

## **EXPERIMENTAL REALISATION OF A PRETENTIOUS TESTING TASK ON THE FIELD OF PIONEER BRIDGE STRUCTURES**

## **VERSUCHSTECHNISCHE REALISIERUNG EINER NICHT ALLTÄGLICHEN PRÜFAUFGABE AUS DEM BEREICH DER PIONIERBRÜCKENKONSTRUKTIONEN**

## **REALISATION D'UN ESSAI DE CHARGEMENT COMPLEXE D'UN PONTON DU GENIE MILITAIRE**

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### **SUMMARY**

An extraordinary test-setup and a pretentious test procedure is described for investigation of a ponton, submitted to the very manifold and complex loading conditions of pioneer bridge structures.

### **ZUSAMMENFASSUNG**

Es wird der aufwendige Versuchsaufbau und die anspruchsvolle Versuchstechnik erläutert, um im Prüflabor die komplizierten Beanspruchungsverhältnisse mit allen Randbedingungen eines in eine belastete Schwimmbrücke eingebundenen Pontons nachzufahren, mit dem Ziel, die Reaktionen (Tragverhalten, Schwingfestigkeit) derartiger geschweißter Aluminium-Leichtbau-Konstruktionen zu untersuchen.

### **RESUME**

Le dispositif et la procédure d'essai complexes servant à simuler en laboratoire les conditions de chargement très compliquées d'un ponton faisant partie d'un pont flottant sont décrites.

**KEYWORDS:** Testing of Pioneer Bridge Structures, Aluminium-Bridge-Structures

## 1. INTRODUCTION

The development of dismantlable bridges (bridge systems, military bridges, pioneer bridges) requires, besides the extensive design work and detailed theoretical analysis, also experimental investigations on materials, structural details, complete substructures (modules) and even on complete bridge structures. Since many decades, the Otto-Graf-Institute is the leading testing institution on this field of dismantlable bridges.

A very important branch of the dismantlable bridges are wet gap military bridging systems, the so-called floating bridges representing very efficient and universal useful structures to overcome big rivers, water surfaces and obstacles (caused for instance by catastrophes, floods etc.).

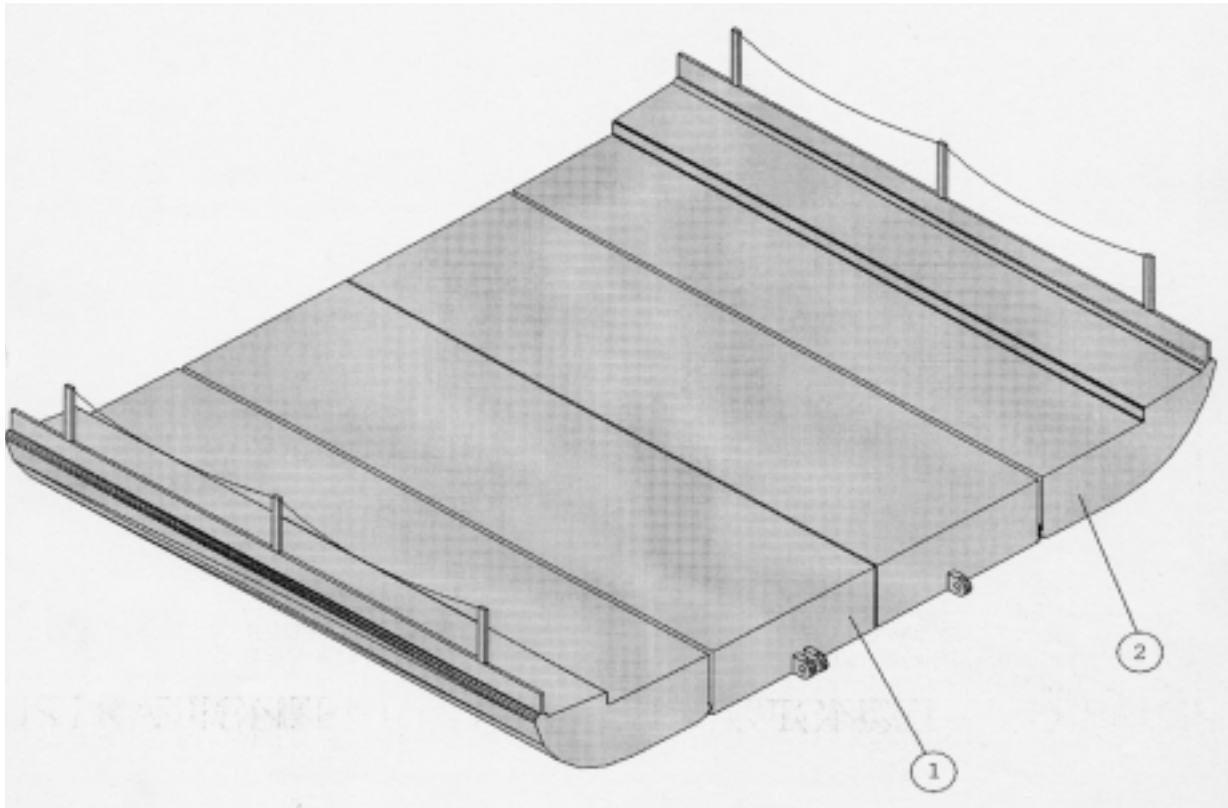
In the following, it will be reported of a recently finished test project concerning floating bridge systems, which was outstanding pretentious if compared with the usual test projects, carried out commonly in the department 2.

## 2. TEST PROJECT

Basic elements of floating bridges are generally the welded hollow box girders in aluminium, the so-called pontoons or bays, which will – dependent on the respective demand – be coupled together in appropriate number to form in composite action a complete floating and load carrying road way, see the following pictures (Fig. 1 and 2).



*Fig. 1: Floating bridge in service*



*Fig 2.: Cross-section of floating bridge (1 = Roadway ponton, 2 = Bow ponton)*

An excellent example of floating bridges, the so-called RIBBON-Bridge, was developed about 25 years ago in Germany by EWK (Eisenwerke Kaiserslautern). Meanwhile the RIBBON-Bridge is in service in 11 armies worldwide. Based on the positive experiences and the perfect performance all over the world in the past, even the US-Army was interested finally in this floating bridge.

However in order to provide extensively the US-Army with the Ribbon Bridge, EWK had to satisfy some American proposals concerning a better handling and carrying capacity of the bridge system. At last, the Americans wished, that the successful demonstration of the demanded improvements should be realized by an appropriate full scale test in the Otto-Graf-Institute.

So, in cooperation with EWK, a testing program was developed to prove the accomplishment of the requested improvements, quasi as a certification of the IMPROVED RIBBON BRIDGE (IRB).

Essentially, the testing program included the static and dynamic loading of a complete ponton in a suitable special test set-up. Testing should be carried out in a procedure, which simulates all the load cases and load characteristics happening in practical use of the IRB.

To create that kind of most unfavourable and harmful loading situations in the ponton means concretely to apply bending moments and longitudinal as well as transverse loads in the same way and magnitude as it occurs, when a battle tank MLC 70 either stands on the floating bridge or passes the bridge, like demonstrated in the following diagram (Fig 3.).

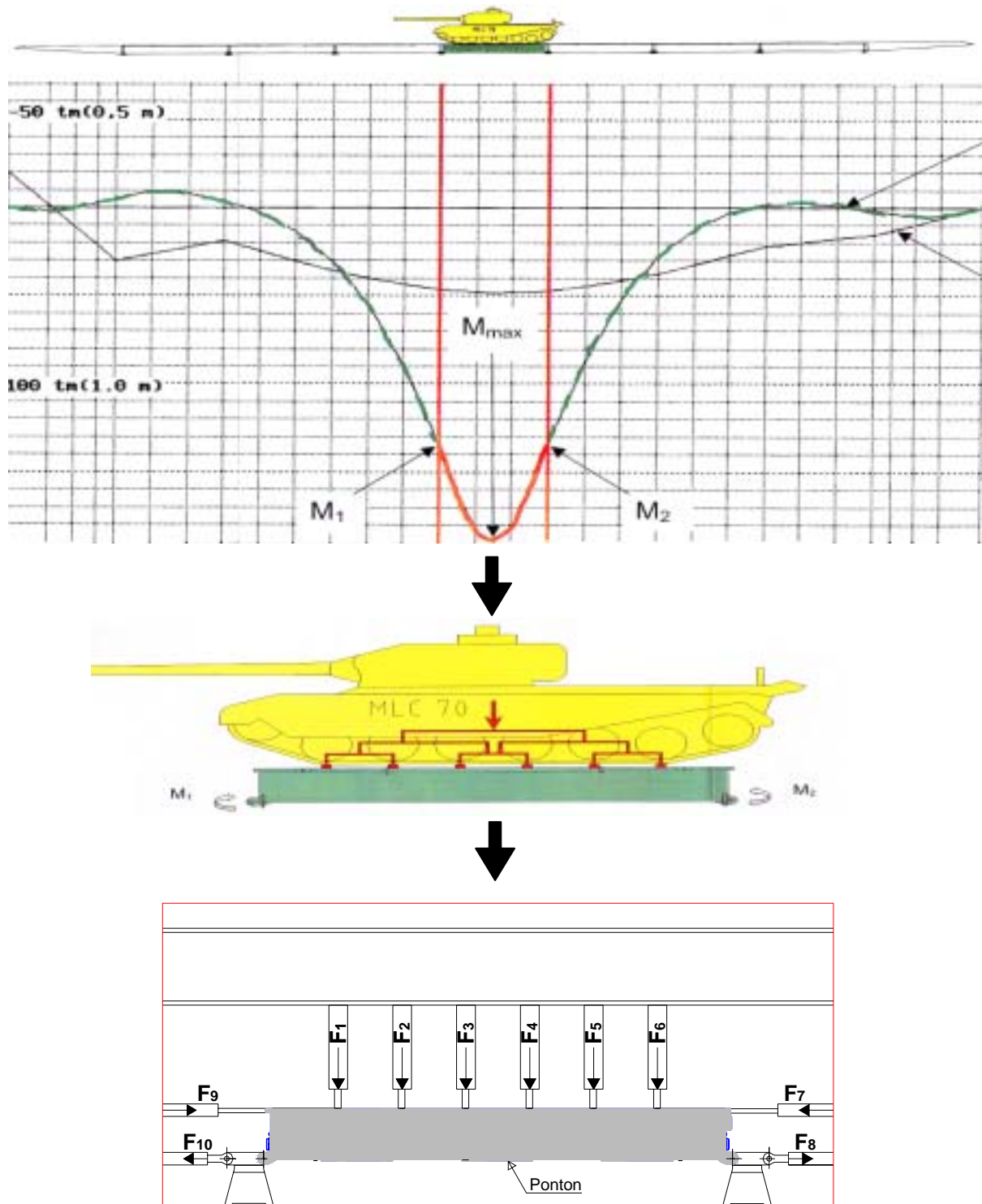


Fig. 3: Tank loading in reality and through laboratory simulation

### 3. EXPERIMENTAL REALIZATION

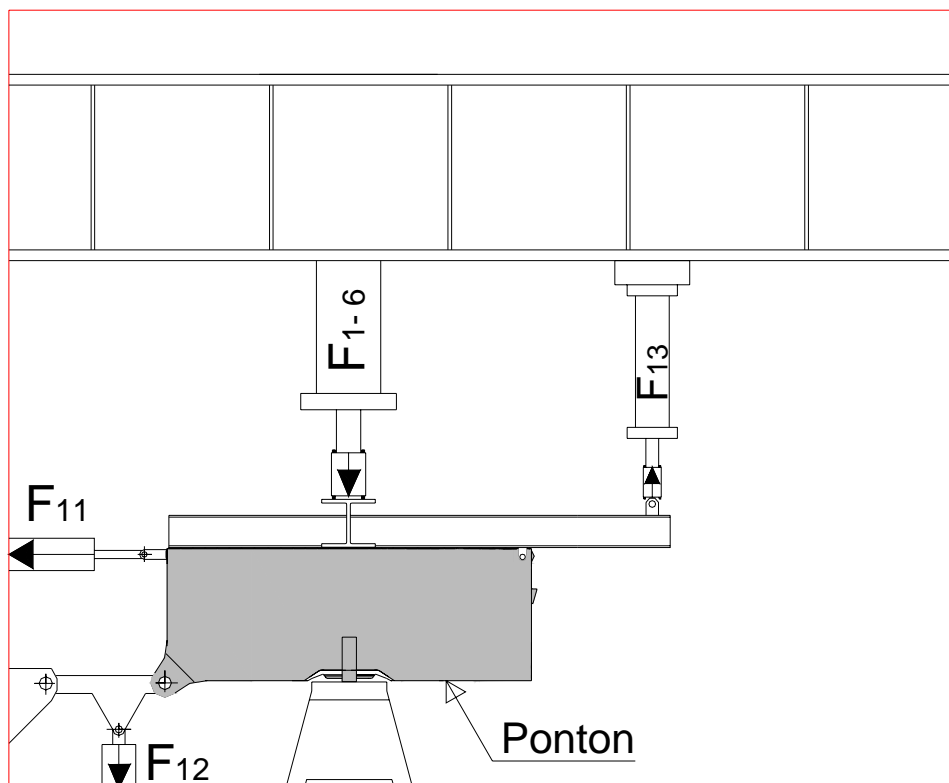
#### 3.1 Test set-up

There were mainly two problems to be solved:

- a) Installation and program-operation of a relatively high number (13) of hydraulic jacks with different capacities (50 kN to 2 MN)
- b) Application of high bending moments (partly  $> 2$  MNm by means of very high horizontal forces)

Even the comparatively abundant and well assorted equipment of the Department 2 of the Otto-Graf-Institute was not able and sufficient to solve satisfactorily the two problems in a direct way. Especially the wanted number and capacity of the hydraulic jacks (at least 4 jacks with more than 2 MN) represented a considerable challenge. So, some reflection was necessary to find a way for the experimental realization, using the available equipment.

The central idea of the solution was the consistent application of the lever-action (Hebelgesetze): The mainly in pairs acting high horizontal forces with opposite signs could be replaced by a lever-structure as shown basically in the following sketch.



*Fig. 4: Forces on the ponton*

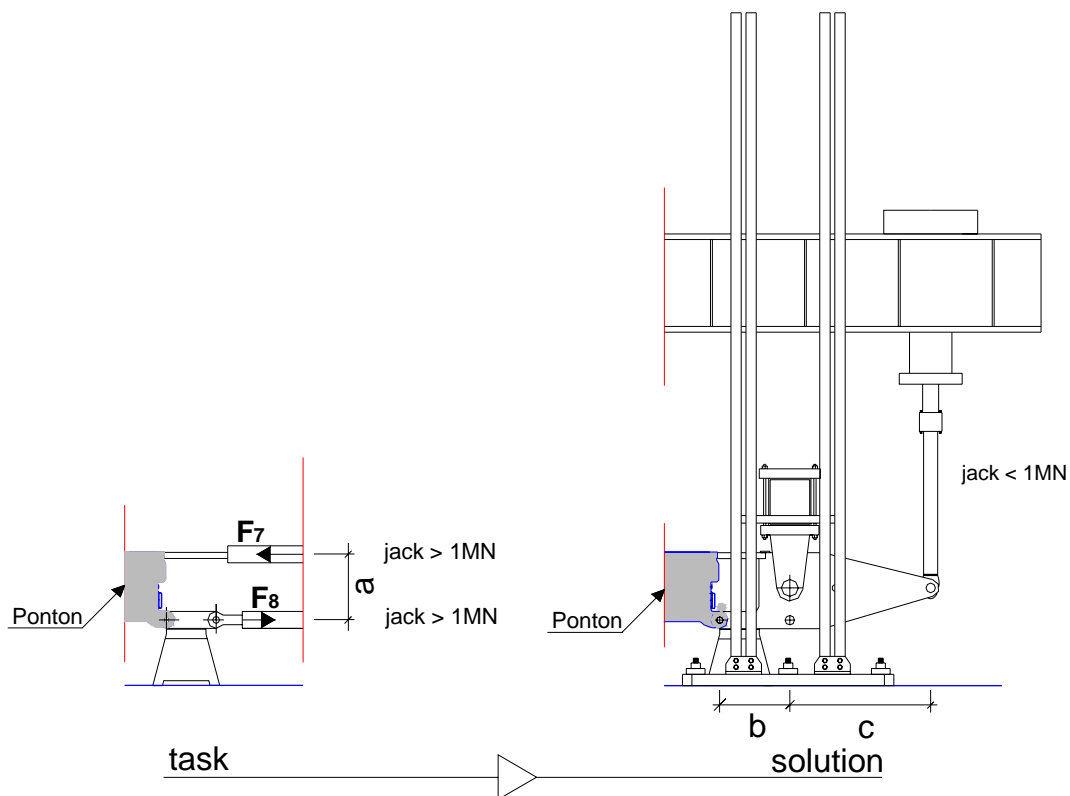
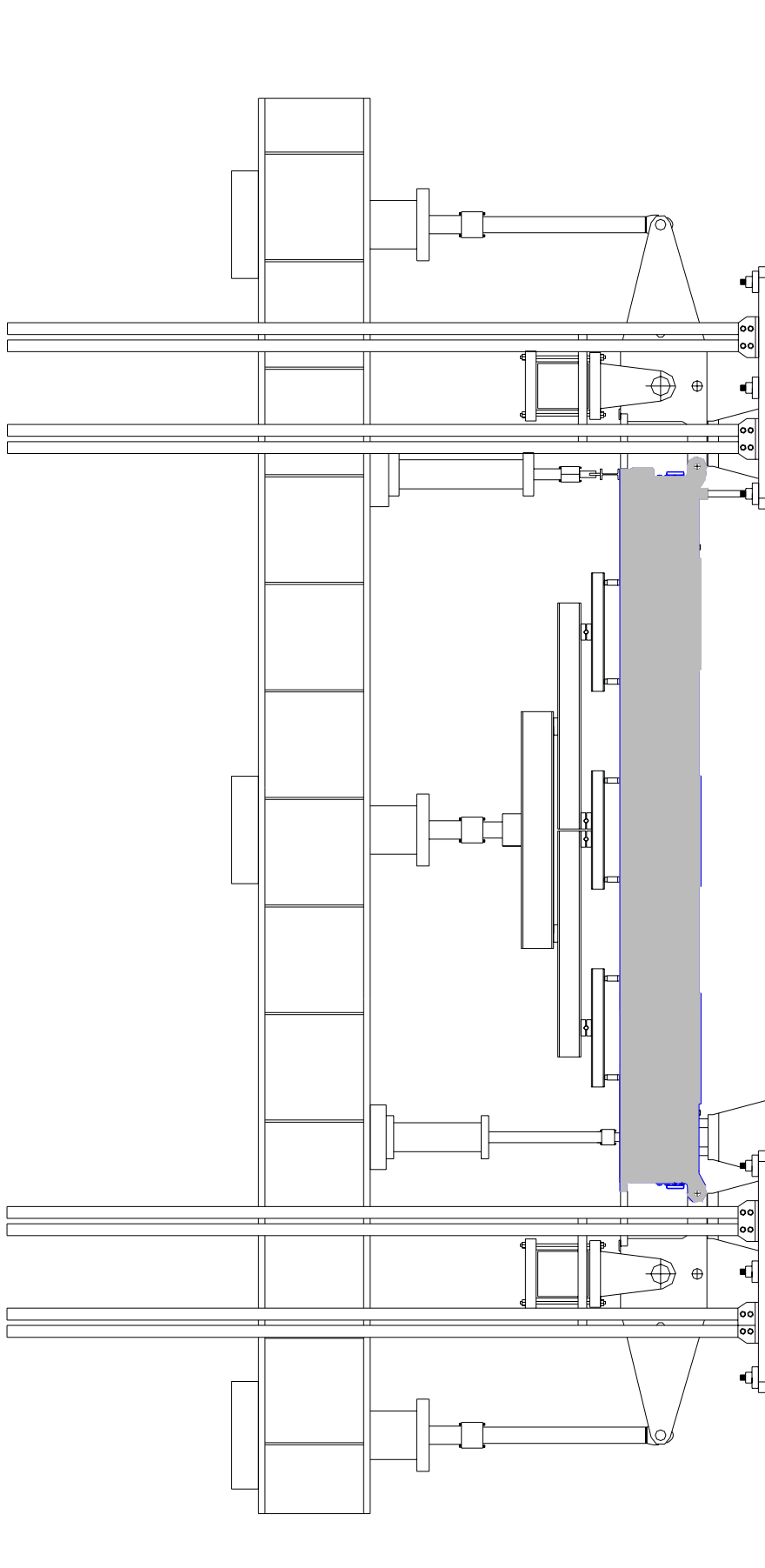


Fig. 5: Solution of the testing task

Proceeding that way, several profitable effects could be achieved: the number of the required jacks was reduced from 13 to 5, the capacity of the used jacks could be adapted perfectly to the jacks available in the department 2 by corresponding choice of the lever-ratios  $b:c$  and last not least – this is very important with regard to the test set-up – the introduction of the lever structures opens the possibility to anchor the initially horizontal forces now vertically either in the strong floor directly or by means of test frames at hand indirectly. The anchorage of high horizontal forces is – as experience shows – on principle very difficult and expensive in a laboratory, because these forces have to be turned round sooner or later to pass and anchor them finally into the floor.

After the concept of the experimental realization was found, the proceeding was evident: after checking the available and suitable jacks in the department, the different lever-ratios were calculated for the different loading points. After that, all the other details were designed. Then all parts were manufactured by EWK together with the ponton to be tested.

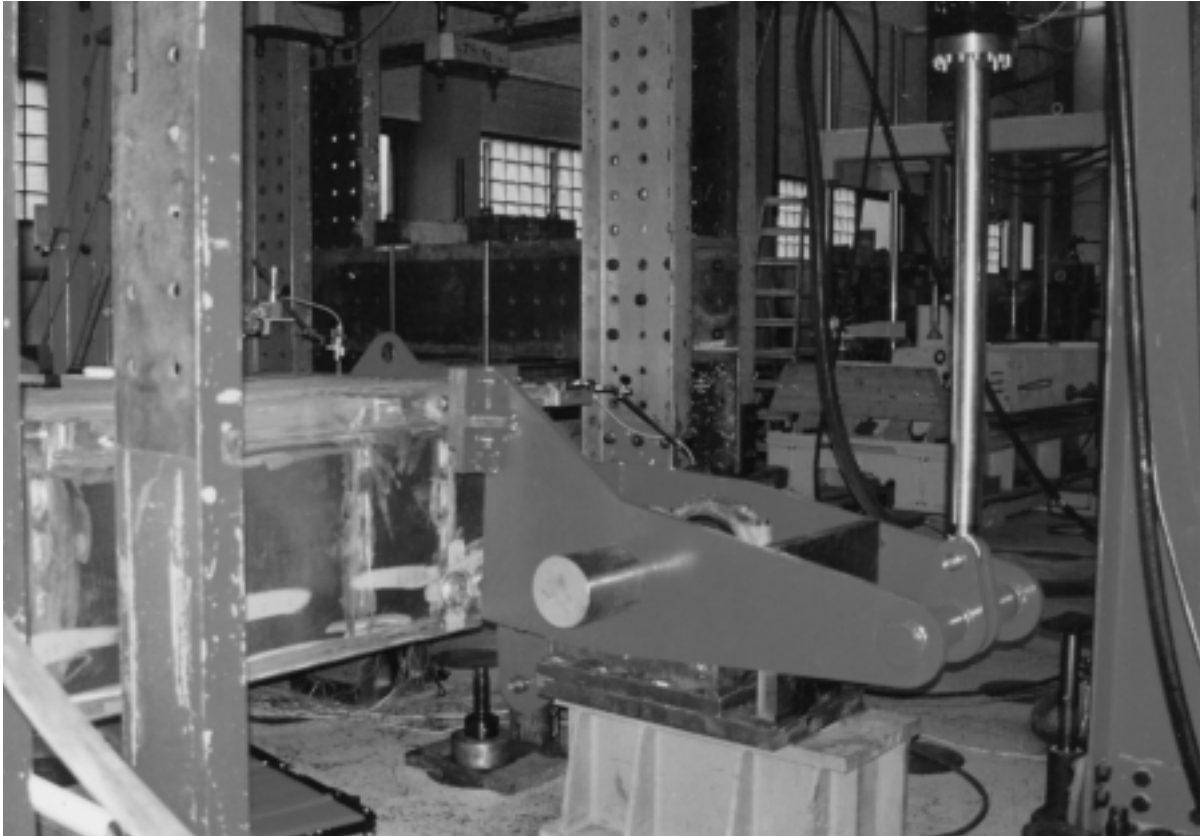
The following pictures will try to give an impression of the complicate and complex test set-up:



*Fig. 6. Testing arrangement on the strong floor*

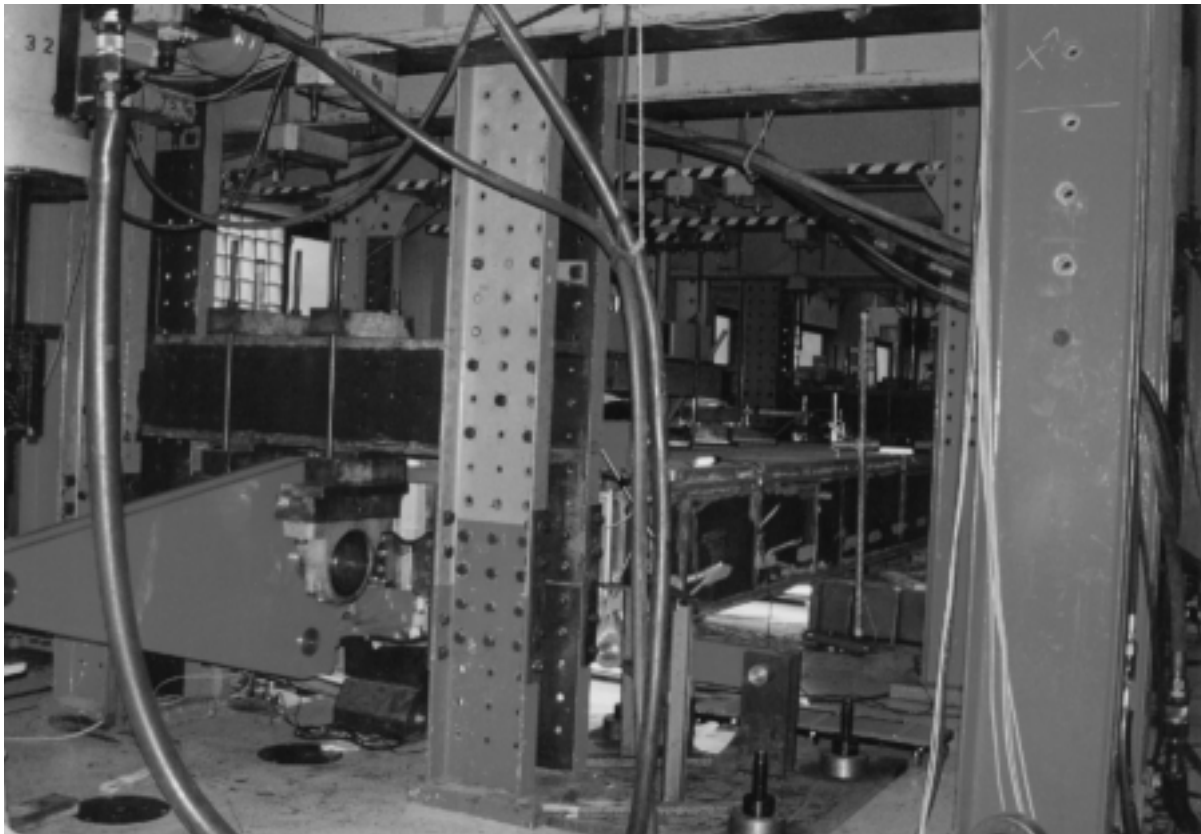


*Fig. 7.a: Mid section of testing structure*

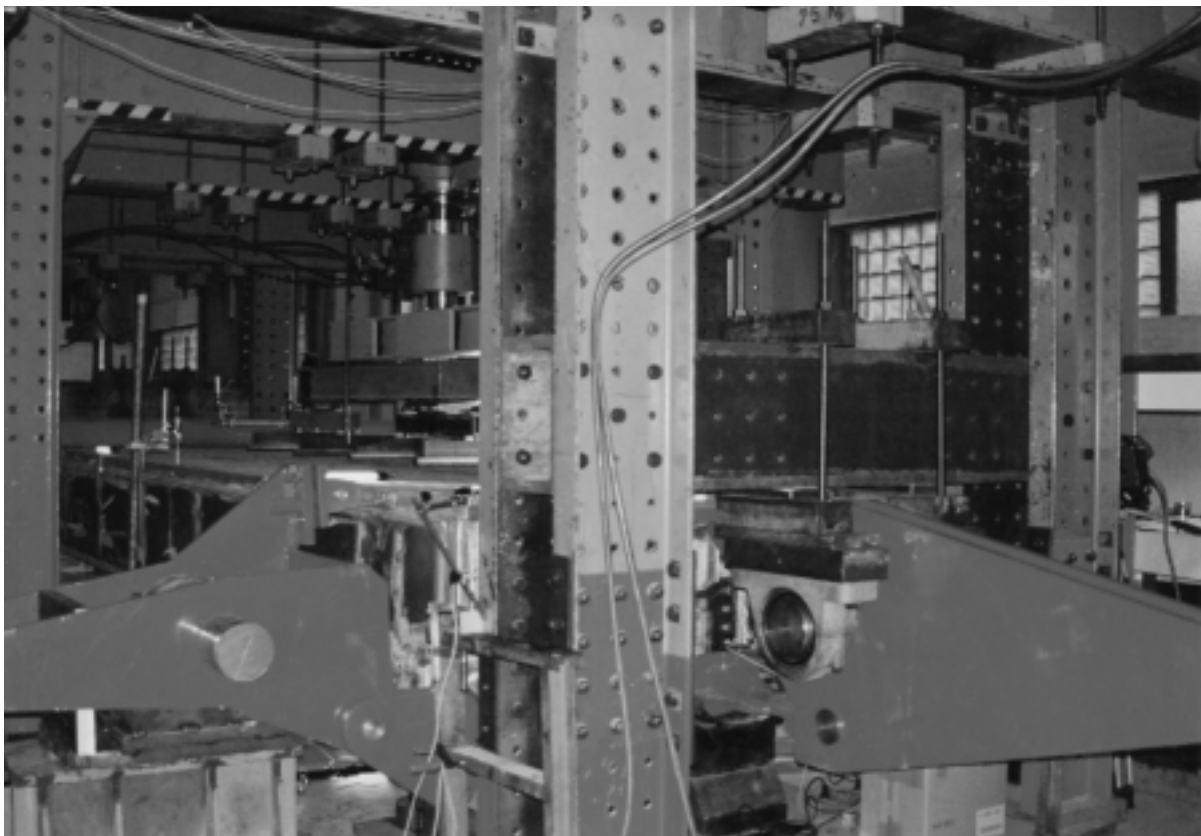


*Fig. 7.b: End section of testing structure*





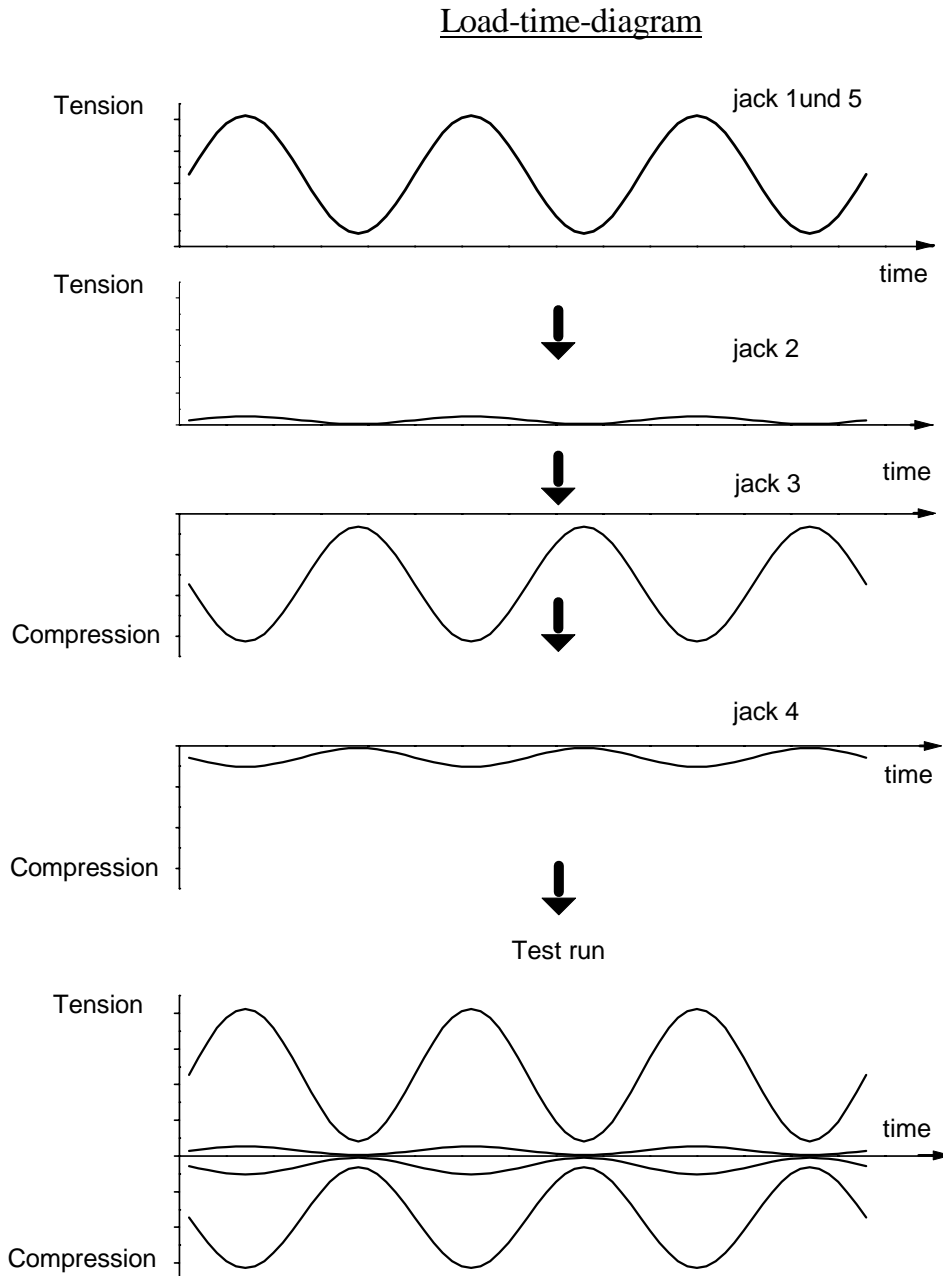
*Fig. 7.c: Oil supply system*



*Fig. 7.d: Complex multi-dimensional loading arrangement*

### 3.2 Test run

The loading program required the independent, however exactly balanced, synchronous controlling of altogether 5 jacks for static as well as for dynamic running. The following systematic presentation of the loading functions illustrates the dynamic test run (Fig. 8).



*Fig. 8: Loading sequence*

The implementation of this working load test procedure supposed the electronic coupling of the controlling units (S-59 Regler) of all the jacks.

The exact run down of the whole test program was realized by means of a „managing“ computer, which directed the different controlling units according to the test program. In certain intervals, that is at times after reaching reconceived numbers of cycles, the test program also provided breaks in the dynamic loading. During these breaks, different static extreme load configurations were tested. All the measurements (loads, displacements, strains) happened automatically by a multipoint measuring system. The data were stored on CD for further evaluation. The described test set-up and equipment allowed a dynamic loading frequency of 0.4 Hz. The estimated lifetime of the bridge was 50 000 cycles, so that the bare net time for carrying out the dynamic tests amounted to ca. 56 hours.

The main result finally was, that the test specimen, will say the ponton (bay), as well as the test set-up itself passed the test procedure successfully. Apart from some insignificant cracks in the welds on uncritical structural points of the ponton, no serious damage could be observed on the test specimen. The test set-up also showed a perfect performance with regard to function and reliability.

As a final statement, it can be concluded, that the experimental realization of this pretentious testing task on the field of pioneer bridge structures was an complete success for EWK and OGI.

