Upgrading of a 70 year old Grandstand

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Summary

The Kerepesi Ügető (racecourse) in Budapest (Hungary) was closed in year 2000 and most of its buildings were demolished except the Class II. Grandstand which was declared as a national monument. Our task was to perform a complete statical investigation for this Grandstand and to develop the methodology of the strengthening if necessary. Statical investigations included in-situ measurements, material tests in the laboratory and finite element analysis of the structure. Results of statical investigation showed strengthening were necessary. Strengthening methods included injection of cracks, integration of new structural elements, application of concrete jacketing and CFRP sheets. The strengthening extended the life-span of the Grandstand by 50 years.

Keywords: grandstand; reinforced concrete; strengthening; CFRP sheets; concrete jacketing.

1. Introduction

Fig. 1: Grandstand before renovation

The building-complex of Kerepesi Ügető (racecourse) in Budapest included several reinforced concrete grandstands of different classes for use by the audience. The racecourse was closed in year 2000 and the land was sold for investors who utilized the ground for the construction of the second largest shopping centre and amusing complex in Europe. Most of the buildings of the racecourse were demolished except the Class II. Grandstand (Fig. 1) which was declared as a national monument. Our task was on one hand to perform a complete statical investigation for this Grandstand, on the other hand the methodology of the strengthening and renovation had to be developed considering the seamless integration of the old Grandstand and the complex new of shopping centre. Another important aspect of the strengthening was to extend the life-span of this Grandstand by 50 years.

2. Historical and structural overview of the Grandstand

The building was built between 1935 and 1941 according to the plans of Ferenc Paulheim Jr. Structural plans and statical calculations were performed by Vilmos Obrist. The superstructure of the Grandstand is a monolithic reinforced concrete frame with crossway beams supporting the concrete slabs. The roof is a ripped concrete slab structure supported by cantilever beams of the frame. Equilibrium of the cantilever beams are ensured by tensioned columns.

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3. Investigations of the Grandstand

3.1 Investigations on site

The Grandstand was investigated six times in 2002. Investigations on site included visual checking of structural damages, recording of structural geometry, boring of concrete core samples, uncovering the structure at several locations, identification of steel bars, measuring of steel strength and non-destructive concrete quality testing.
During our investigations on the site, no visible sign of major damage or overloading of reinforced concrete structures could be detected. However cracks were spotted at the connections of outside columns and cantilever beams. Some cracks caused by shrinkage of the concrete were also detected in the secondary structures such as concrete barriers and banisters. Higher grade of corrosion of reinforcing steel bars and the lack of concrete cover were observed on the columns of the roof floor.

3.2 Laboratory tests

Uniaxial compression tests were carried out on concrete specimens taken from the Grandstand in the Structural Laboratory of Budapest University of Technology and Economics. Test results were evaluated for different structural groups (beams, columns, slabs, balustrades). Results of the compression tests were used for the calibration of the non-destructive test results.

Strength of the plain reinforcing steel bars was determined by in-situ investigation with Poldihammer. The value of steel strength was around 210 N/mm^2. Tensile test was performed in the laboratory on some steel bars taken from the Grandstand during the investigation on site. Results of the tensile tests were used for the refinement of the in-situ test results.

3.3 Statical analysis of the structure

Design values of internal forces were derived by finite element analysis. Geometrical sizes measured on site and material properties derived from in-situ and laboratory tests were used during the calculations. The actions were calculated according to the European Standard “MSZ ENV 1991 Eurocode 1: Basis of design and Actions on Structures”.

Typical cross sections were controlled by the Standard MSZ ENV 1992-1-1 Eurocode 2: “Design of Concrete Structures. General rules and rules for buildings”. Statical investigations were performed in 26 different cross sections. Deflection of the structure was also evaluated and checked. Most of the controlled cross section fully satisfied the requirements of the Eurocode Standard, however the load carrying capacity was insufficient in some places, and therefore strengthening of the Grandstand had to be performed.

4. Strengthening of the Grandstand

The anchorage for the cantilever structure was ensured by the application of new suspending columns and anchorage beams. Cantilever beams on the roof were strengthened by CFRP sheets. Cracks in the concrete structure were cleaned and injected. Middle columns in the upper section were strengthened by 5 cm concrete jacketing. Chimneys were cleaned with water jet and the holes were filled with concrete. A force distribution layer was applied on the stepped slab to provide the necessary resistance against concentrated loads. Strengthening of the reinforced concrete structural parts was followed by complete restoration of the Grandstand.

5. Conclusions