EXAMINING FATIGUE PROBLEMS OF WELDED FLOOR STRUCTURES

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SYNOPSIS

Fatigue cracks were observed in the floor structures of many road bridges over the past decades. Since critical stress relations are difficult to establish in that environment to a high degree of accuracy by theoretical means, the Authors strive after obtaining a more profound and accurate knowledge of the environment sensitive to fatigue cracking by several methods of measurement (strain gauges, magnetic noise measurement).

For the past ten years, fatigue cracks have been observed mainly on the floor structures of steel bridges of welded sructure. The cracks appeared after 10 to 20 years of service, fairly early as against the normal endurance of such bridges. The signs of fatigue were anticipated by a high frequency of loading which, as a consequence of a quick increasing in traffic, was as high as $12 - 20.10^6$ by the time of the appearance of cracks. At the points illustrated in Figure 1, most cracks were observed at the joints of longitudinal trusses supporting the floor slabs and the cross beams. The stresses arising in that environment are not easy to establish to a high degree of accuracy, but it is beyond doubt that the longitudinal truss does apply a certain vertical bending moment on the cross beam while a load is passing along in longitudinal direction /Figure 2/.

This had been the reason why we focussed our attention at that structural section sensitive to fatigue. Our aim was to acquire a more profound knowledge of the effective stresses arising in that type of structure, and preferably to gather data for improving the design.

As the first step, optical analysis of stresses was made on a plastic model scaled down to a ratio of 1-to-3 at Budapest Polytechnical Institute. That test only allows loads applied parallel to the plane of the model. According to the test results obtained, local stress maxima appeared in the bottom junction point for flat steel truss, and in the top junction point for trapezoidal box truss.

The following experiment was carried out on a 3x6 m floor piece of bridge of absolutey realistic finish. The element is shown in Figure 3.

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Under the loads applied at different points, local stress maxima could be obtained at the bottom junction point the trapezoidal truss, on the cut-away section of cross beam. Under the direct bending moment of load, about the same stresses /approx. 150 MPa/ arise inthe floor piece of bridge, but apperently without any risk of fatigue.

At last, the element was subjected to fatigue testing by a single force, altered after repetitions of 0,25 . 10^6. The test element was also provided with a welded joint for modelling a mounting connection. The stresses arising in the element were measured by strain gages.

Magnitude and effect of remanent welding stresses were examined in the vicinity of welded joint by the magnetostriction method /by measuring Barkhausen's noise/. It has been found that under fatigue, the stresses /and Barkhausen's noise proportional to them, respectively/ gradually abated and got rearranged by being shifted away from the immediate vicinity of load along the weld seam /Fig. 4/. In a subsequent stage of the test, stresses could be detected in environments which had previously been free of stress.

Throughout the experiment, a single fatigue crack appeared in the welded joint established for modeling purposes, and even that occurred only after 1,46.10^6 repetitions of load. At the starting point of crack, lack of fusion could be detected over a length of 5 mm.

No crack appeared at the junction of longitudinal truss and cross beam until 6 . 10^6 repetitions of load.

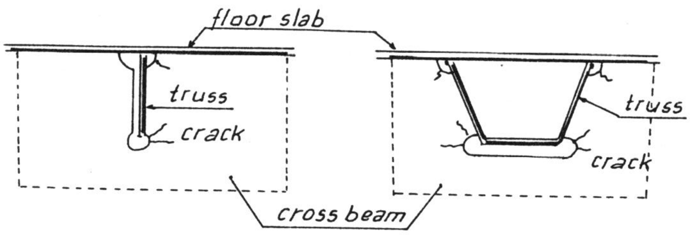

Figure 1 Cracks on the floor structures

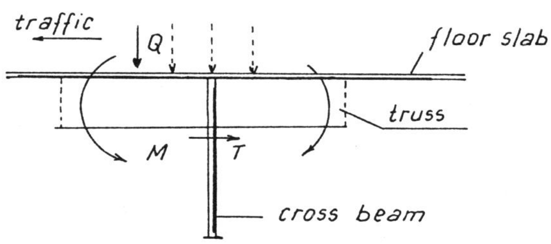

Figure 2 Stresses arising in the junctions tested

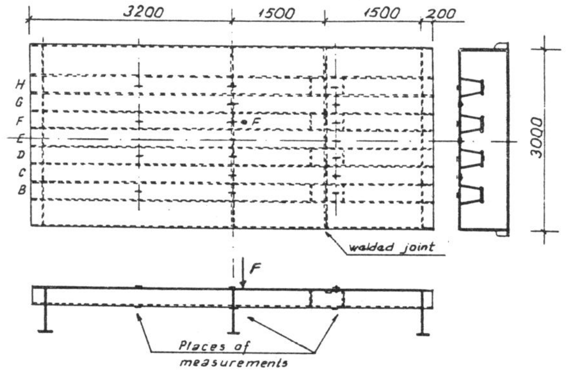

Figure 3 The floor structures tested

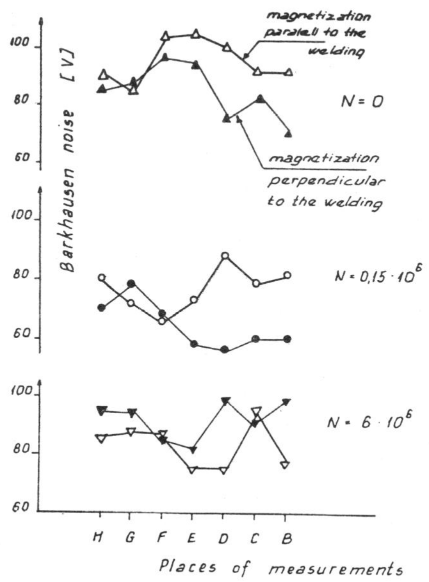

Figure 4 Change of Barkhausen noise distribution in the floor after N loading cycles