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Evaluation of the Behaviour of Corroded Beams

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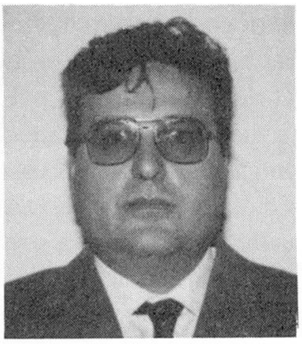

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Summary

To analyse the behaviour of corroded beams, in the paper a model based on damage function D.F. is shown linked to a global damage coefficient D.C. of the beam that may be obtained by means of dynamic tests.

1. Analysis of damaged beam

In the r. c. beams, the damage due to reinforcement corrosion may cause cracking of concrete around the bars both at the compressive and tensile zone of section [1]. Cracks due to rust create a *compressive softening* effect [2] in the concrete with an influence on the strength and ductility and load-deflection response of the concrete beam. The damage of concrete subjected to tension by rust causes a reduction of stiffness that has consequence on the dynamic behaviour of the beam [3]. The comparison between natural frequency of an undamaged beam, $\omega_{0,r}$, and a damaged beam due to corrosion, $\omega_{1,r}$, can define the state of damage if there are significant changes in the dynamic characteristics.

In the paper, we consider that the beam has a stiffness uniformly reduced on the length by diffused cracks due to corrosion. This situation is, for example, characteristic of cantilever beams. In this case, it is sufficient to use only one value of frequency to evaluate the undamaged and damaged state of the beam by means of global value damaged coefficient D.C. :

$$\text{D.C.} = 1 - (\omega_{1,r}/\omega_{0,r})^2, \quad r=1 \tag{1}$$

In the Fig.1, undamaged and damaged r.c. sections are shown with own strain - stress diagrams. The global coefficient of damage D.C. expressed in (1), considering the bending stiffness in undamaged $(EI)_0$ and damaged state $(EI)_1$, is defined in this way:

$$\text{D.C.} = \frac{(EI)_0 - (EI)_1}{(EI)_0} \tag{2}$$

$$M = \chi_1 \, (1 - \text{D.C.}) \, (EI)_0 \tag{3}$$

respectively for the curvature χ_1 and bending moment M in a damaged section (Fig.1).

To define the modified strain - stress state in the section, we assume a linear function D.F. which reaches the value D for $\eta = -k_1$:

$$D.F. = D \cdot (1 - \frac{k_1}{2 \cdot \alpha}) - (\frac{D}{2 \cdot \alpha}) \cdot \eta \quad (4)$$

where $\eta = \frac{y}{d}$.

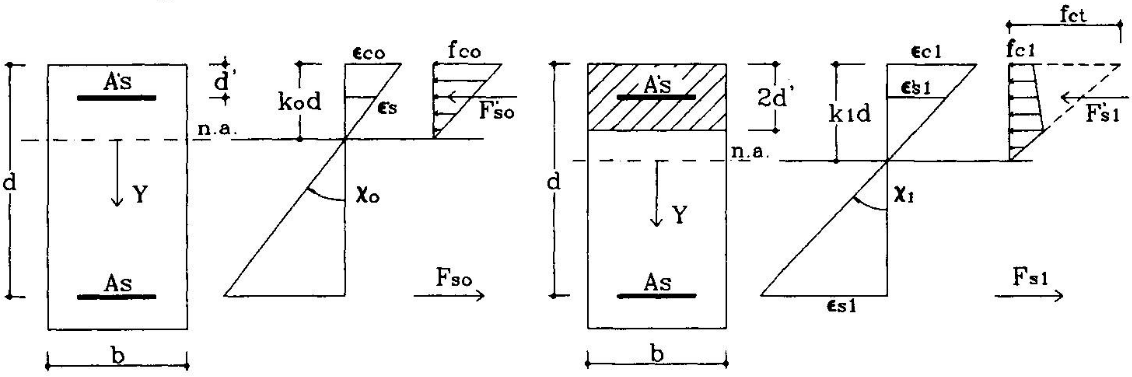

Fig. 1 - (a) Undamaged section ; (b) Damaged section

The value of D may be related to the strain ε_{c1} of the extreme fiber of compressive concrete of damaged section :

$$D = \gamma \cdot \varepsilon_{c1} \cdot E_c \quad (10)$$

using a coefficient γ enclosed between 0 and 1.

In the damaged section of Fig. 1b, considering the compatibility and equilibrium relations, we obtain two relations in the unknown parameters γ, k_1 and D.C.. These relations together to the (1) permit to evaluate the stress-strain state in a r.c. damaged section.

2. Conclusions

The deterioration of r.c. beams due to corrosion reduces the bending capacity of the section with increase of curvature and deflection. The corrosion especially influences the strength of compressive concrete by means of the biaxial stress state due to the rust on the bars. Using dynamic tests it is possible to estimate the state of damage expressed by a global coefficient D.C.. Above we have defined also a linear damage function D.F. to analyse the stress distribution in the damaged compressive concrete.

3. References

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