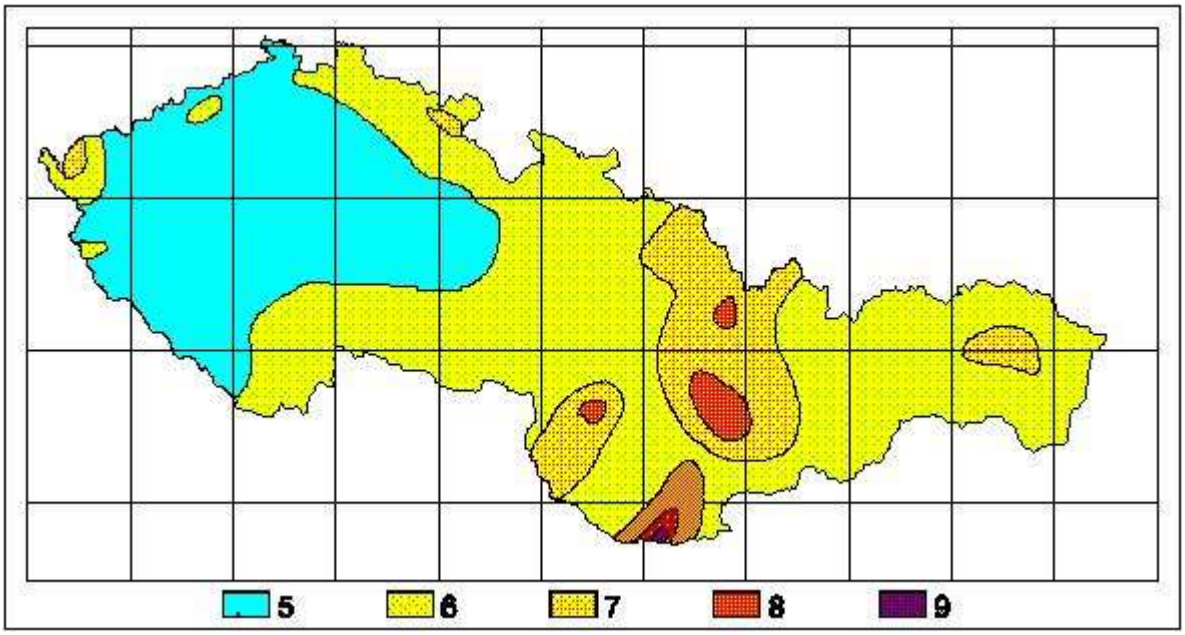
Enclosures



Enclosure 1: Estimated maximum earthquake intensity on the territory of Czech Rep. and Slovakia

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EMS intensity	Definition	Description of typical observed effects (abstracted)
I	**Not felt**	Not felt.
II	**Scarcely felt**	Felt only by very few individual people at rest in houses.
III	**Weak**	Felt indoors by a few people. People at rest feel a swaying or light trembling.
IV	**Largely observed**	Felt indoors by many people, outdoors by very few. A few people are awakened. Windows, doors and dishes rattle.
V	**Strong**	Felt indoors by most, outdoors by few. Many sleeping people awake. A few are frightened. Buildings tremble throughout. Hanging objects swing considerably. Small objects are shifted. Doors and windows swing open or shut.
VI	**Slightly damaging**	Many people are frightened and run outdoors. Some objects fall. Many houses suffer slight non-structural damage like hair-line cracks and fall of small pieces of plaster.
VII	**Damaging**	Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many well built ordinary buildings suffer moderate damage: small cracks in walls, fall of plaster, parts of chimneys fall down; older buildings may show large cracks in walls and failure of fill-in walls.
VIII	**Heavily damaging**	Many people find it difficult to stand. Many houses have large cracks in walls. A few well built ordinary buildings show serious failure of walls, while weak older structures may collapse.
IX	**Destructive**	General panic. Many weak constructions collapse. Even well built ordinary buildings show very heavy damage: serious failure of walls and partial structural failure.
X	**Very destructive**	Many ordinary well built buildings collapse.
XI	**Devastating**	Most ordinary well built buildings collapse, even some with good earthquake resistant design are destroyed.
XII	**Completely devastating**	Almost all buildings are destroyed.

Enclosure 2: International macroseismic scale EMS-98 (abbr.)

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