Influence of the Crack Width on the Corrosion of Steel in Lightweight Concrete

Part V

results after 18 years storage of the test specimen in the open air

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Brief report by

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Within the scope of a long–term research programme investigations have been carried out on cracked reinforced beams made of three different types of lightweight concrete (three different aggregates) and normal weight concrete after a period of 3, 6, 11 and 18 years storage in the open air.

The beams were loaded to achieve cracks with widths up to 0.4 mm.

The following influences were studied:

- **type of concrete**:
  - L1: expanded clay and lightweight sand, LB 25
  - L2: expanded slate and lightweight sand, LB 25
  - L3: expanded clay and natural sand, LB 25
  - N: normal weight concrete, B25

- **cracks**:
  - non cracked areas and cracks up to 0.4 mm

- **place of storage**:
  - Rheinhausen (polluted air in an industrial area)
  - Munich

- **concrete cover**:
  - 15 to 36 mm

- **position of the transverse reinforcement**:
  - inside and outside the longitudinal bars

- **period of storage**:
  - longest: 18 years

The following results were found:

The **different types of concrete** showed different permeabilities of gas and therefore different depths of carbonation. Due to the accumulation of cement in the form at the bottom of the beams the average depths of carbonation were about the same (3 – 4 mm) by the concrete types L2, L3 and N. The concrete type L1 showed carbonation depths double the size as the other concrete types. At the lateral surfaces the average depth of carbonation of the L1 beams was with 20 – 30 mm about four times the value of normal weight concrete. The carbonation of the other lightweight concretes was between these positions.

In accordance with the deeper carbonation, the corrosion on the reinforcement of the lightweight concrete beams was more **frequent** and more **intensive** than in the normal weight beams.
By comparing the frequency of corrosion in non-cracked concrete covering, the lightweight concrete L1 showed the most unfavourable results. The normal weight concrete had only one spot of corrosion and the lightweight concretes L2 and L3 showed no corrosion in non-cracked concrete.

In the case of narrow crack widths and small concrete cover (15 mm) corrosion occurred on all the cracks of the L1 and N beams. It was, however, more intensive in the lightweight concrete than in the normal weight concrete as the peaks of the carbonation had reached the reinforcement earlier. The damage of the reinforcement was significant (up to 9% loss of cross section).

An increase of the concrete cover to 25 mm reduced the frequency and especially the intensity of corrosion. An influence of the crack width can be recognized. The influence of the concrete cover was greater in the case of lightweight concrete than in the case of normal weight concrete. The extent of corrosion of the reinforcement was much less with normal weight concrete than with all the other types of lightweight concrete which did not differ much.

An improvement was achieved by a further increase of the concrete cover of the lightweight concrete L1 beams to 36 mm. Not only the frequency also the intensity of corrosion was significantly reduced.

Since the last investigations after 11 years storage, the corrosion has become more intensive.

The corrosion had only a slight effect on the tensile strength of the reinforcing bars. The elongation at fracture of the corroded samples was in some cases 50% less in comparison to that of the non-corroded samples.