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In Situ Stress Evaluation of Reinforced Concrete Elements

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Summary

In the structural assessment of concrete structures, the evaluation of the existent stresses is essential for the quantification of the structure's residual strength and for the optimisation of a future repair operation. This paper presents the "Reinforcement Release Method", a method developed at IST for the assessment of in situ stresses in reinforced concrete elements, based on the stress release of reinforcement bars.

Keywords: In situ assessment; reinforced concrete; columns; stress release.

1. Introduction

Structural assessment is performed in concrete structures if anomalies occur (cracks, excessive strains, deterioration) or if the strengthening of the structure must be performed due to changes in the design conditions. In these cases the evaluation of the existent stresses is particularly important for the design and construction engineers since the actual level of the total stresses is one of the major parameters in the assessment of the structural residual capacity.

The existing methods for experimental assessment of in situ stresses in concrete structures are essentially based in two techniques [1]: local and partial release of the stresses followed by a controlled pressure compensation (direct method); relief of stresses around either cylindrical inclusions or cores extracted from the structure (indirect method).

The "Reinforcement Release Method", presented in this paper, was developed to quickly perform the assessment of in situ stresses in reinforced concrete elements. The use of the technique is mainly restricted, in this initial phase, to columns where compression stresses due to the axial loads are paramount.

2. The Method

The proposed technique is based essentially on the determination of the axial force in columns through the local and total stress release in one of the reinforcement bars of the column. This release begins with the opening of a groove in the concrete, around the bar. This operation must expose completely some centimetres of bar. Afterwards, the exposed reinforcement bar is cut with an appropriate disk *(Fig.1)*. The strain released in the bar during the cut is recorded through electrical strain gauges, previously glued, in a position close to the cut section. The existing total stress in the bar is evaluated from the change of strain. The technique is completed by welding the bar and the groove is closed

with mortar to guarantee the ultimate strength of the analysed column.

To obtain, more accurately, the stress in the bar due to the existing applied loads (external component) it is necessary to perform a complementary analysis. This includes an evaluation of the self-balanced stress components due to the thermal-hygrometric behaviour of the concrete, and of the components associated with disturbance due to the concrete opening.

The technique was calibrated in reinforced concrete specimens that were subjected to compression under a known axial force, that was later compared with the axial force evaluated through the method [1].

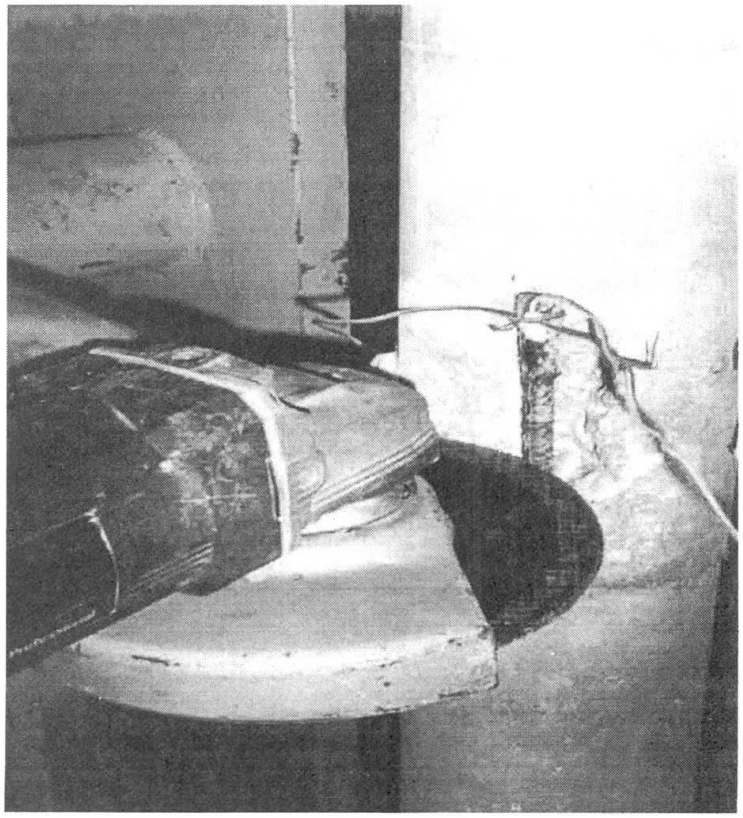

Fig.1 Electrical saw cutting the bar [1]

3. Concluding Remarks

The major conclusions of the "Reinforcement Release Method" are:

1) The stresses obtained with the direct measurement of the strain variation while the cutting a reinforcement bar are a maximum of the existing stresses;
2) More accurate results can be obtained if the E_c value is measured in situ;
3) More accurate results can be obtained if creep and shrinkage effects are considered. The opening area effect can also be considered;
4) The great advantage of this technique is the technology simplicity.

4. References

[1] Santos, J. R. "In Situ Stress Evaluation of Reinforced Concrete Columns", *MSc. Thesis in Structural Engineering*, 1997, Technical University of Lisbon, Lisbon.