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Rubrik: Poster session 2: Construction management, health and safety

POSTER SESSION 2

Construction Management, Health and Safety

Gestion de la construction, prévention des accidents

Baumanagement, Arbeitssicherheit

Coordinator: R.S. Stilwell, Canada

Management of Two Major Turnkey Projects in Vienna

Martin FENZ
Dr.-Ing.
Rella Baugesellschaft
Wien, Austria

1) DISTRIBUTIONSZENTRUM
WIEN-HIRSCHSTETTEN

Warenverteilerzentrale für Österreich

Bauherr: Konsum Österreich, Wien

Baudaten:	Umbauter Raum	1,100.000	m^3
	Verbaute Fläche	85.000	m^2
	Geschoßfläche	125.000	m^2

Bauzeit: Oktober 1979 bis März 1981 = 18 Monate
=========

Ausführung: Generalunternehmer für Planung und schlüsselfertige Einrichtung

2) WOHNPARK ALT-ERLAA

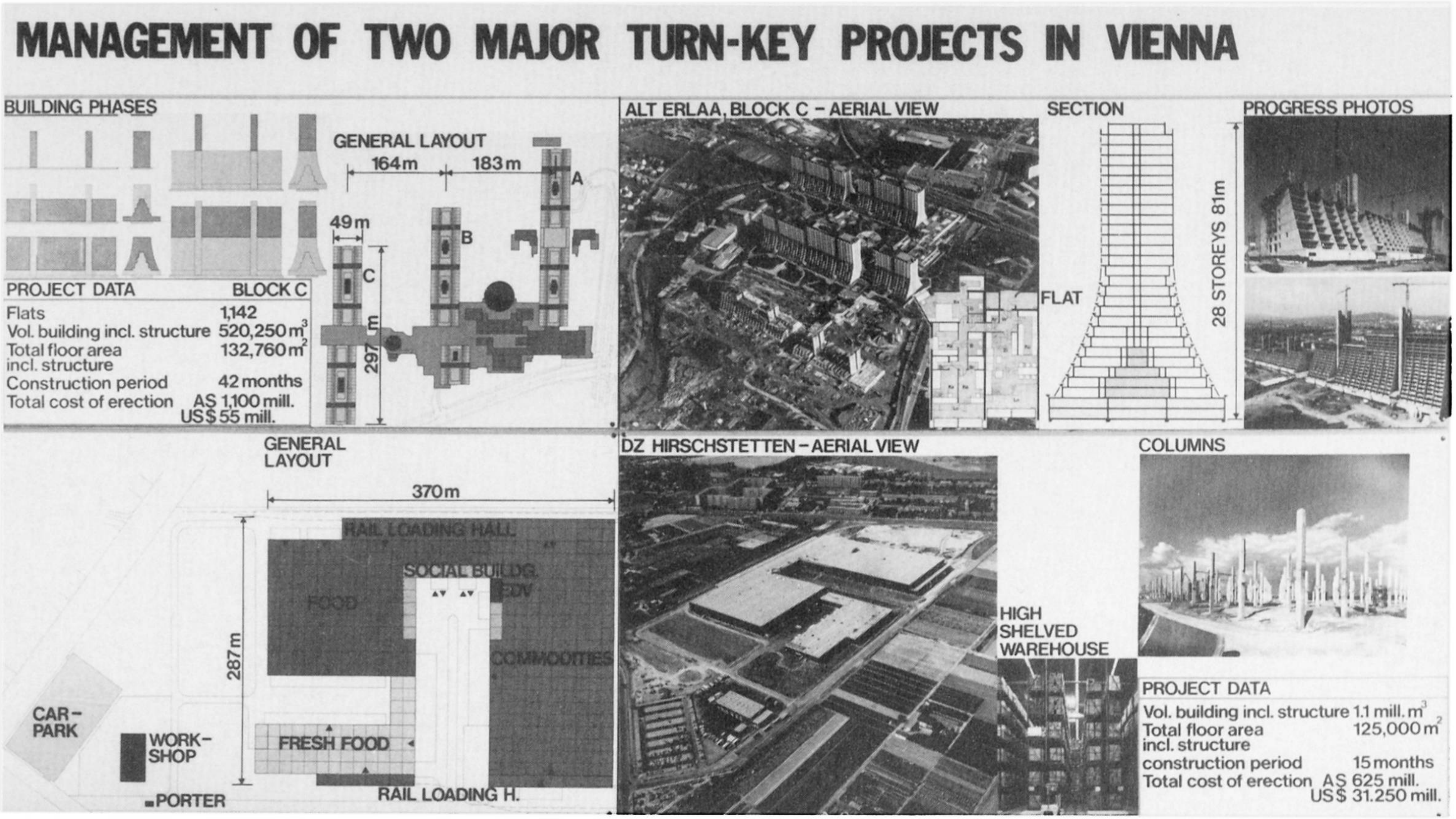
Wohnhausanlage mit drei Wohnblockreihen (A, B, C) mit je 22 - 26 Wohngeschossen

Bauherr: "GESIBA" Gemeinn.Siedlungs-u.Bauges., Wien

		gesamt	Block C
Baudaten:	Wohnungen	3.200	1.142
	Wohnfläche	370.400 m^2	106.210 m^2
	Umbauter Raum	1,480.000 m^3	520.150 m^3

Bauzeit: Block C als Generalunternehmer
Dezember 1981 bis Mai 1985 = 42 Monate
=========

Ausführung: Technische Geschäftsführung im Rahmen einer Arbeitsgemeinschaft


MANAGEMENT OF TWO MAJOR TURN-KEY PROJECTS IN VIENNA
BUILDING PHASES
GENERAL LAYOUT
164 m
183 m
A
49 m
B
C
297 m
PROJECT DATA BLOCK C
Flats 1,142
Vol. building incl. structure 520,250 m³
Total floor area incl. structure 132,760 m²
Construction period 42 months
Total cost of erection AS 1,100 mill. US$ 55 mill.
ALT ERLAA, BLOCK C – AERIAL VIEW
SECTION
FLAT
28 STOREYS 81m
PROGRESS PHOTOS
GENERAL LAYOUT
370 m
287 m
RAIL LOADING HALL
SOCIAL BUILDG.
EDV
FOOD
COMMODITIES
FRESH FOOD
RAIL LOADING H.
CAR-PARK
WORK-SHOP
PORTER
DZ HIRSCHSTETTEN – AERIAL VIEW
HIGH SHELVED WAREHOUSE
COLUMNS
PROJECT DATA
Vol. building incl. structure 1.1 mill. m³
Total floor area incl. structure 125,000 m²
construction period 15 months
Total cost of erection AS 625 mill. US$ 31.250 mill.

Fliessfertigung in der Rekonstruktion

Kurt FIEDLER
Prof. Dr.
TH Leipzig
Leipzig, DDR

Die Berechnung von Taktstraßen im Bauwesen fußt auf Ansätzen von Budnikow (UdSSR) und Nezval (CSSR). Sie minimierten die Beginnabstände kontinuierlicher Teiltaktstraßen.

Der Autor wies bereits 1974 /1/ auf die theoretische Möglichkeit hin, den Algorithmus umzukehren , um die Kontinuität im Objekt zu ermitteln.

Durch die Zunahme serieller Rekonstruktionsprozesse (siehe Poster) erhält diese Möglichkeit in den 80er Jahren praktische Bedeutung: Reko-Taktstraßen erfordern häufig minimierte Störungs-Dauern im Objekt und somit Kontinuität des Kapazitätseinsatzes im Produktionsabschnitt /2/.

Am Lehrstuhl des Autors wurden Methoden des Angleichens von Taktstraßen entwickelt /3/, um beide Kontinuitätsforderungen gleichzeitig annähernd zu erfüllen.

Für die computergestützte Ablaufplanung und interaktive Aktualisierung von Bau-Taktstraßen entstand ein Programmpaket /4/, mit dessen Hilfe Terminlisten und Balkengraphiken berechnet und gedruckt, Zyklogramme automatisch gezeichnet und die Parameter im Bildschirmdialog variiert werden können.

Zur Kompensation von Abweichungen gegenüber dem Ressourcen - Plan, die durch verdeckte Schäden der Bausubstanz entstehen können, wird mithilfe eines spieltheoretischen Verfahrens /5/ eine optimale Größe der Kapazitätsreserve ermittelt.

Die Forschungen werden fortgesetzt und auf die Kombination von Neubau- und Reko- Taktstraßen sowie die Integration von nichtkontinuierlichen Prozessen in die Takt- und Fließfertigung ausgedehnt.

L i t e r a t u r :

/1/ K.Fiedler, D.Hunger: Prozeßtheoretische Grundlagen (in Ingenieurtaschenbuch Bauwesen Bd.V/2)
BSB B.G.Teubner Verlagsgesellschaft, Leipzig, 1974

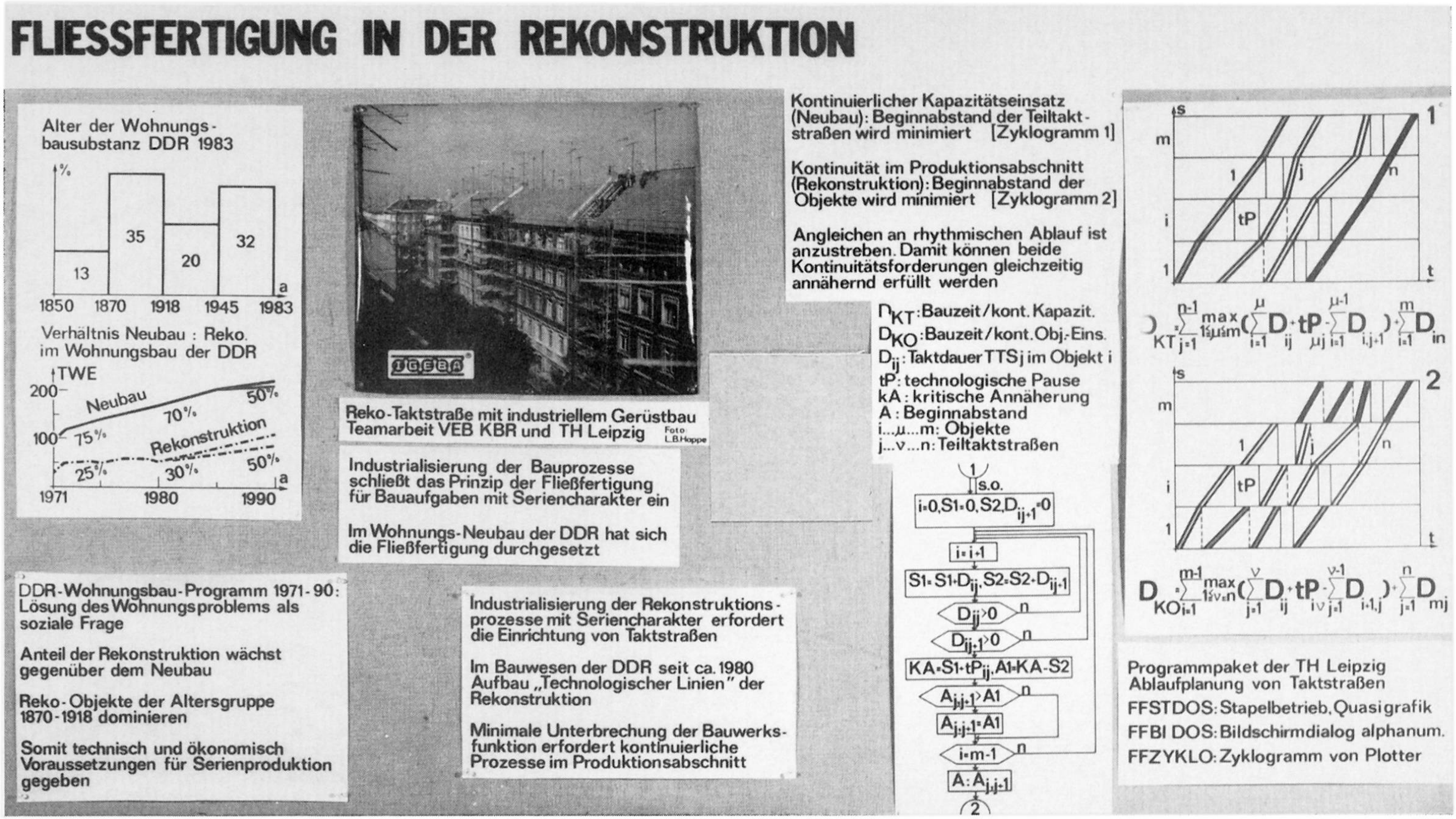
/2/ K.Fiedler: Ablaufplanung für Taktstraßen der Rekonstruktion
IX.Vedecká Konference VUT Brno Fak. Stavebni 3.-4.10.1984

/3/ E.Müller: Möglichkeiten zur Anwendung von Prinzipien der Fließfertigung bei der Rekonstruktion im Wohnungsbau
Dissertation B, TH Leipzig 1984

/4/ W.Jörn: Anwenderhandbuch für das Programm Fließfertigung
TH Leipzig, 31.12.1982 sowie

W.Jörn: Programm Fließfertigung - ein Beispiel zur Nutzung der EDV
Wiss.Zeitschrift TH Leipzig 1983/6 S.337-344

/5/ G.Höher: Ein Beitrag zu Verbesserung der Vorbereitung der Rekonstruktion im Wohnungsbau
Dissertation A, TH Leipzig 1982


FLIESSFERTIGUNG IN DER REKONSTRUKTION
Alter der Wohnungs-bausubstanz DDR 1983
%
13
35
20
32
a
1850 1870 1918 1945 1983
Verhältnis Neubau : Reko. im Wohnungsbau der DDR
TWE
200
100
Neubau
Rekonstruktion
75%
70%
50%
25%
30%
50%
a
1971 1980 1990
DDR-Wohnungsbau-Programm 1971-90: Lösung des Wohnungsproblems als soziale Frage
Anteil der Rekonstruktion wächst gegenüber dem Neubau
Reko-Objekte der Altersgruppe 1870-1918 dominieren
Somit technisch und ökonomisch Voraussetzungen für Serienproduktion gegeben
Reko-Taktstraße mit industriellem Gerüstbau Teamarbeit VEB KBR und TH Leipzig
Foto L.B.Hoppe
Industrialisierung der Bauprozesse schließt das Prinzip der Fließfertigung für Bauaufgaben mit Seriencharakter ein
Im Wohnungs-Neubau der DDR hat sich die Fließfertigung durchgesetzt
Industrialisierung der Rekonstruktions-prozesse mit Seriencharakter erfordert die Einrichtung von Taktstraßen
Im Bauwesen der DDR seit ca. 1980 Aufbau „Technologischer Linien" der Rekonstruktion
Minimale Unterbrechung der Bauwerks-funktion erfordert kontinuierliche Prozesse im Produktionsabschnitt
Kontinuierlicher Kapazitätseinsatz (Neubau): Beginnabstand der Teiltakt-straßen wird minimiert [Zyklogramm 1]
Kontinuität im Produktionsabschnitt (Rekonstruktion): Beginnabstand der Objekte wird minimiert [Zyklogramm 2]
Angleichen an rhythmischen Ablauf ist anzustreben. Damit können beide Kontinuitätsforderungen gleichzeitig annähernd erfüllt werden
DKT: Bauzeit/kont. Kapazit.
DKO: Bauzeit/kont. Obj.-Eins.
Dij: Taktdauer TTS j im Objekt i
tP: technologische Pause
kA: kritische Annäherung
A: Beginnabstand
i...µ...m: Objekte
j...ν...n: Teiltaktstraßen
s.o.
i=0, S1=0, S2, Dij+1=0
i=i+1
S1=S1+Dij, S2=S2+Dij-1
Dij>0
Dij-1>0
KA=S1-tPij, A1=KA-S2
Aj,j+1>A1
Aj,j+1=A1
i=m-1
A: Aj,j+1
n
1
2
s
m
i
1
t
tP
j
Programmpaket der TH Leipzig Ablaufplanung von Taktstraßen
FFSTDOS: Stapelbetrieb, Quasigrafik
FFBI DOS: Bildschirmdialog alphanum.
FFZYKLO: Zyklogramm von Plotter

Load Variations in Bridge Falsework

D.W. QUINION
Chief Engineer
Tarmac Construction Limited
Wolverhampton, England

Construction Method

It was necessary to construct the concrete box girder section on a multitude of tubular steel members using a proprietary frame system because of the complex geometry of the bridge and the heavy loads to be carried. The four spans are unequal, the bridge has a reverse curve on plan and it is on a vertical curve. The east abutment is adjacent to a disused railway tunnel whilst the west abutment is on the top of a steeply inclined schist slope which has a river at its foot. In the more heavily loaded areas there were 26 lines of tubular supports, many of which were expected to receive safe maximum working loads.

The box construction, up to 6.3 m overall depth, was constructed in 10 m lengths of bottom slab, walls and then road deck. After the first span and a quarter had been concreted and had matured, it was post-tensioned using a stressing gap whilst concreting continued westwards. The gap was then filled. This procedure was followed for three spans.

Design of Falsework

The falsework supports were designed to withstand the dead load of the concrete work plus the imposed loadings during construction immediately above, together with the distributed wind load from wind speeds of 46 m per second with reduction factors. The wind load calculations based on the Code for permanent structures gave unrealistic answers and questioning led to evaluation of a more relevant design approach to wind loads on multi-tubular frameworks.

The bridge designer was involved in the assessment of likely vertical movements of the bridge as post tensioning was carried out. Whilst the first two operations were predicted to give small acceptable movements, the third span cantilever was predicted to rise by 55 mm and the rotation about the adjacent pier would increase the load in the Falsework east of it. The difficulty of assessing the magnitude of this increase and the risk to the safety of the Falsework for use here or elsewhere led to the use of load-measuring gauges to monitor the load history in the more critical area.

Load History

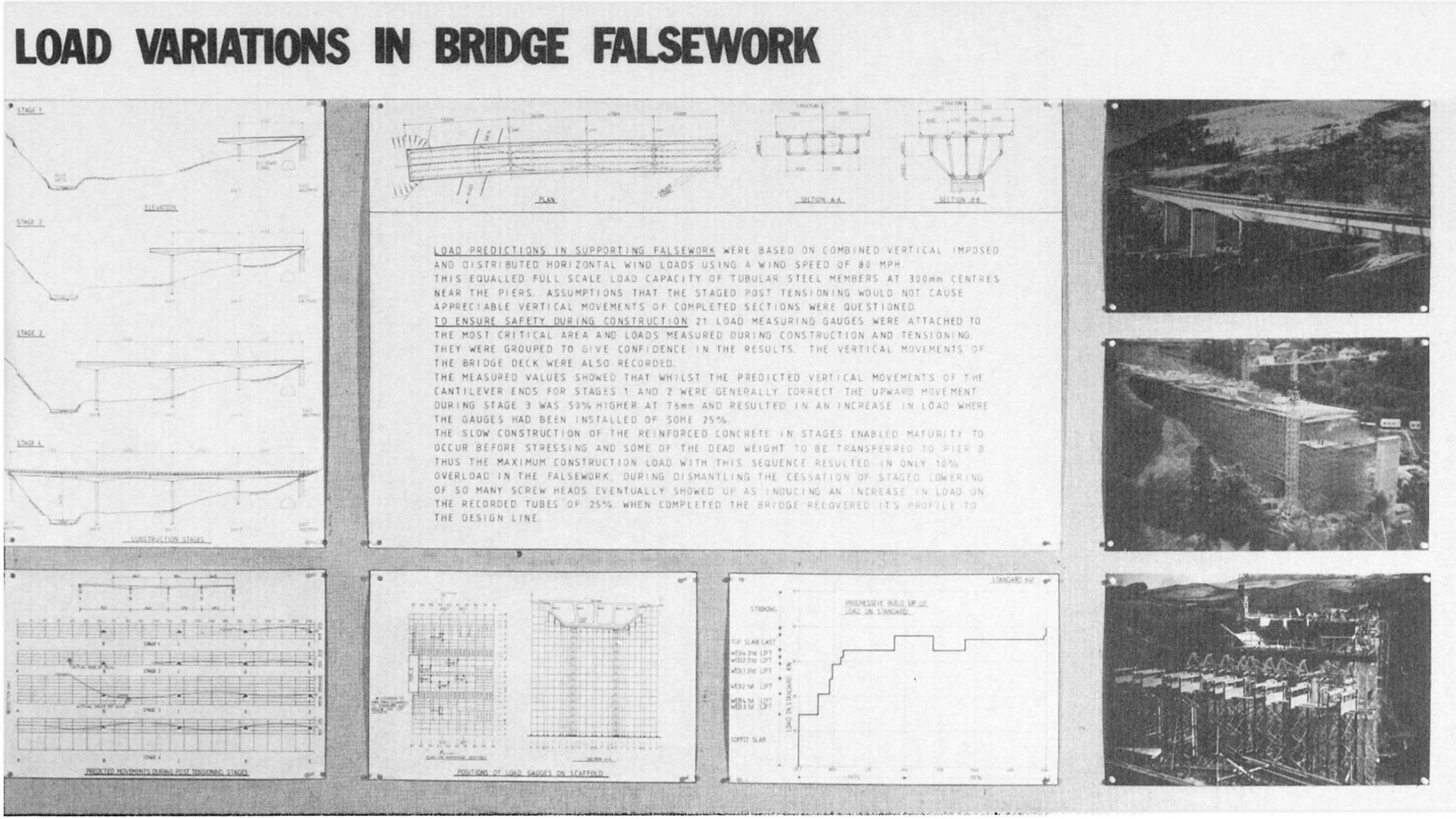
As concrete construction progressed the loads in the Falsework increased and approached the design values. As the concrete matured and particularly after a span was completed, the loads dropped in the Falsework as some 20% was transferred to the piers.

During post tensioning the third cantilever end rose by 76 mm and the adjacent span moved 14 mm downwards. The loads on the measured members rose by 25% from their previous values.

Subsequently, during removal of the Falsework the loads in some of the members which were the last to be fully relieved of load increased by a further 25%.

Summary

The measurements of the load history in the Falsework have shown the significance of post tensioning movements on supporting temporary works and the need to assess them. Monitoring of this kind is not only of value to future designs but enables safe control of Falsework to be demonstrated as the work proceeds.



LOAD VARIATIONS IN BRIDGE FALSEWORK
STAGE 1
ELEVATION
STAGE 2
STAGE 3
STAGE 4
CONSTRUCTION STAGES
PLAN
SECTION A-A
SECTION B-B
LOAD PREDICTIONS IN SUPPORTING FALSEWORK WERE BASED ON COMBINED VERTICAL IMPOSED AND DISTRIBUTED HORIZONTAL WIND LOADS USING A WIND SPEED OF 80 MPH.
THIS EQUALLED FULL SCALE LOAD CAPACITY OF TUBULAR STEEL MEMBERS AT 300mm CENTRES NEAR THE PIERS. ASSUMPTIONS THAT THE STAGED POST TENSIONING WOULD NOT CAUSE APPRECIABLE VERTICAL MOVEMENTS OF COMPLETED SECTIONS WERE QUESTIONED.
TO ENSURE SAFETY DURING CONSTRUCTION 21 LOAD MEASURING GAUGES WERE ATTACHED TO THE MOST CRITICAL AREA AND LOADS MEASURED DURING CONSTRUCTION AND TENSIONING. THEY WERE GROUPED TO GIVE CONFIDENCE IN THE RESULTS. THE VERTICAL MOVEMENTS OF THE BRIDGE DECK WERE ALSO RECORDED.
THE MEASURED VALUES SHOWED THAT WHILST THE PREDICTED VERTICAL MOVEMENTS OF THE CANTILEVER ENDS FOR STAGES 1 AND 2 WERE GENERALLY CORRECT THE UPWARD MOVEMENT DURING STAGE 3 WAS 50% HIGHER AT 76mm AND RESULTED IN AN INCREASE IN LOAD WHERE THE GAUGES HAD BEEN INSTALLED OF SOME 25%.
THE SLOW CONSTRUCTION OF THE REINFORCED CONCRETE IN STAGES ENABLED MATURITY TO OCCUR BEFORE STRESSING AND SOME OF THE DEAD WEIGHT TO BE TRANSFERRED TO PIER B THUS THE MAXIMUM CONSTRUCTION LOAD WITH THIS SEQUENCE RESULTED IN ONLY 10% OVERLOAD IN THE FALSEWORK. DURING DISMANTLING THE CESSATION OF STAGED LOWERING OF SO MANY SCREW HEADS EVENTUALLY SHOWED UP AS INDUCING AN INCREASE IN LOAD ON THE RECORDED TUBES OF 25%. WHEN COMPLETED THE BRIDGE RECOVERED IT'S PROFILE TO THE DESIGN LINE.
PREDICTED MOVEMENTS DURING POST TENSIONING STAGES
POSITIONS OF LOAD GAUGES ON SCAFFOLD
STANDARD
PROGRESSIVE BUILD UP OF LOAD ON STANDARD
STRIKING
TOP SLAB CAST
SOFFIT SLAB

Wheel and Axle Plant, Bangalore, India

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Bombay, India

P.J. JAGUS
Director
STUP Consultants Ltd
Bombay, India

J.S. PADALKAR
Princ. Consult.
STUP Consultants Ltd
Bombay, India

Sprawling over an area of 120 hectares, on the outskirts of Bangalore City, the Wheel & Axle Plant is a gigantic project built for the Railways. The complex is designed for the manufacture of 70,000 wheels and 23,000 axles per year for national consumption and export. The main wheel and axle plant covers an area of over 50,000 sq.m. and the ancillary buildings including maintenance shops, stores, metallurgical laboratory and staff housing occupy an area of about 35,000 sq.m. The technologies utilized, achieved speed and economy of construction for these visually arresting building.

Due to the large floor area of the buildings, maximum use of natural light and ventilation had to be achieved whilst minimising the cost of construction and maintenance.

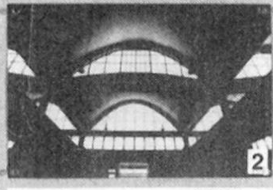
Therefore, it was proposed that concrete structures, both prestressed and R.C.C. be adopted instead of the conventional structural steel. Since column free spaces of 30 m were required for the main wheel and axle plant and the linking assembly shop, precast, prestressed tied arch girders were utilized. These were spaced at 12 m intervals and capped by precast folded plates. For the electrical and mechanical engineering maintenance shops and store buildings, since the span requirement was only 12 m, cast-in-situ conoidal shells, 6.5 cm thick, were used.

Both these structural forms were optimized to achieve maximum use of natural light and ventilation. This was done by correlating the height of tied arch girders, glazing across tied arch girders, height of conoidal shell elements, spacing of shells, glazing area across shells and reflecting interior surfaces of shells. Thus, a pleasant interior environment and saving in energy was achieved without compromising structural economy. The design of the plant also took into consideration the possibility of concrete fatigue due to high ambient temperature generated in the melting shop.

The girders were tested at a load of 240 t, which was 1.25 times their service load. As the rise of the girder at its central point was 5 m, and the load was heavy, the girders were tested horizontally in pairs, with two restraining frames at ends. Jacks with a common power source were used to apply the loads at 11 node points simulating the actual loading conditions.

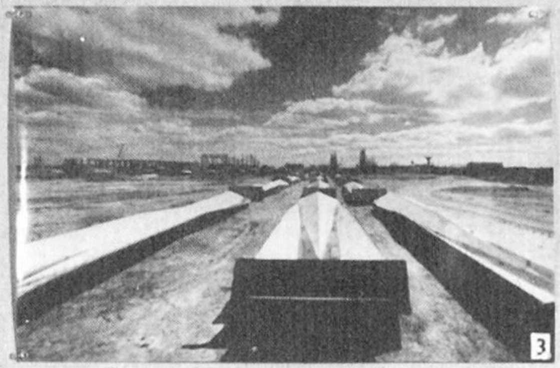
The project represents an optimization of functional requirements, economy of construction and maintenance, aesthetic appeal and conservation of energy, achieved by a complete familiarity with design and construction technologies and by the innovative adaptation of these technologies to the environment.

WHEEL & AXLE PLANT, BANGALORE, INDIA



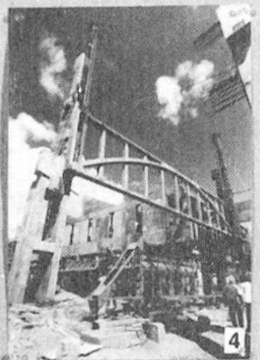
2 Interior view of EME Maintenance Shop with its natural lighting and pleasant environment.

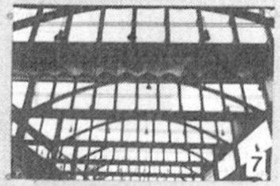
3 Mini precasting factory on site.



One of the largest industrial plants in South Asia. Producing 70,000 wheels and 23,000 axles for the railways. Total area 85,000 sq. m. including main building 51,000 sq. m. and ancillary buildings 35,000 sq.m. Functional requirements and aesthetic appeal achieved by use of precast prestressed tied arch girders, precast folded plate elements, and conoidal shells creating natural lighting and conservation of energy. Design takes into consideration structural economy and concrete fatigue due to high ambient temperatures.

1 EME Maintenance shop. Metallurgical Laboratory in foreground.





4 Lifting 40 T precast prestressed tied arch girder 30 M span.
5 Tied-arch girders erected and in position
6 6 cm thick folded plate element 12 m.
7 Folded plate elements in position

Bhima Aqueduct, Maharashtra, India

C.R. ALIMCHANDANI
Chairman & Manag. Dir.
STUP Consultants Ltd
Bombay, India

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J.S. PADALKAR
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Bhima Aqueduct is part of a major irrigation scheme comprising a gravity dam, reservoir, canals and distributories. The 947 m long aqueduct is designed to carry 42.5 cumecs of water across Bhima, a perennial river in the State of Maharashtra, India.

To maximise hydraulic and structural efficiency, a truncated circular cross section was chosen over the conventional rectangular section. This choice resulted in the following advantages:

- The hydraulic mean radius of the section was increased to 1.43 m compared to 1.0 m in the original design.
- This resulted in a reduced waterway of 13.80 m^2 compared to 18.0 m^2 in the original design, the discharge and slope remaining the same.
- The reduced waterway section decreased the water load by as much as 23 %.
- Transversal effects were reduced mainly to membrane forces easily taken care of by transverse prestressing.

The spans were made continuous over 4 or 5 supports achieving substantial reductions in design moments.

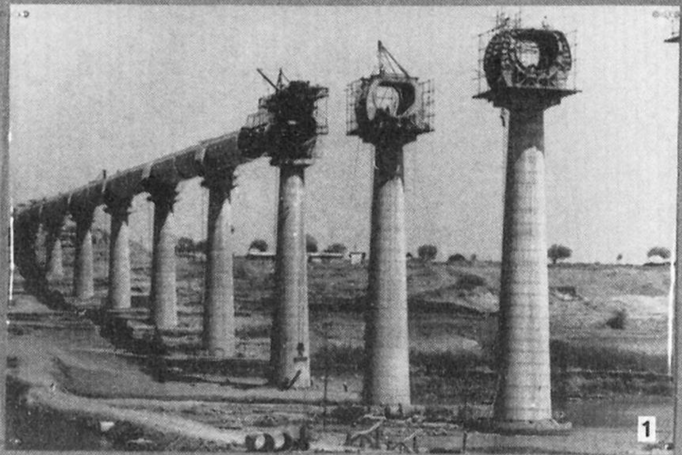
The efficient cross-section, continuity of the structure and use of longitudinal and circumferential prestressing resulted in a reduction of the concrete section by as much as 55 %. This led to a reduction in dead load on the substructure which enabled use of tapering hollow R.C.C. piers filled with plum concrete, instead of solid concrete piers.

The use of scaffolding was not desirable due to the presence of running water and the height of some of the piers which rise to over 40 m. Therefore, the cantilever construction method using precast matchcast voussoirs was applied. The voussoirs in 3.26 m length were produced in a casting yard located at site. Specially designed shuttering was used consisting of trolleys, external side shuttering and internal shuttering. To facilitate early release of voussoirs from the casting yard, 50 % of the transverse prestressing force was applied at the end of 3 days. Special equipment was designed to handle the voussoirs in the casting yard. After curing, the voussoirs are taken to the site and lifted with specially designed cantilever lifting equipment which has cradles to facilitate application of epoxy glue and prestressing force to the aqueduct.

A steel gangway is utilized to shift the cantilever lifting equipment from a completed span to the next span to save the time taken in dismantling shifting and subsequently reassembling the equipment on the next pier. The key segment of 1.9 m length is cast-in-situ for which the shuttering is supported from the already constructed arms of the tube.

This project serves as an example of the application of advanced technology, suitably adapted to the environment, to create an efficient, economical and aesthetically pleasing structure.

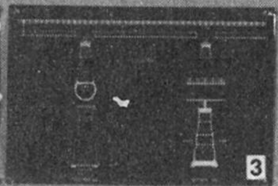
BHIMA AQUEDUCT, MAHARASHTRA, INDIA



42.5 cumecs; 947 m long, 41.5 m continuous spans, 3.75 m roadway. Truncated circular cross section 4.8 m dia. Constructed by cantilever technique using epoxy glued precast matchcast voussoirs prestressed longitudinally and circumferentially.

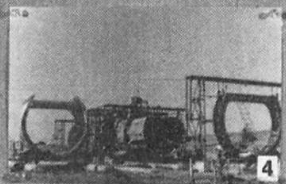
Efficient, economic aesthetic structure integral with environment achieved by appropriate design and specially devised construction techniques and equipments.

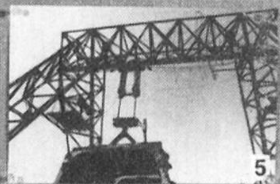
1 Piers with saddles and external diaphragms
—Cast in situ segment on pier-second from right
—Cantilever lifting equipment.



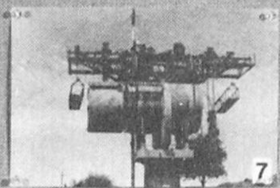
2 Sequence of establishing continuity

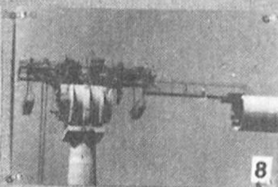
3 Salient dimensions, cross section and longitudinal elevation

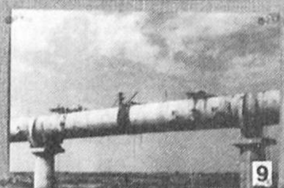




4 Shuttering for Voussoirs Voussoir partially prestressed to release trolley
5 Specially designed equipment for handling voussoirs
6 Stacked Voussoirs







7 Cantilever lifting equipment cradles and walkway
8 External diaphragms at supports. Walkway to transport material
9 Key Joint concreted in situ. Prestressing of continuity cables.

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