

# Steel – Concrete Materials Performance in Composite Joints Configuration

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**Abstract.** In many buildings there is a need to combine reinforced concrete, steel or composite members. The paper aims to an experimental program focused on the behaviour of the materials steel and concrete what makes up for a composite joint configuration. Material tests were performed prior each type of testing. The main purpose is to investigate the main parameters that affect the response and the contribution of the two materials. The tests were performed at the TUCN – Laboratory of Civil Engineering Faculty, Romania. The results of the tests on the materials were used for preliminary experimental analysis and presented in the paper.

## 1. Introduction

Multi-storey buildings have been a preferred investor option for centuries and a challenge for engineers involved in materializing these projects. Due to the growth of the service sector, tourism and other age-specific branches on the one hand and due to acute managerial influences, such as the cost-benefit ratio, on the other hand. An optimal structural model for their realization is the steel-concrete composite structure solution. Structures composed of steel and concrete have had a significant development since their conception, both materials having structural potential and good fire resistance and good cooperation between them. Although the two materials are different, they complement each other with comparable thermal expansion. The materials used must have adequate strength and deformability, fundamental performance of the materials to withstand the various actions. Over time, it has resistance to damage or wear. Another important aspect is the minimal influence on the environment both during manufacture and in operation [1-6].

## 2. The design materials

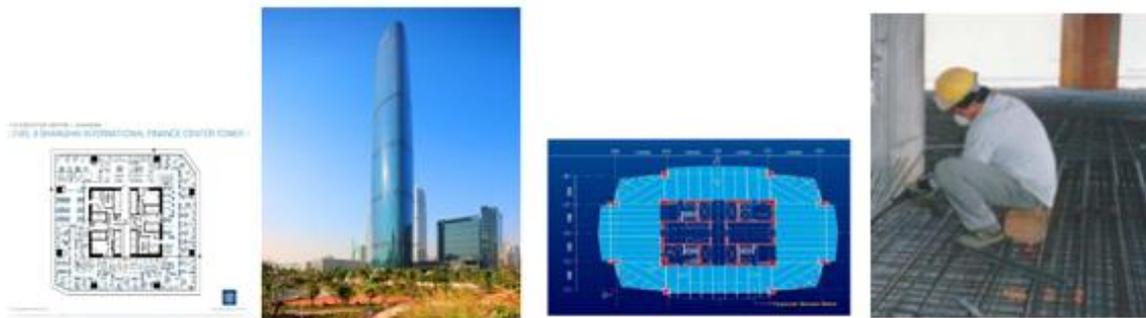
Working in the structure of the two materials can refer to the whole building, resulting in mixed steel - concrete structures or sub - assemblies, resulting in composite steel - concrete elements:

- concrete
- steel

Multi-story structures in composite steel-concrete aim to make the most of the advantages of each of the components in order to obtain preponderant technical and economic performances. In figure 1 are showed a composite structures The International Finance Center.

Steel-concrete composite structures can achieve material savings ranging from 15 to 50%, depending on the type of structure and execution, compared to steel structures and also lower weights compared to reinforced concrete structures.





**Figure 1.** Composite Structures.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete.

Concrete strength was determined on three specimens showed in figure 2: cube 150mm dimensions, samples were taken at the site were the concrete casting was made and tested after 7 days and 28 days.



**Figure 2.** Concrete Strength of the tested specimens.

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Due to the testing of the concrete materials (see table 1), the results showed similar behaviour and the concrete, the proper class was achieved in all specimens.

**Table 1.** Concrete characteristic values.

Testing	$f_{cm,cube}$	Unit
7days	31,31	N/mm <sup>2</sup>
28days	32,25	N/mm <sup>2</sup>

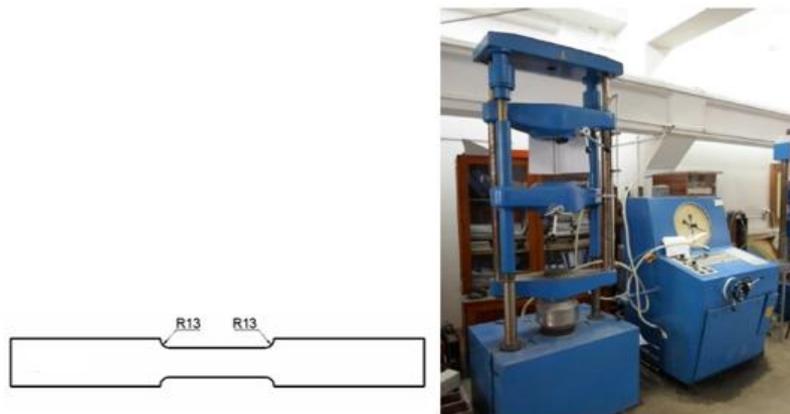
Due to the testing of the concrete materials (see table 2), the results showed similar behaviour and the concrete, the proper class was achieved in all specimens.

Steel resistance is an important feature of structural steel, depending on its chemical composition, such as the percentage of carbon or manganese, the heat treatment used, and all the processes during the profiles. The resistance to steel flow can be determined experimentally by stretching the steel [7-

14]. The steel materials were tested also according to the tensile testing procedure ECCS [11]. The specimens were tested to determine the characteristics physical and mechanical. All the tested specimens had the same material properties.

Ultimate tensile strength is measured by the maximum stress that a material can withstand while being stretched or pulled before breaking. In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analysed independently.

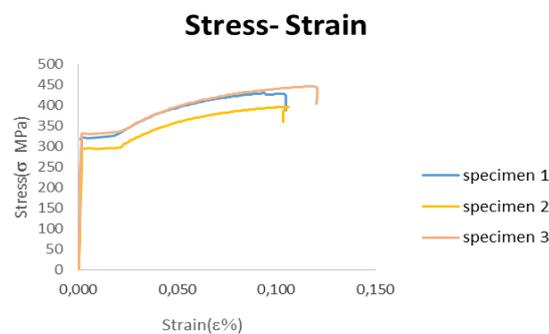
Three coupons were fabricated from each type of steel elements and tested at room temperature with the INSTRON universal testing machine at the UTCN Civil Engineering Laboratory, Romania. universal testing machine and the elongations were measured using a video extensometer module. Coupon specimen dimensions are shown in figure 3.



**Figure 3.** Steel coupons and traction test press.

In order to determine the physical-mechanical characteristics of the structural steel, the tensile test was performed for the metal profiles. The tensile strength was determined by the tensile testing of the metal profiles: IPE 270 Europrofiles, with samples taken from the web and the flanges of the steel profiles.

The results of the tensile test on the tree coupons tested are given in figure 4. The ultimate elongation shows the steel elements have a good ductility.



**Figure 4.** Stress–Strain curve.

In figure 4 the stress-strain curve ( $\sigma$ - $\epsilon$ ) of the steel is illustrated. It can be noticed that the initial steel has a stress-strain, defined by the  $f_y$  flow velocity and the deformation  $\epsilon_y$ .

The aim of the test of the steel traction test is to determine the ultimate strength and elastic limits by determining the tensile and compressive strengths.

### 3. Conclusions

The tested materials in the experimental program have adequate strength and deformability, fundamental performance of the materials to withstand the various actions. Another important aspect is the minimal influence on the environment both during manufacture and in operation.

The research recommended for composite steel-concrete elements that it is necessary to use a minimum concrete class C20/25.

The adhesion in the structure of the two materials can refer to the whole building, resulting in mixed steel - concrete structures or sub - assemblies, resulting in composite steel - concrete elements.

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