Unbonded steel tube concrete

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Unbonded Steel Tube Concrete

Tubes en acier remplis de béton

Stahlrohre mit Betonfüllung ohne Verbund

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1. INTRODUCTION

The structure has been developed to apply to structural members subjected to large axial force such as the columns of highrise buildings, the columns of multistoried large span structures, the main poles of suspension bridges or the supports of underground structures. This is a new structural form, which is different in axial force supporting mechanism from conventional reinforced concrete (RC) or from steel reinforced concrête (SRC). The structure is constructed in such a way that a thin frictionless material (asphalt layer of 0.2mm thick) is applied to the inner surface of the cylindrical steel tube in which concrete is filled. The structure is named as "Unbonded Steel Tube Concrete" (UTC). This paper describes the principle and composition of the UTC and the outline of results of various tests.

2. PRINCIPLE OF UTC

In the UTC, axial force (N) is supported only by the filled concrete sections, and at the time axial stress ${}_s\sigma_z$ is generated in the steel tube as less as possible thanks to the frictionless material and only the restraining effect by circumferential stress ${}_s\sigma_\theta$ is expected. Bending moment (M) and shearing force (Q) are supported by both sections of the steel tube and filled concrete, similar to other structural forms. The comparison on the supporting mechanism of axial force (N) is shown in Figure-1. The stress conditions under combined force, when compared with that of bonded steel tube concrete (BTC) as a representative of other structural forms, are shown in Figure-2. On the assupmtion that the filled concrete is not failed as far as the steel tube is not failed, the design strength depends on the local yield or buckling of the steel tube. It is apparent from Figure-2 that the UTC has larger strength in bending moment (M) than the BTC, as axial force N becomes larger.

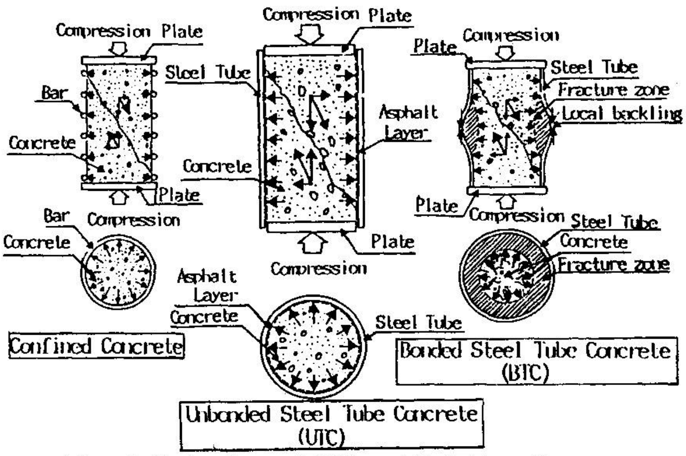


Fig.-1 Mechanism of UTC and Relative Forms

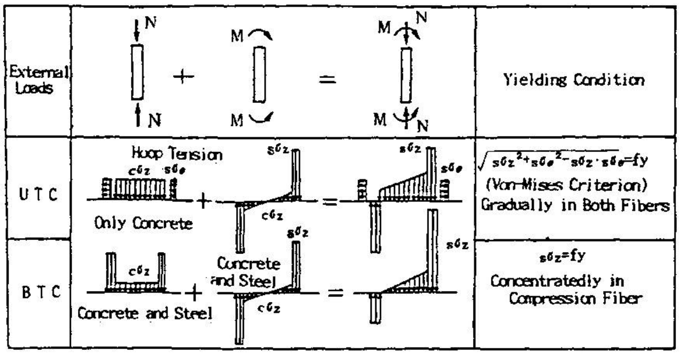
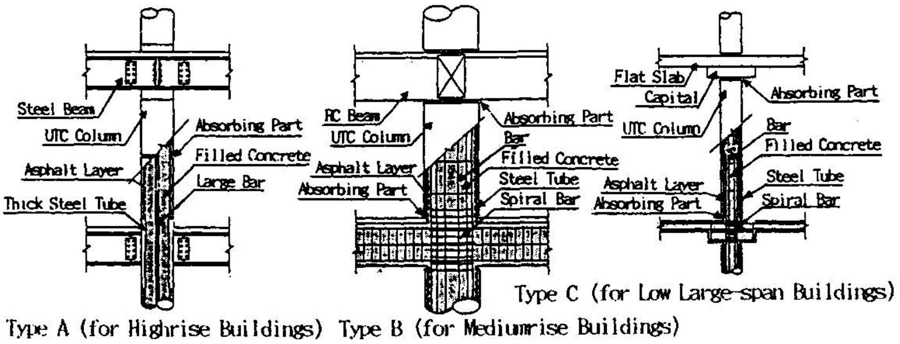


Fig.-2 Stress Condition under Combined Force

3. BEAM-COLUMN JOINT

The 3 types shown in Figure-3 are considered as a joint of the UTC column with beam in building structures. Type A is expected to improve the strength of N, M, Q, type B and C improve only N.



Type A (for Highrise Buildings) Type B (for Mediumrise Buildings) Type C (for Low Large-span Buildings)

Fig.-3 Detail of Beam-Column Joint

4. OUTLINE OF RESULTS OF VARIOUS TESTS

4.1 Concentric compression test

A concentric compression test is carried out for 3 kinds of specimens U, B and R of which the UTC, the BTC and the positioning between the 2 are simulated respectively (ϕ114x600mm). In specimen R a frictionless material is not applied but force is loaded only to filled concrete section. As shown in Figure-4, specimen U has yielding strength Ny approximately 30% higher than specimen B, and having sufficient toughness. Specimen R is between them. The frictionless material effect is cofirmed.

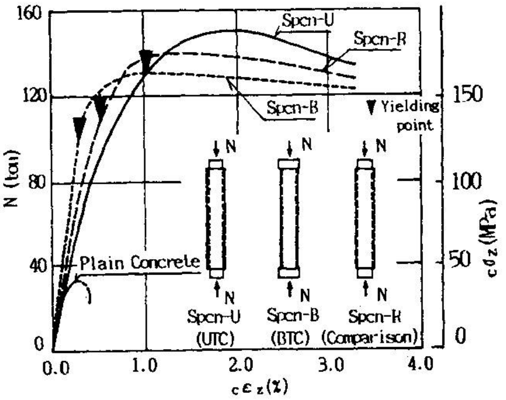


Fig.-4 Concentric Compression Test

4.2 Bending test

To compare the UTC and the BTC (ϕ216x1500mm), load is added to bend at constant axial force N. As shown in Figure-5, yielding bending strength Py of the UTC is approximately twice that of the BTC. The difference depends on the intensity of constant axial force N. This is also understood from Figure-2. However, maximum bending strength Pu is almost equal, and has suffiecient toughness.

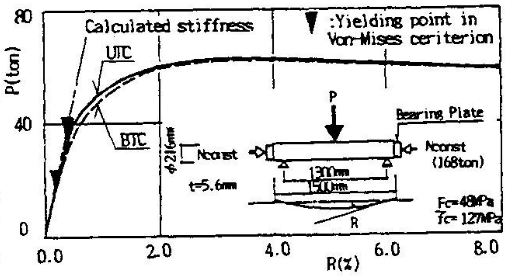


Fig.-5 Bending Test

4.3 Shear test

Even if the steel pipe and filled concrete are not bonded as in UTC, it is made clear experimentally (ϕ216x2800mm) and analytically that shear transfer occurs between them by side pressure distribution, as shown in Figure-6.

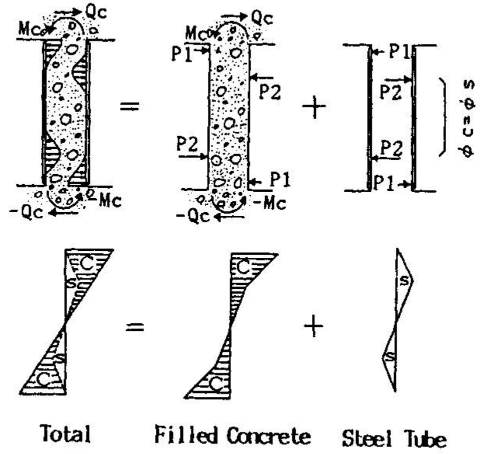


Fig.-6 Shear Transfer Mechanism

5. SUMMARY

"Unbonded Steel Tube Concrete" (UTC) which is different from other structural forms (RC and SRC) is proposed and in order to apply it to actual structures, various tests are carried out and described the outline of them.

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