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"PROOF OF NEW CYLINDER TECHNOLOGY IN MOVABLE STRUCTURES"

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PROOF OF NEW CYLINDER TECHNOLOGY IN MOVABLE STRUCTURES

by Jacques A.C. Wels*

Introduction

A hydraulic cylinder, a linear force generator, is a vital "muscle" in movable structures. Improvements in technology of hydraulic cylinders will directly influence the effectiveness and reliability of the total structure. Such improvements are not just born by coincidence. They are a result of experience in applications and the continuous urge of an organisation to do better, supported by successes of earlier developments. Developments such as the ceramic piston rod coating Ceramax® and the position indicator CIMS brought the cylinder product to a higher level. As with all new developments acceptance or adoption can only gained by 'Proven in practice'.

Technology of Ceramax and CIMS

Ceramax on piston rod of hydraulic cylinders is not just a ceramic coating. It is a development of many years, supported by well known research institutes and experiences in the field. This research gave the necessary insight in:

- corrosion resistance
- tribological conditions
- required surface quality, roughness, hardness
- optimal seal and bearing materials
- behaviour with bending

Since its introduction Ceramax rod coating has built-up a solid name as an extremely efficient corrosion and wear resistant rod protection for movable structures in all kind of applications.

The basis of a succesfull product is a well controled production. A Ceramic layer has after applyance a rough surface which without proper finishing cannot be used in hydraulic cylinders. To reach the required roughness the surface has to be honed or ground. Honing results in a wild texture of the surface with a typical tribological effect. Because of the wild texture the neccesary oil film for lubrication of seals and bearings can not hold out. To come to the adequate surface finish of an additional finishing methode is developed to remove the "peaks" of the surface. For ceramic layers the regular methodes for measuring roughness (Ra, Rt) are not sufficient. A much better way is to measure according DIN 4776 to measure the actual surface character, describtion of the measuring conditions and evaluation. The surface is described through 5 parameters and the "Abott" curve, see fig. 1.

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Using this methode a more detailed conclusion can be taken in relation to the production parameters and to the behavior of the rod, seals and bearings in practice.

A total of 7231 Ceramax cylinders are in full operation for many years, having cycled with a total stroke of 40,000 km. Ceramax has proven to have superior qualities compared to the existing solutions.

A logical development on Ceramax is CIMS (Ceramax Integrated Measuring System).
In present movable structure designs with lighter and more flexible constructions synchronisation of the hydraulic cylinders is increasingly important. By making use of the non-conductiong properties of Ceramax it is possible to sense the under the Ceramax machined grooves. This principle (fig. 2) provides the necessary information to determine electronically the position of the piston rod. Synchronisation of 2 or more cylinders is achieved by combining the position signal with a PC or PLC. Proof of this is the train Ro-Ro bridge in Travemünde, Germany, see fig. 3.

Proof of this technology

Project: Harry S. Trumandam
Bulkhead Hoist System

Several units of the Harry S. Trumandam experienced failures in the areas of high blade bushing wear, blade seal sleeves, blade control linkage and stub shaft coupling bolt studs. These failures are directly attributable to poor component fabrication and inadequate design for the situations in which they are being operated.

Engineering analysis demonstrated the need for both intake and discharge bulkheads and hoists which could rapidly close and deter very costly damage to the internal powerplant structure and its operation. The intake gates are already equipped with hydraulic cylinders that are able to meet the closing time.

For the draft tube bulkhead hoists the U.S. Army Corps of Engineers decided to acquire telescopic hydraulic cylinders instead of using the overhead gantry crane for the following reasons:

1. Wire rope hoists would not provide a downward force to lower the bulkheads, there is insufficient space below the draft tube.
2. Rollers would need to be added to the bulkheads and slot widths would have to be enlarged to use wire rope hoists under a gravitational force method.

3. There is not sufficient space below the draft tube deck for installation of a 40 foot non-telescopic cylinder and installation of such a large hoist above the deck would clearly interfere with the draft tube gantry crane. The combined bulkhead structure weighs approx. 75,000 pounds and must be operated within the physical, structural constraints currently present at the powerplant.

The 5 stage telescopic hydraulic cylinders as described during the 4th biennial Bridge symposium in 1992, were seen as the ideal solution for a set of unique problems, see fig 4 and 5.

From the Corps' perspective, in house design of the hoist and power systems was not the most desirable one available in this situation due to the unusual set of constraints involved and the industrial expertise available through other methods. For this reason a "Request For Proposal (RFP)" was developed detailing the project's requirements, performance criteria, structural constraints and scheduling needs. The extent of this supply included design, fabrication and assembly of twelve telescopic cylinders and hydraulic power units and one portable power unit. The awarding of a contract of this type is based upon evaluation factors, weighted to each offerer's proposal in the areas of performance capabilities, past performance on similar work, organizational plan for management of the project and technical merit.

All of the above mentioned items were taken into concideration in design and manufacturing and in accordance with the U.S. Army Corps of Engineers' strict guidelines and quality assurance requirements. Additionally, as a result of the Army Corps investigation into the details of the Ceramax rod coating, they have included the Ceramax specification in the Army Corps of Engineers guide specification for civil structures.
The first two units have been commissioned by a Rexroth field engineer in early June, 1993. The performance of the initial components leads to the conclusion that the products received are of the highest quality and are well designed for the unusual application. These custom built multi-stage cylinders are expected to perform well for many years to come.

Project: Ybbs Persenbeug
Mechanical lock Drive replacement by Hydraulic cylinders

The Österreichische Donaukraftwerke (Austrian Donau Power Works) was founded in 1947 in order to build and operate water power stations along the Austrian Danube. At present, eight power stations are in service. The ninth power station "Wien-Freudenau" has been under construction since 1st October 1992.

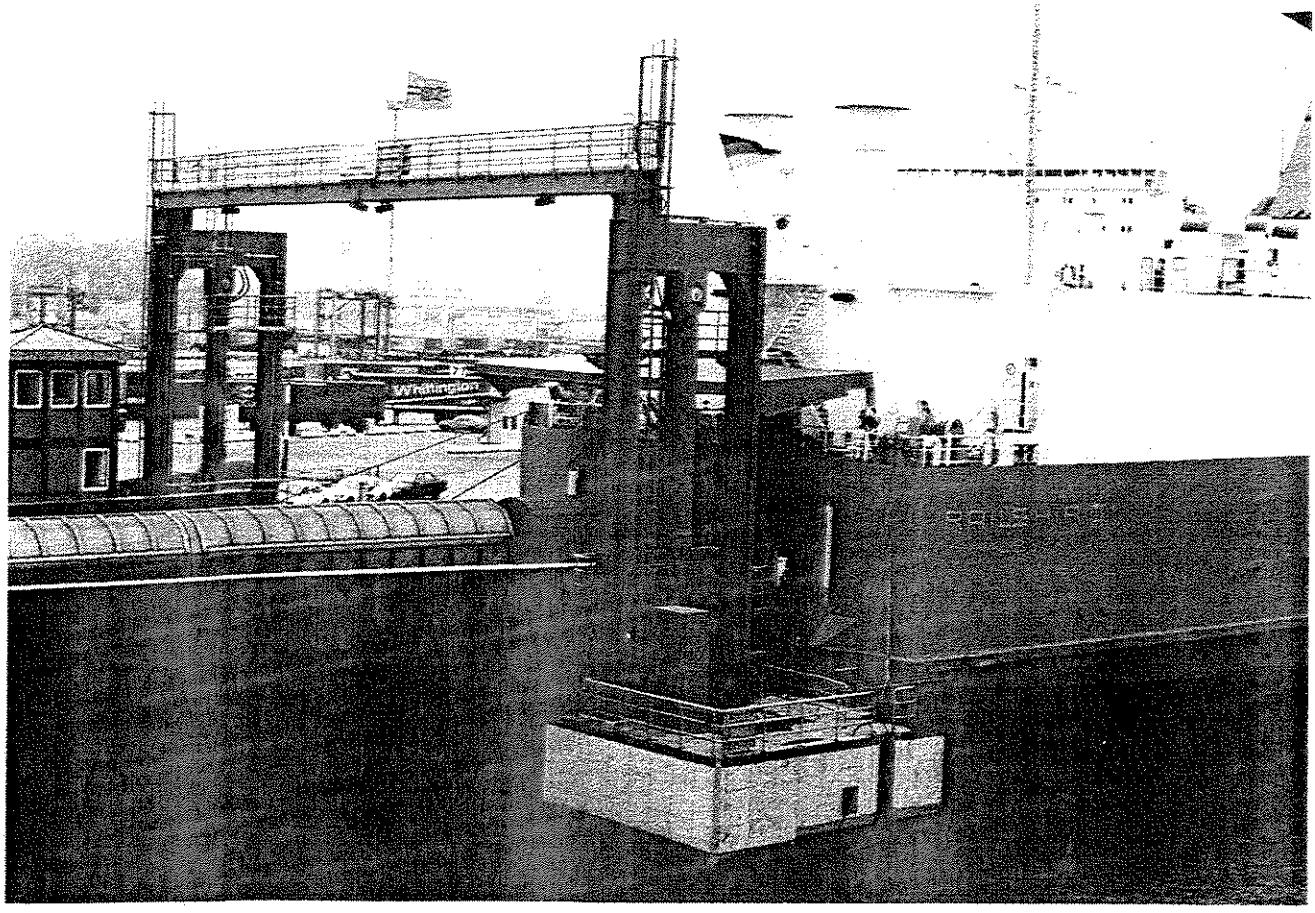


fig. 3 Train Ro-Ro Bridge in Travemünde, Germany

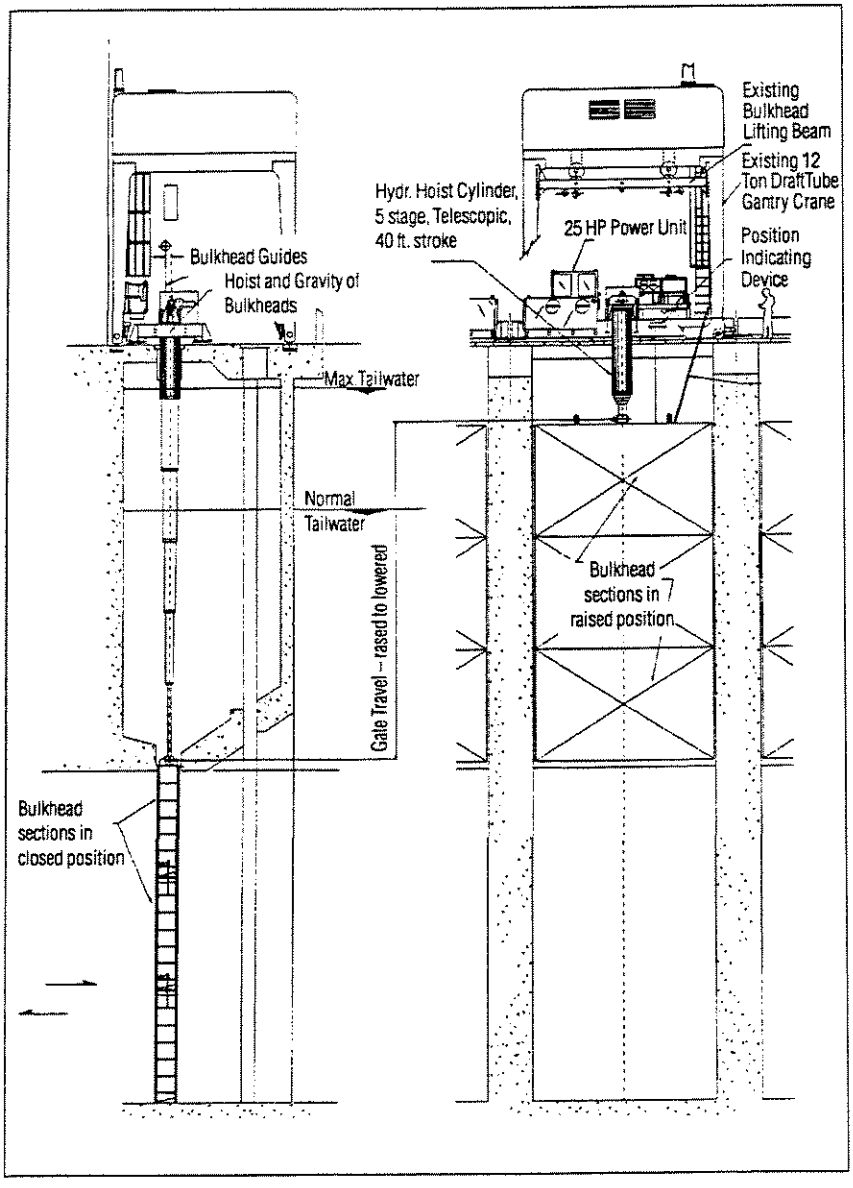
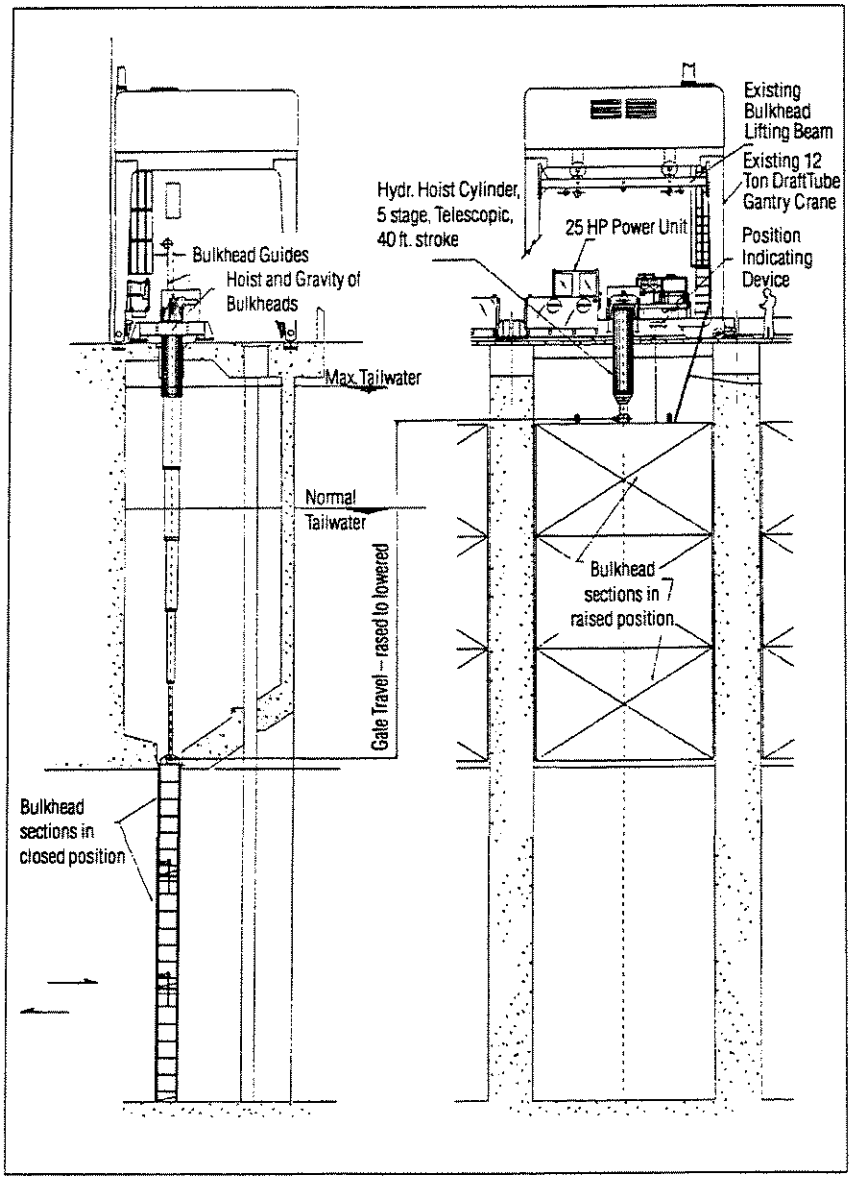


fig. 4 Bulkhead transverse section



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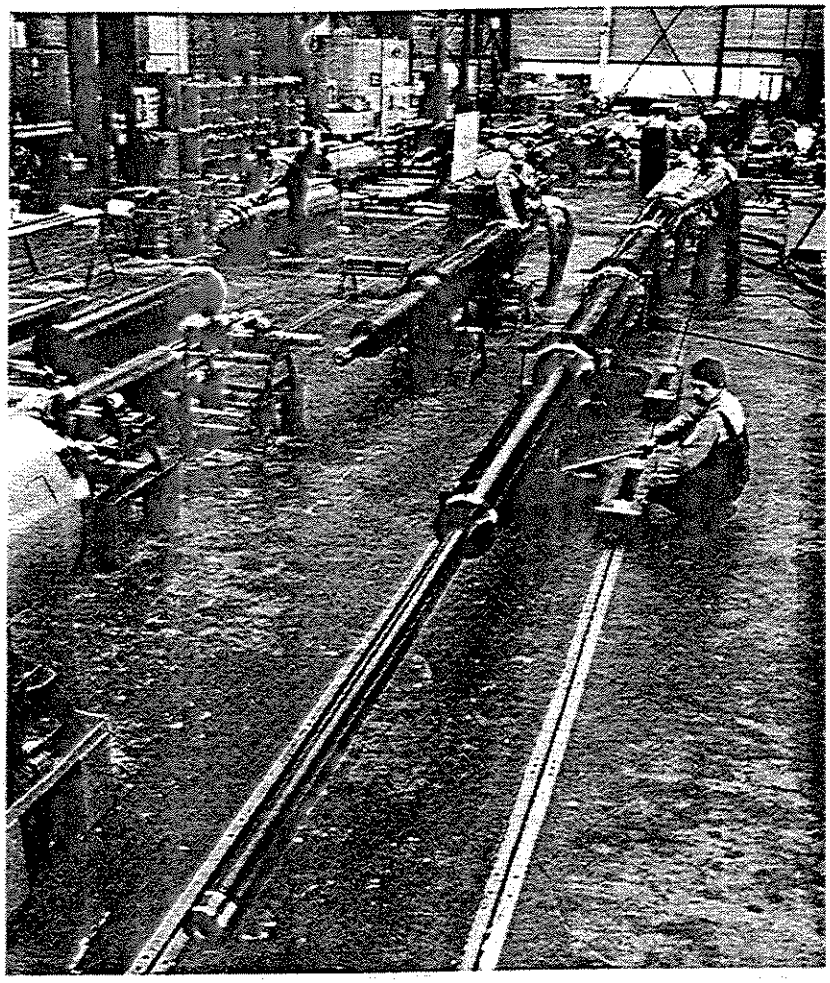

The cylinder specifications as designed and manufactured are:

	Bore (mm)	Rod Diameter (mm)
stage 1:	10" (254)	4.9" (125)
stage 2:	14" (360)	11" (280)
stage 3:	18" (460)	15.7" (400)
stage 4:	21.6" (550)	19.7" (500)
stage 5:	25.2" (640)	23.6" (600)

Outside Diameter: 29" (737)
Total Stroke: 40' (12,192)
Rod Coating: Ceramax® - 1000
Piston and Rod Bearing Material: Impregnated Polyester Bearing Strips

fig. 5 5-stage telescopic cylinders

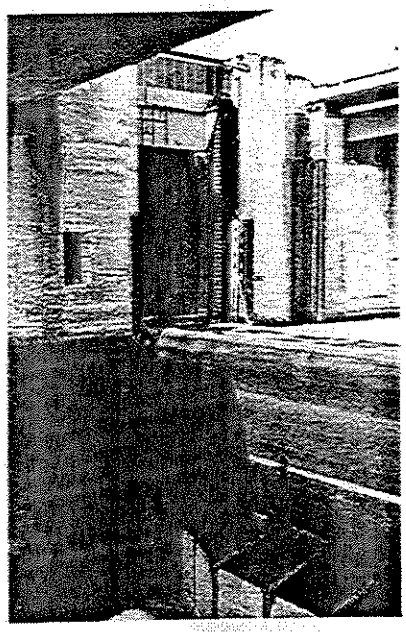

fig. 6 Upper head drive with chains

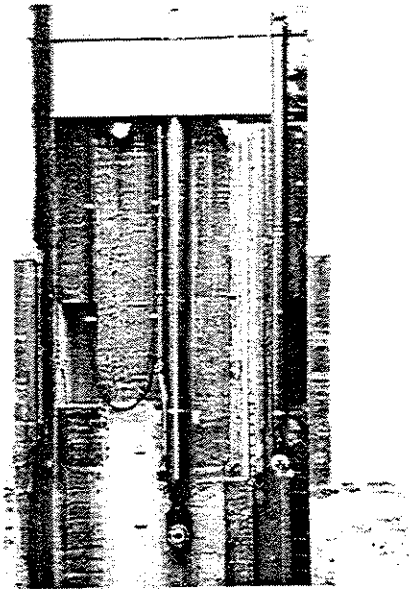

fig. 7 Upper head drive replacement with hydraulic cylinders

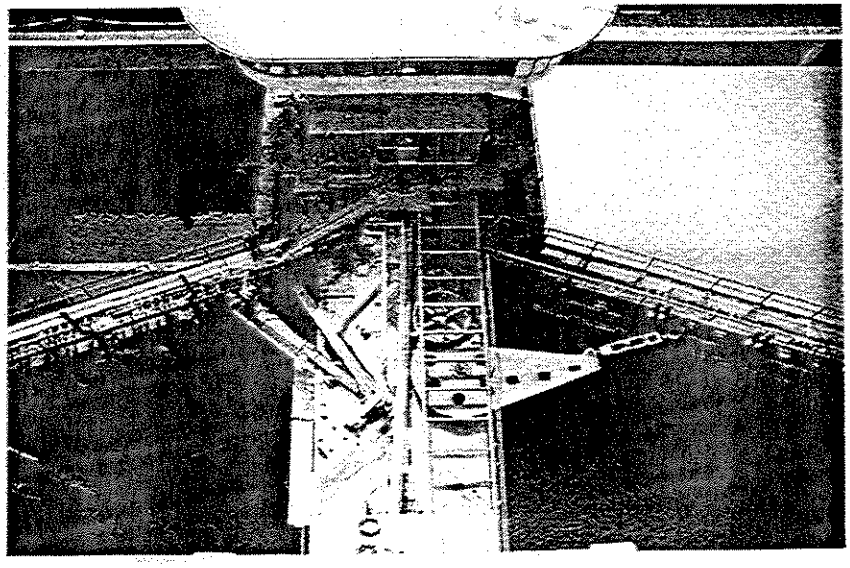

fig. 8 Mitre gates in lower head, left side hydraulic drive right side mechanical drive