A major residential building project has been completed in Stockholm, which consists of 800 tonnes of steel structure supported on steel springs over railway lines. The use of long spans and rigorous sound and vibration control were some of the conditions for this project in Liljeholmen.

Residential building on steel springs in Stockholm

Liljeholmstorget is situated a few kilometres southwest of Stockholm city and is one of the most important centres for the public transport network. About 40,000 people pass through here every day. A major new building project in the town centre included 350 apartments, 3,500 m_2 of shopping area, an open square and an underground station. A new bus terminal, waiting hall and a car parking were built below ground.

The project started with a transfer structure over the railway tracks. A beam grid with a total weight of 800 tonnes made the construction over the rail tracks possible. This was made simultaneous as the traffic was running as usual on all four tracks, but the work had to be done in the night when there was no traffic on the tracks.
For normal residential buildings in Sweden, the rules in Boverkets Byggregler (BBR) and Boverkets Konstruktionsregler (BKR) are used. In this project for buildings spanning over Liljeholmens station with its four tracks, the construction was classified as a bridge structure and so the rules for bridges in BRO 2004 were applied.

The main challenge in the project was the design of the residential buildings on top of the rail tracks and to prevent vibrations from the trains to spread upwards in the buildings. The solution of this problem was to install 230 steel springs under the building.

To calculate the propagation of vibrations and sound in the framework from passing trains, the subcontractor Ingemansson Technology used FEM analyses. The client JM, Stockholm Transport and Stockholm City Development Administration agreed to a lower reference value than 30 dB for the noise level, which is the normal value for residential buildings in Stockholm. Due to the steel springs the maximum noise transfer was 26 dB.

Application Benefits: • All work was carried out without stopping the railway traffic • Work on site required installation of beam grids that weights 37 tonnes • New solutions were provided to avoid transfer of vibrations and noise inside the apartments • Awarded 2005 with Stockholm's Chamber of Commerce price for " the best example of embellishing or improvement of Stockholm's city environment"	***Project Team:*** **Client:** JM AB, Stockholm Transport and Stockholm City Development Administration **Architects:** White Arkitekter, Törneman & Co, Nivå, Reinius & Sporrong **Structural Engineer:** ELU Konsult AB **Sound Engineer:** Ingemansson Technology AB **Subcontractor:** PPTH Norden Oy, Besab AB

Detail of steel spring

Detail of steel support structure

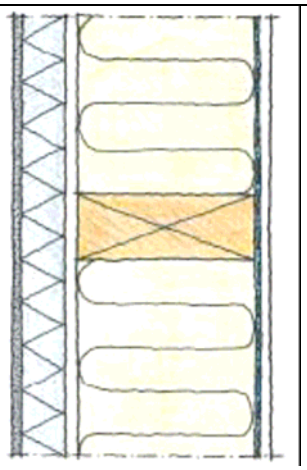
Construction Details:

The steel springs used to damp the vibrations were placed in steel boxes with 1 to 15 springs in each box. The steel boxes contain a viscous liquid that damps the movements of the spring. The dimensions of the boxes are between 200 to 366 mm wide and 440 to 760 mm long. The size depends on where they are located and what load they support.

When the spring packages are delivered heavy bolts preload them. This means that when the full load from the building rests on the springs they are compressed a few millimetres so that the bolts are unloaded. If there were no preload, the building would settle by up to 20 mm. The steel springs has almost infinite lifetime and are not intended to be replaced. If necessary, it is possible to lift the house a few millimetres and replace the springs.

The depth of the beams in the grid are 5 m, they are 45 m long and has a free span of 21 m. Each beam grid weighs 37 tonnes and consists of four columns and two beams. The beam grid was manufactured by PPTH Norden Oy in Finland and transported to Liljeholmstorget and assembled at site. The column heads are designed as crowns with a bridge bearing consisting of either Teflon or rubber on top.
To avoid vibrations being transferred through the building, for example by pipes for water and sewage it was necessary to use elastic fixings and also to wrap the pipes in elastic blankets.

The finished building consists of six floors where the two lower floors comprise a composite structure of steel and concrete. The façades in the buildings are constructed in typical Swedish manner with rendered external walls and the use of slotted C-section wall studs, as shown in the figure below.

 1 2 3 4 5 6	1 render 2 a stiff board of insulating mineral wool attached to (3) 3 gypsum plaster 4 perforated studs with intermediate thermal insulation 5 moisture barrier 6 internal gypsum plaster
Detail external façade	