V-185 A STUDY ON STRUCTURAL IMPLICATIONS OF REINFORCEMENT CORROSION

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1. INTRODUCTION

This study was carried out to clarify the implications of the corrosion of the reinforcement in terms of the loss in load carrying capacity in static tests, fatigue life of RC beams and the changes, if any, in the load carrying mechanism of RC beams. Since corrosion takes several years to occur in natural environments like off-shore structures, etc., the galvanostatic method(1) was adopted to accelerate the process in this study.

2. OUTLINE OF EXPERIMENTS

The specimens used were RC beams of size 10x20x210 cm, cast using ready-mix concrete having a compressive strength of 300 kg/cm^2 at 28 days. All reinforcing steel bars used conformed to SD35. Table 1 summarises the details of the tests and the specimens used. A constant current of 1 ampere was impressed for 7 days in all the beams that were subjected to corrosion.

3. RESULTS AND DISCUSSION

Table 1 Summary of the Test Programme

Series	Stirrups	a/d	Test
A	10mm @ 140mm	varied	Static
B	6mm @ 170mm	3.55	Fatigue

As a result of the corrosion, cracks were formed along the top and bottom reinforcing bars and along the stirrups, in all the beams.

Experiments in series A were conducted to clarify the effect of reinforcement corrosion on the load carrying capacity and mechanism, if the shear span to depth ratio of the specimen was changed. The results are given in table 2. We see that there is practically no effect on the load carrying capacity of the beams. However, the concrete strains measured at a location 5 cm below the top (at the middle of the beam), as shown in fig 1, show that the strains for the corroded beams are consistently higher than the corresponding strains for the non-corroded beams. Also the strains measured at the top were lower in the case of the corroded beams. This can be taken to mean that there is a significant stress redistribution above the neutral axis because of the cracks formed along the top reinforcement.

Table 2 Results of Series A

a/d	Pmax(ton)*
2.65	11.8(11.9)
3.55	8.4(8.4)
5.0	6.2(6.2)

*: Values for corroded beams in brackets

It has been reported that the reinforcement corrosion could lead to a reduction of upto 33% in beams(2), if no shear reinforcement is present. However the findings of series A show that if sufficient shear reinforcement in the form of stirrups is present, the load carrying capacity is not significantly affected.

The results obtained from the fatigue tests of the beams are summarised in table 3. We see that when the applied load is high (B3/B4), there is a drastic change in the fatigue life of the beam, because of the progressive rapid debonding and spalling of the bottom concrete. For beams B6/B7, it was found that even though the fatigue life of the beams is not effected, the load carrying mechanism underwent changes over

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time presumably because of the gradual separation of the top cover concrete. The strains measured at the top and 5 cm below, at the initial loading and after 250,000 cycles are plotted in fig. 2. A similar redistribution of stresses was observed in B5/B8 also. In the case of B8, the failure in the beam was caused by the failure in fatigue of the main reinforcing bars after 830,000 cycles. (Such failure was not observed in a separate series of tests with non-corroded beams).

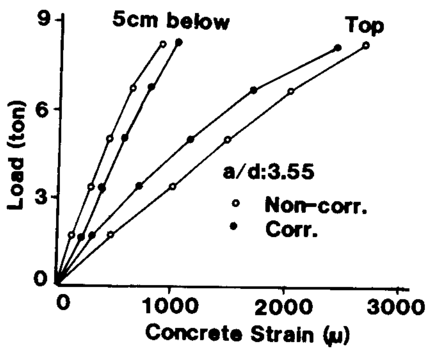

Fig.1 Concrete strains at top and 5cm below for a/d=3.55

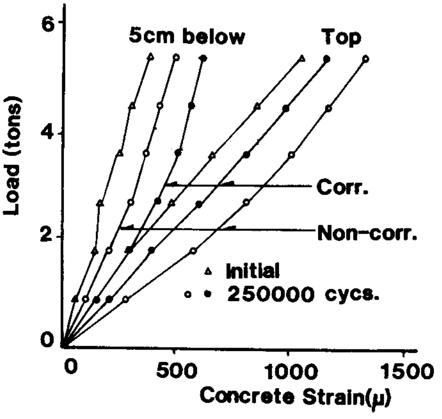

Fig.2 Changes in concrete strain under fatigue loading

Based on the results obtained a model, as shown in fig. 3, is suggested to understand the behaviour of beams subject to reinforcement corrosion. It was further established that the tensile strength of the bars was not appreciably affected by the corrosion, within the scope of this study.

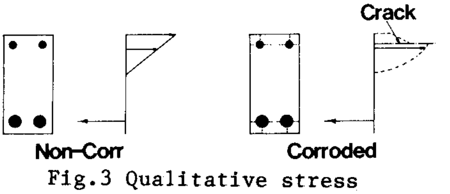

Fig.3 Qualitative stress distribution

4. CONCLUSIONS

1. The structural implications of rebar corrosion arise basically from the accompanying crack formation and loss of cover concrete, and thus could cause significant redistribution of stresses.

2. The fatigue life and the load carrying mechanism of corroded RC beams could be affected by various factors as the load applied, loss of cover concrete, etc.. The fatigue life of corroded reinforcing bars may become suspect, even though the tensile strength may not change appreciably.

Table 3 Results of Series B

No	Max Load (t)	Life (1000 cycles)	Failure mode
B1	9.6	-	Flex. Comp.
B2*	9.2	-	Compression
B3	6.8	48	Shear
B4*	6.8	5	Bond
B5*	6.3	220	Shear Comp.
B6	5.8	306	Shear
B7*	5.8	288	Shear Comp.
B8*	4.8	833	Flexure

*:corroded beams

REFERENCES

1) TAKEWAKA T., and MATSUMOTO S., Annual Meeting of the JSCE, NO. 38, V-131, 1983.
2) UOMOTO T., et al, "Deterioration of Concrete Beams and Columns Caused By the Corrosion of the Reinforcing Steel", 4th Asian Pacific Corrosion Control Conference, Tokyo, May, 1985.