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### **POSTER SESSION 6**

**Concrete Structures** 

Structures en béton

Betontragwerke

Coordinator: R.S. Stilwell, Canada

New Column for Tall Reinforced Concrete Buildings

Kiyoshi MUTO, Kuniaki SATO, Satoshi BESSHO Minoru FUKUSHIMA et al. Kajima Corporation Tokyo, Japan

A twenty-five story condominium constructed by Kajima Corp. is the highest reinforced concrete building in Japan, meeting the structural requirements for earthquake resistance. However, demand for the construction of taller buildings, particularly in urban reconstruction, is increasing. Therefore it has become necessary to develop new structural systems, especially a column system applicable to high-rise buildings taking into account earthquake resistance, economy and execution of works.

Now, in the twenty-five story condominium, the special lateral reinforcement which combines a circular spiral hoop and conventional lateral hoop is used. Since the concrete is effectively restrained by this special lateral reinforcement, it was proved that the restoring force is slightly reduced by cyclic lateral loading as shown in Fig.2.

So, for  $30 \sim 40$  story buildings, we have devised a new column system using high-strength concrete, small-size H-shaped steel and special lateral reinforcements, as shown in Fig.1.

And many specimens were tested to investigate the structural characteristics of the column system. The central compressive force was applied to test specimens as shown in Fig.3. As a result of this test, the maximum load capacity and its reduction ratio for the KS-type column compared to the central compressive force are the same or more than those for the conventional H-type column which uses H-shaped steel with a large sectional area.

The bending and shearing force was applied to test specimens as shown in Fig.4. As a result of these tests, the special lateral reinforcement is superior to the conventional lateral reinforcement on the capacity of restoring force after the maximum load. And the load capacity and ductility of this column are sufficient performance comparing with the conventional column under high compressive or tensile axial load. In addition, this new column has restoring characteristics regardless of the internal H-shaped steel load direction.

As a result of our research, design range of the column has been setting up like Fig.5. And the construction of economical forty-story buildings has been made possible.

#### **NEW COLUMN FOR TALL REINFORCED CONCRETE BUILDINGS** BACKGROUND **DESIGN** RESEARCH AND DEVELOPMENT Ultimate design strength conventional 15cm In Japan, demand for the construction calculated by AIJ code (large H-shaped steel) special 1conventional of 30~40 story condominium is growing. Design range of newly 15cm 150 n=0.70 devised column So it has become necessary to develop tonf Ultimate strength of new column system taking into account reinforced concrete column 2100 calculated by ACI code earthouake resistance, economy and 450 S n=0.3 Design range of special execution of works. 50 reinforced concrete colum 50-8 A1+A2 A1 M (t-m) 2×300 spiral hoop N õ 0.5 1.5 2 -= = [00 A.F. Fig.3 Axial Loading Tests square hoop Equivalent sectional area 03 of concrete (I) 200 N=O $A_n = BD + (n - 1 + A + A)$ high-strength concrete compression N=0.52F.BD F. Concrete design strength N= 1.05F.BD 150 Fig.5 Design ange of Coumn ۵. small-size H-shaped steel 100 N=-0.45F.BD Fig.1 Newly Devised Column 50 F.= 360kgf/cm2 . B= D= 35cm special lateral 2./D=2.86 R=s/0. Restoring 00 08 00 reinforcement 10 20 30 40 KS Type) -R(x10-3rad) strong axial biaxial weak axial conventional latera loading loading loading reinforcement special conventional of I 40 (H Type) I I Reduction For at 200 200 R=1/100rad 20 2150 150 0 O 5 10 15 20 25 /Fc=300kgf/cm2 . B=D=40cm 1100 a 100 an example of analytical Number of Loading Cycles N=0.4F.BD 50 deformation magnified one 50 Fig.2 R=8/Q . Q/D=3.25 2/2 hundred times Effects of Special Lateral Reinforcements 20 Ő 10 30 40 30 40 10 20 0 Fig.6 Perspective of First Building ~ R(× 10-3rad) on Restoring Force for Cyclic Loading Fig.4 Bending and Shear Tests under Constant Axial Load in which System to be Applied

VI – POSTERS

### **Cable Stays for Bridges**

### H. SCHAMBECK

Civil Eng. Dyckerhoff & Widmann München, FR Germany

### DYWIDAG POSTTENSIONING SYSTEMS

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### DYWIDAG CABLES

Cable type Performance	STRAND CABLE	BAR CABLE					
LOAD BEARING 1 CABLE (Static+Dynamic)	STRAND (7-wire stress-relieved) Grade St 1570/1770 Diameter 0,6" (Low relaxation)	THREADED BARS STEEL TUBES Grade St 835/1030 Grade St 37 Dia. 32, 36 mm (DIN 17100)					
2 ANCHORAGE Static Dynamic Bending	WEDGE ANCHORAGE Combined WEDGE+BOND ANCHOR STEEL TUBES	NUT ANCHORAGE BOND ANCHORAGE STEEL TUBES					
CORROSION PROTECTION	Multiple anti-corrosion barriers to m eg SHEATHING, GROUT, COATING OF STRANDS etc	eet different requirements eg STEEL TUBES, GROUT etc					
PRESTRESSING	SINGLE and MULTIPLE STRAND-JACKS	SINGLE BAR-JACKS					
CABLE ERECTION	Different procedures to fit into various construction demands eg Erection on site, Prefabrication						
ADDITIONAL FEATURES	FULLY REPLACABLE ADJUSTABLE before and after grouting	REPLACABLE ADJUSTABLE before grouting					

## CABLE STAYS FOR BRIDGES



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### Rehabilitation of Post-Tensioned Bridge Deck

Klaus H. OSTENFELD	Leif JONSEN						
Head of Bridge Dep.	Chief Bridge Eng.						
Cowiconsult	Cowiconsult						

Virum, Denmark

Virum, Denmark

The bridge was constructed in 1967 and hereafter regular routine inspections were carried out. In 1981 a major examination took place. Larger zones of deteriorated concrete were found in one of the cantilevered flanges, especially in areas near the abutments.

The bridge deck surface has a cross slope of 6% and consequently damage had only taken place in the lower cantilever, and fortunately not in the central part of the girder where the longitudinal main tendons are positioned. This distribution of the damage made repair possible. A full replacement of the superstructure would have resulted in an expenditure of more than 250% of the repair cost and almost total closure of one of the major motorways in Denmark.

The deterioration had started due to a leak in the waterproofing membrane. Unfortunately, the underneath concrete was not resistant against alkaline reactions.

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After removal of the bridge deck pavement and water proofing, the deteriorated areas were surveyed by core drilling.

The deteriorated concrete was removed, however, in such a way that the reinforcement and prestressing tendons were not harmed. In this context it was very important that the transverse prestressing in the cantilevers could be reestablished. The transverse prestressing tendons consist of 12 dia. 5 mm wires. In order to protect these wires, the original sheath and grout were not removed until just before the new sheathing was ready to be installed. As it can be seen from the original transverse tendon arrangement, it was not possible to reuse the existing anchorages.

A new system was developed by Skandinavisk Spændbeton. A simple bar anchorage with thread and nut was connected to the wires. The details are shown on the poster. After casting the deck the wires were re-stressed and grouted.

Due to the repair work the longitudinal prestressing forces were lost in the cantilever. Consequently, it was necessary to place some additional ordinary reinforcement in the longitudinal direction, especially at the end of the bridge deck.

# **REHABILITATION OF POST-TENSIONED BRIDGE DECK**



Wind Structure Interaction on 235 m Tall RCC TV Tower in Delhi

H.R. VISWANATH, B.R. NIRMALA, H.R. Surya PRAKASH Bangalore University Bangalore, India

All India Radio has started the construction of an RCC TV tower, the first of its kind in India, 235 M height with revolving restaurant and viewing gallery at top, in the North - West suburban parts of Delhi, surrounded by industrial and residential area.

In connection with the above design Indian Meteorological Department (IMD) was requested to undertake analysis of surface and pilot baloon winds at Delhi air-port, to obtain wind escalation law. Utilising available surface upper wind and temperature data spread over long periods, IMD obtained the extreme values of wind and return period with different confidence limits. IMD further corrolated the IS code wind figures with the extreme values obtained by their study, indicating the probabilities of occurance of tornado and storms with return period, by determining maximum wind causing collapse of the structure.

The highest wind value recorded was 159 km/h in 1960. Wind speed for return period 100 years was determined at 175 km/h. For this, with confidence level (95%) and correction (31) wind speed was obtained as 206 km/h for the design. Since Delhi was affected by severetornado in 1978 with damaging wind speed of 250 km/h, the value of the power law co-efficient was worked out to be 1/9 under unstable and neutral conditions and 1/3 for stable conditions.

The power-law co-efficient 1/7 suitable for the change of gust speed with height was used for deriving wind profile.

Wind profile and a few structural details of pile cap, shaft and mast of this unique tower are shown in the photograph.





VI - POSTERS

**Continuous Reinforced Concrete Pavement on Bridges** 

**Ch. Van BEGIN** Civil Eng. Public Works Ministry, Bridges Office Brussels, Belgium

Continuous reinforced concrete pavement is widely used in Belgium since 1970. It consists of a 20 cm thick slab lying on an adequate fundation.

The longer the segments are, without transversal joints, the better. It is therefore very useful to pass over the under bridges and to avoid expansion joints.

The problem is important in Belgium because of the high density of the highway network and the short intervals between bridges.

Small frame bridges (10-20 m span) can be overpassed without problem.

More complex is the case of bridges with precast guirders, the pavement lying on the deck slab with a friction interface.

The last evolution is to use the pavement as bridge slab, supported on the superstructure frame by "neopreen" bearings. Steel beams are incorporated in the pavement.

The main problems are :

- behaviour of the pavement between the embankments, behind the abutments, and the bridge (differential settling)
- interaction between pavement and bridge deck (deflection, expansion)

1400 Km continuous reinforced concrete pavement (2 ways) are in service in Belgium. The longest bridge overpassed is 136 m long and the greatest span is 65 m long.



# **CONTINUOUS REINFORCED CONCRETE PAVEMENT ON BRIDGES**

#### Saudi Arabia - Bahrain Causeway

D.W. BILDERBEEK **K.B. SVENSSON** Civil Eng. Civil Eng. Ballast Nedam Groep Ballast Nedam Groep Amstelveen, the Netherlands Amstelveen, the Netherlands General The Causeway incorporates 5 bridges and 7 embankments. The superstructure of the bridges consists of 2 separate boxgirders, each 12,3 m wide, prestressed in both longitudinal and transverse direction. The bridges have a spanlength of 50 m and are constructed as a "Gerber" structure: alternatively cantilever girders of 66 m and drop in spans (suspende girders) of 34 m. Both cantilever and suspended girders have been prefabricated on shore and are placed in position as a complete unit. The substructure consists of prefabricated hollow prestressed piles with an outer diameter of 3,5 m. Bridge no. 5 has been founded on caissons due to the presence of an aquifer. Bridge no. 3 incorporates the main navigation span. This navigation span has been constructed in accordance with the prefabricated segmental system. Spanlengths: 80-150-80 m. The cast in situ piers rest on direct foundations. Durability Special measures have been taken because of the very aggressive environment: Blast furnace Portland cement (slag content 70-80%) has been used. This cement has a high sulphate resistance and a hight impermeability. A max Cl ion content of 0,1% by weight of cement has been prescribed for the concrete. As a result the sand, dredged from the sea, had to be washed extensively. - Cover to the rebar for the piles 70 mm, for the superstructure 50 mm. - The piles have been epoxy coated from -2,0 CD to +4,0 CD (splash zone). Design criteria In accordance with AASHTO, with some exceptions regarding the loading: lane loads : 10 kN/m' lane. : 2 trucks, one of 600 kN and one of 300 kN. trucks - future pipeline : 10 kN/m', situated 4,5 m outside centre line of bridge : static load consisting of 6% of the permanent vertical load. earthquake : -56000 kN on each of the two mainspan piers. - ship collision -28000 kN on each of the side piers of the mainspan. -varying load of 300-1000 kN for the piers adjacent to navigation spans. Materials  $f_c = 40 \text{ N/mm}^2$  for prefabricated part of halving joint.  $f_c = 35 \text{ N/mm}^2$  for all structural elements. : Concrete quality : Fe B 400 and Fe B 500 (f  $_{\rm y}$  = 400 N/mm<sup>2</sup> and 500 N/mm<sup>2</sup> Reinforcement steel respectively) : Longitudinal prestressing, consisting of BBR CONA-MULTI 0,62" strands:  $f_{pu} = 1770 \text{ N/mm}^2$ . Prestressing steel Transverse prestressing, consisting of BBRV 7 mm wires:  $f_{pu} = 1670 \text{ N/mm}^2$ . Inclined Dywidag bars in halving joints  $f_{pu} = 1035 \text{ N/mm}^2$ 

### Soil conditions

- sea bottom 4.00 to 12.00 minus CD.

- top layer of caprock 0.00 3.00 m thick.
- soft soil (sand/clay) 2.00 8.00 m thick.
- soft rock of claystone/siltstone.



# SAUDI ARABIA-BAHRAIN CAUSEWAY

### Wolfgang KRUGER

Prof. Dr., TU Dresden, Dresden, DDR



Honshu-Shikoku Bridge Authority, Tokyo, Japan



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### M. MARCHETTI

Dragages et Travaux Publics, Puteaux, France

### PONTS DU ROI TAKSIN-BANGKOK, THAILAND **CARACTERISTIQUES DES OUVRAGES** OUVRAGE EN RIVIERE Beux tabliers parallèles = \_ longueur 224.00 m \_ largeur 13.25 m Parties 66.00m \_ 92.00m \_ 66.00m VIADUCS D'ACCES 4 ouvrages = \_ longueur 305.00 m \_ largeur 11.51m Portées courantes = 45.00 m **VIADUCS D'ACCES** RIVIERE **OUVRAGE EN** ZRANG TTO \$1406 C. TTE -TTYN ITTE ITTE 100 L-TTT TIT CTT tint a. -