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Consolidation of the Church of St. Mihajlo near Ston

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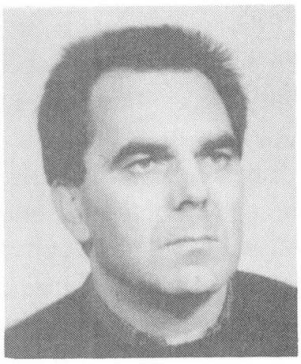

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Summary

Since the structural system is a constitutive part of a piece of architecture because it materializes the architectural idea, the significance of its form for the transmission of all foreseeable loads makes the bearing system a factor in the design of architecture, which requires multiple criteria for the consolidation and the solution requires both rational and emotional factors. The consolidation of the pre-Romanesque church of St. Mihajlo near Ston is an example of a "soft" strengthening of a small, but culturally important building. The church is one of the finest buildings of the specific "Southern Dalmatian type" of the Croatian pre-Romanesque churches: small-scale, aisleless longitudinal building, barrel-vaulted, originally with a miniature dome above the central of its three bays. Therefore, we decided to strengthen it with a minimal possible intervention, in order to prevent further deterioration caused by the seismic and atmospheric action.

Keywords: architectural heritage, structural system, "soft" strengthening, tension ring, minimal possible intervention, St. Mihajlo, Ston, Croatian pre-Romanesque

1. Basic Principles of Consolidation

The basic principle of consolidation can be defined as the need to re-establish the consolidated bearing system, making it resistant to all foreseeable events. By materializing the architectural idea, the bearing system enables its existence in the space and time. The meeting point of the two aspects of architecture, emotional and rational, is the form, because this is how the architecture is realized, both conceptually and really. Due to the spatial compatibility of the form as a determinant of architectural specificities, and of the form as a decisive principle of the structural system's behaviour in the rational domain of architecture, its consolidation becomes respectable not only as a technical problem.

Therefore, consolidation must in no way disrupt the specificities of the structural system as a whole, i.e. in order to preserve it in its fundamental principles, possible interventions must have both material and formative features of the existing bearing system. The consolidation solution should therefore give the structural system the possibility of utilizing the bearing potentials from its spatial configuration, and thus provide sufficient resistance to all relevant influences.

2. Consolidation of the Church of St. Mihajlo

The church of St. Mihajlo near Ston, very modest in dimensions (vault span about 1.7 m), is one of the finest churches of the specific "Southern Dalmatian type" of the Croatian pre-Romanesque architecture: small-scale, aisleless longitudinal building, barrel-vaulted, originally with a miniature dome encased within a rectangular turret above the central of its three bays. [1]

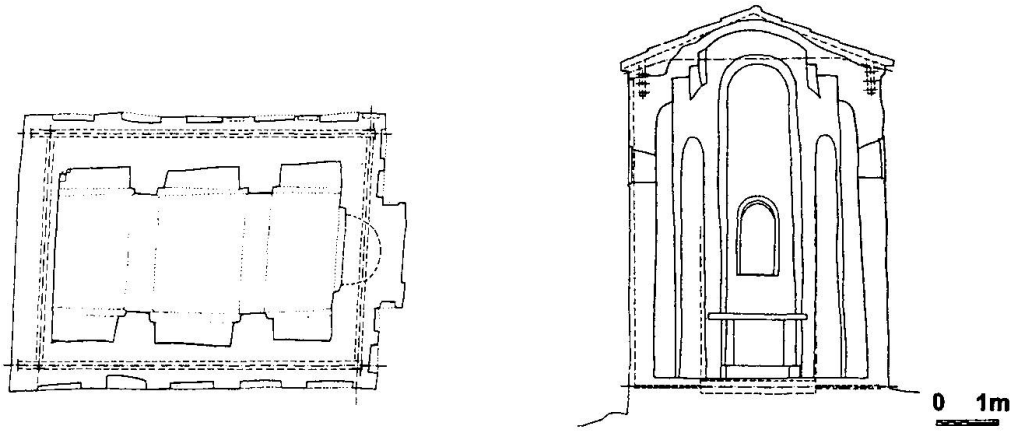

Fig. 1 Strengthening of the church of St. Mihajlo: plan (left) and section (right)

The small church, built of rough stone in lime mortar, using primitive building methods in the 10th century, proved its structural strength by resisting weathering, remodelling and strong earthquakes in the region for a millennium. Even a series of earthquakes in 1996, which caused serious damage to the ancient town of Ston (a small town north to Dubrovnik), provoked but a scant damage to the church of St. Mihajlo, situated on the top of a nearby hill - in spite of its poor condition even before the earthquakes. Therefore, we decided to strengthen it with a minimal possible intervention, in order to prevent further deterioration.

Due to their shape, the vault and the dome create important horizontal thrust on the top of the walls, unusually tall in relation to the church width. The bearing potential of the walls is used by the church builder to the full, nearly to the endurance limit. Since the horizontal thrust of the vault and the dome on a deteriorated wall seem to make a jeopardy to its stability, a horizontal tension ring consisting of iron bars placed in lime mortar, is inserted at appropriate height, as a possible and suitable strengthening of the existing system. The same approach is applied in strengthening the church foundations by adding two transversal connections consisting of iron ties, protected by concrete coating, between the north and the south walls, enhancing their mutual action, the more so since the stone base on which the church lies is gently inclined to the south. Because of very valuable wall paintings the wall consolidation will be done by careful grouting of lime mix under low pressure as the basic ingredient in order to comply with the original binder.

The purpose of all the interventions is to provide an integral bearing system for the church, because this is a crucial factor in transferring all relevant loads.

3. References

[1] Goss, V. P., *Pre-Romanesque Architecture in Croatia*, A. Mutnjaković, Zagreb, 1996