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Experimental Assessment of the Safety of Bridges

Détermination expérimentale de la sécurité de ponts

Experimentelle Ueberprüfung der Sicherheit von Brücken

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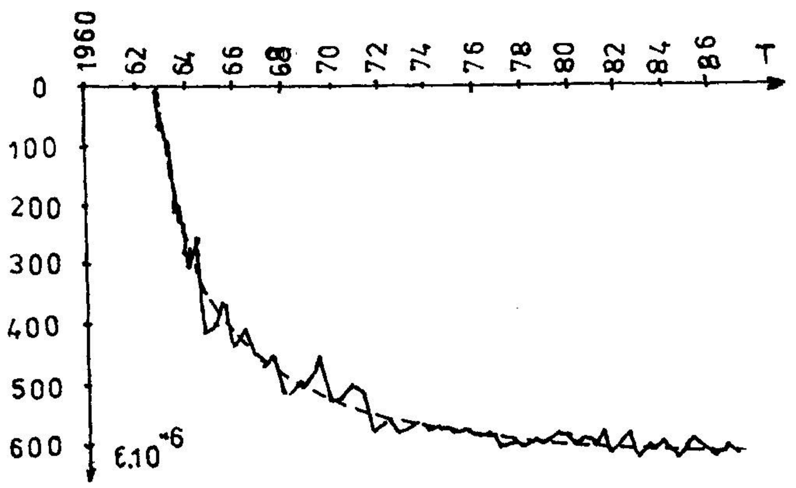
1. INTRODUCTION

The assessment of the behaviour of concrete bridges is possible by various short quality checks and tests in situ or by long-term observations and analysis of the durability of the materials of structural elements.Service life,i.e.durability of concrete bridge structures has always been and increasingly becomes a problem not only in the domain of maintenance of bridges but in the public and economic life of a society as well.

2. LONG-TERM OBSERVATION OF PRESTRESSED CONCRETE BRIDGES

On 12 prestressed concrete bridges of larger spans /over 60 m /, continuous precast concrete structures,rigid framework bridges, casted in place or precasted box-girder bridges erected by the cantilever method,have been made observations for 10 to 27 years. During the construction of the bridges mentioned above in each of these examined structures vibro-wire gauges in number of 50 to over 300 were embedded.At the same time geodetical marks for measuring vertical displacements of structures were set.

The received results showing the course of deflections and strains of various bridges.The creep of better bridges is stabilized after 7 years and the deformations in the following period oscillates owing the temperature and humidity changes.The mathematical correlation of the received courses show,that the very simple functions allowed us to predict the course of deformations for the next period.The results of observations with the course of strains versus time of one cantilever erected,casted in place, prestressed concrete double box-girder bridge /span 80m/ during 24 years show us in Fig.1 compared with various creep curves that the best result for the prediction of the strains for the next period we received using the Ross-function of creep in generally form $Y = A + B \cdot \frac{T}{T+Q}$, where A is the deformation for the time T=0, B is the increased deformation, Q is the time to receiving the 50% of the full long-term deformation /strain or deflection/.The observations were executed every year after winter and summer season, but mostly 4 times during the year.On several of these bridges load tests following lo or 25 years were repeated and hereby fatigue characteristics after long-term traffic were ascertained.



By the correlation function for Q = 615 was ascertained,that A = 22,25 and B =-679. The standard deviation s = 26,95; the theoretical deformation after 20 years $Y_{20} = -604.10^{-6}$ and after 100 years $Y_{100} = -646.10^{-6}$.Very similar result we received also using the function

$$Y = A.\sqrt{T} + B.T.$$

Fig.1 Strain history of a cast-in place cantilever bridge with the correlation function $Y = A+B.\frac{T}{T+Q}$ bottom in the first segment.

3.ASSESSMENT OF THE SAFETY BY HELP OF REPEATED LOAD TESTS

The long-term observation of this mentioned cantilever bridge constructed in the years 1961-1962 were carried out owing to relatively large deflections.The deflection at centre of the span after 25 years is about 150 mm.At the loading test carried out in 1962 was measured the maximum deflection 65,7 mm,in 1976 it amounted to 84,45 mm and in 1986 it was for the same load efficiency 100 mm though from the influence lineas of deflections 83,95 mm was expected.In the hinge zone the first and second joints opened by 1,5 mm and after the loading were closed.In 1963 following the completion of construction the measured prestress with embedded vibro-wire gauges in the upper fibre over the pier was -7MPa.At the loadtest in 1976 was measured there the maximum stress +2,8 MPa,in 1986 at the repeated load test with the same load efficiency we measured +3,35 MPa,which means that in the structure in the tensile zone remained a sufficiently large prestress -3,65 MPa.The bridge complied from the point of view of bearing capacity,but in spite of cracks was proposed the reconstruction using free prestressed cables after injection of cracks.

The second bridge was one framework prestressed concrete structure with bad concrete quality /span 63,40m/ with deflection after 25 years traffic 182,8 mm.This structure was controlled by 4 repeated load test/after erection and after 2,10 and 25 years traffic/. The maximum deflection during the first load test in 1961 was 34,17mm, in 1964 39,8 mm,in 1972 it was 33,95 mm and after reconstruction by help of free prestressed cables the deflection for the same load efficiency was only 24,2mm..

4. CONCLUSIONS

The long-term observation of deformations using mathematical correlationgive the possibility to predict the behaviour of bridges for the next period.The results of the repeated load tests after lo and 25 years has given good datas for the assessment of the safety and serviceability of prestressed concrete bridges.