Seismic upgrading of Buildings with Sika® Composite Strengthening Systems

Old Cibali Tekel Factory, Istanbul, Turkey

**Project**
The old Cibali Tekel Factory, near the Golden Horn, Istanbul, was taken over and refurbished to become a University’s Main Building. They wanted to keep the historical aspects of the building and to avoid damaging the existing structure but substantial renovation and upgrading was obviously necessary.

**Problem**
This historic masonry building is in a desirable location near the Golden Horn in Istanbul. It was formerly used as a factory building, but for many years it had been empty. There were some wide cracks on the masonry walls which needed to be repaired and strengthened, but without changing the overall appearance of the building. This important structure will now be used as the main building of the University.

**Sika Solution**
Cracks in the masonry were opened to a V shape and with temporary formwork they were filled in with SikaGrout® pourable mortar. Sika® CarboDur® plates were bonded above the windows on the outer walls on two sides. The walls were then refurbished with over 60'000 kg Sika® MonoTop® repair mortar. The four corners of the building were wrapped to an L shape with SikaWrap® fabrics to increase the overall stiffness and stability of the building. One of the inner walls was additionally strengthened by bonding 2'500 m of Sika® CarboDur® CFRP plates as bracings on both sides of the wall.

Retirement Home, Ioannina, Greece

**Project**
During January 2003 a retirement home in Ioannina, North Western Greece, was completely refurbished.

**Problem**
The home was originally built during the 1970’s when the 1954 Greek Seismic Code was in practice. In 2000, a new seismic code (based on the European Union Codes) was implemented. Ground Acceleration data for calculation changed from 0.04 g to 0.16 g. Therefore the entire structure now also needed to be strengthened against these increased potential seismic loads.

**Sika Solution**
The project was completed by repair of the damaged concrete using Sika® MonoTop® repair mortars. Strengthening of the columns and beams was achieved with Sika® CarboDur® plates and SikaWrap® fabrics, using Sikadur® epoxy resin based adhesives.
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Court-House of Naples, Italy

**Project**
The structure of this high rise building has a height of 110 m and it was built in 1980 following old design codes without full seismic considerations. After a terrible earthquake in November 1981 some serious damage had already occurred to part of the structure.

**Problem**
It was necessary to strengthen the building against increased potential shear forces from another earthquake. In the first step, intensive lab tests had to be carried out to establish the suitability of the proposed lightweight composite materials for shear reinforcement of the concrete slabs and walls.

**Sika Solution**
The tests were carried out successfully by the University of Naples, in co-operation with Sika Italy and a specialist contractor. These proved that the seismic reinforcement of the vertical concrete walls could be achieved with the Sika composite system using approx. 20'000 m of Sika® CarboDur® plates and 2'000 m² of SikaWrap® fabrics together with 12 tons of Sikadur® epoxy resins. For the concrete repair works, approximately 30 tons of Sika® MonoTop® repair mortars have been successfully applied.

Gymnasium "Friedberg", Gossau, Switzerland

**Project**
The 7 storey Gymnasium building Friedberg in Gossau, Switzerland, was originally built in 1961.

**Problem**
After a routine structural assessment of the building, it was discovered that it had to be strengthened against seismic action sufficiently to meet modern design standards.

**Sika Solution**
The brickwork staircase walls were strengthened with Sika® CarboDur® plates in vertical and diagonal directions to create a structural framework. All the plate ends had to be anchored to the thin concrete floors. In order to decrease the anchorage length, Sika® CarboShear®L plates were used in a "sandwich" construction together with the straight plates. These short plate legs could then be anchored in predrilled holes in the wall, using Sikadur® epoxy mortar. After finishing the strengthening work the wall has been overcoated as it was before with a mineral based cementitious coating, which also masks the necessary strengthening works.

Lucerne Police Headquarters, Lucerne, Switzerland

**Project**
The 9 storey police headquarters building in Lucerne, Switzerland had to be completely refurbished and upgraded.

**Problem**
As part of the project to improve and generally refurbish it, the building had to be made earthquake resistant in accordance with modern standards. A new concrete wall was installed rising from the ground floor the full height of the building, to strengthen and stiffen it.

**Sika Solution**
The new concrete wall had to be tied in and anchored with the existing basement construction in very confined conditions. The old basement walls were able to be connected to the new wall using Sika® StressHead prestressed CFRP plates that were installed on both sides.

Lucerne Police Headquarters, Lucerne, Switzerland

**Project Participants**
- **Client:** Canton of Lucerne Building Dept.
- **Consultant:** PlüssMeyerPartner AG, StressHead AG, Lucerne
- **Contractor:** Stutz AG, Willisau
- **CFRP prestressing system:** Sika StressHead System
- **Completion:** November 2000

Nuclear power plant, Gösgen-Däniken, Switzerland

**Project**
Gösgen nuclear power plant was commissioned in November 1979. Its annual production is now nearly 8 billion kilowatt hours of electricity, which represents about 15% of the total Swiss electricity consumption.

**Problem**
The emergency feed building at Gösgen nuclear power plant had to be strengthened as part of a general seismic upgrade. The four deionized water tanks, in which the reactor coolant is stored, did not meet the latest design standards. The tank walls had to be strengthened with a secondary strengthening system using prestressing techniques. To avoid restricting the operation of the plant, the strengthening works on each basin had to be completed in only 2 days.

**Sika Solution**
Surface strengthening which could be applied in just a few hours was therefore necessary. The ideal solution was Sika® StressHead prestressed, chemically resistant CFRP plates, which could be applied in a very short time. They were also able to accommodate the transfer of tensioning forces at the ends of the plates, through concentrated end anchorages into the cross walls. Quality control had top priority. Every CFRP pre-stressing component of the Sika® StressHead system was able to be factory tested to tensioning force [+10%] before being actually installed on the site.

**Project Participants**
- **Client:** Kernkraftwerk Gösgen-Däniken AG
- **Consultant:** PlüssMeyerPartner AG, StressHead AG, Lucerne
- **Contractors:** SikaBau AG, Kriens, VSL (Schweiz) AG
- **CFRP prestressing system:** Sika StressHead System
- **Completion:** 2004/2005
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Project Participants
Consultant: Ing. Fürer Bergflödt Köppel AG, St. Gallen
Contractor: SikaBau AG, St. Gallen
Completion: August 2000

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