THE HYSTERETIC BEHAVIOUR OF THE PRECAST PRESTRESSED CONCRETE FRAMES TO THE ALTERNATING LATERAL LOADS

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SUMMARY

For the determination of the resistance, deformability and structural ductility of a lightweight concrete frame, made up precast elements (prestressed with adherent strands), assembled by general prestressing, both vertical and horizontal, two models of "closed" frames were experimented to alternating lateral loads.

The results are expressed in terms which define the structural ductility of the frame and the sectional ductility of the component elements (girders and columns), respectively the girder-girder and column-column connections.

The final remarks refer to the building of the prestressed frames assembled by prestressing outside the joints in order to obtain the expected response to the seismic loads.

1. EXPERIMENTAL FRAMES AND TESTING WAYS

According to the romanian standards of semiprobabilistic calculus (level 2), refering to resistance, stability and structural ductility, it was conceived the resistance structure for an industrial three-storeyed hall (P+3E), situated in a high seismic area. This is made up of spacial elements of lightweight prestressed concrete with adherent strands which are assembled both vertical and horizontal with gross bars, respectively with post-tensioned tendons; details about the structural system using outside joints connections, achieved by the straight passing of the post-tensioned tendons are given in /1/; the seismic design is based on static-dynamic method.

The research was made on two models (1/3) of "closed" frames, similar to a reticular frame which delineate the girder-girder and column-column connections, "fig. 1a, b."

In order a) to apply the energy conception of verification of the structural performances to alternating lateral loads, and b) to determine the sensitiveness of the component elements (girders and columns), respectively the prestressed connections to nature of the sectional efforts that appear in the loading history of the structure, it was adopted the loading diagram presented in the "fig. 1c, d".

The component elements are made up from lightweight concrete with f'_c=39 N/mm^2; the adherent strands have R_r=188o N/mm^2 (3Ø3 SBP.I), and the tendons made up of wires SBP I Ø2,5 mm, having R_r=195o N/mm^2; the PC 6o have $R_{0.2}$=44o N/mm^2.

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2. RESULTS

There were measured strains in the characteristic concrete fibres necessary to the establishment of the sectional ductility factor (μ_θ, respectively μ_ϕ) in 2-2, respectively in A and B. The primary results are given in the "fig.2,3,4". The response of the model in its lateral displacement is shown in "fig.5"; the model aspect after its failure is shown in "fig.6".

Definying the structural ductility $\mu_\Delta = \Delta_{max}/\Delta_{crack.} = 9.6$, and equalizing the deformation-energies for elastic system and elasto-plastic system (T=o.3...2 sec) one can get to the reduction factor of the response $k_e = S_p/S_e = 1/\sqrt{2\mu_\Delta - 1} = 0.23$; this value is achieved in a great measure on the grounds of the plastic deformations in A (the transition zone).

For the system from /1/, this effect can be advantageous, because the precast floor obteined from the rib two-directions prestressed slabs, supported over the contour, oblige the zones of the 2-2 type to support suplimentary loads after the formation of the plastic hinges in the girder span.

3. FINAL REMARKS

Structural ductility corresponding the formation of the plastic hinges in the girder span is sufficiently; by a more careful making of the transition zones we can limit the damage near the joints, to secure the prestressing conservation.

The energy dissipated by elastic deformations, before the cracking is reduced as compared with that one dissipated by hysteresis; viscous damping is 1.5% before the prestressed concrete cracking, and after the cracking, the hysteretic damping increase up to 4%, in the conditions of the stable structural deformations.

Paying attention to the girder-girder connections by the working up of the connection surfaces with the teeth shear and by the extending of the non-pretensioned reinforcement to outside, towards the upper surface of the girder, to weld with that which is provided for stressed zone of the intermediary element, we can assure both the local strain control and the structural response.

REFERENCES

/1/ Negoiţă Al., Hobjilă V., 1979, The Seismic Analysis, Theoretical and Experimental, of the Joints of Prestressed Concrete Frames, Bulletin d'information CEB, 132 Bis, 9 pages

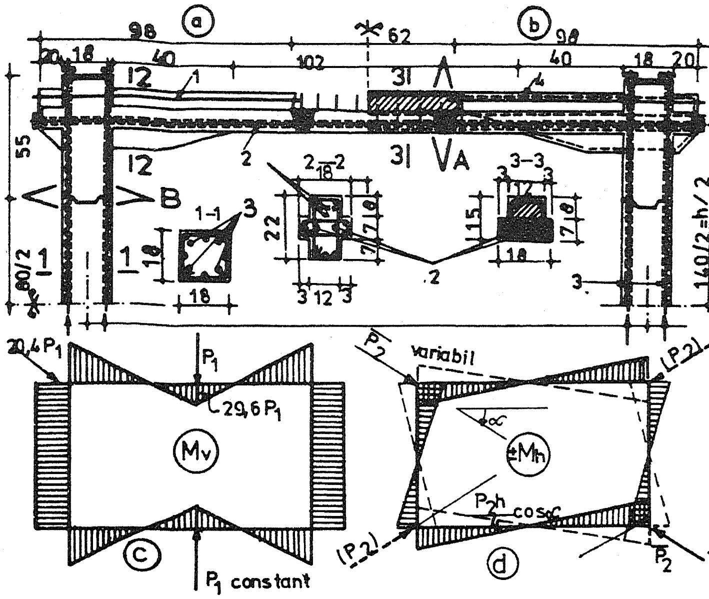

Fig. 1 Geometric characteristics and load diagram; a) assembly phase; b) service phase; c) vertical constant load; d) alternating variable load

1-adherent strand; 2,3-post-tensioned tendon, respectively gross bar; 4- non-pretensioned reinforcement;A,B- girder-girder and column-column connections.

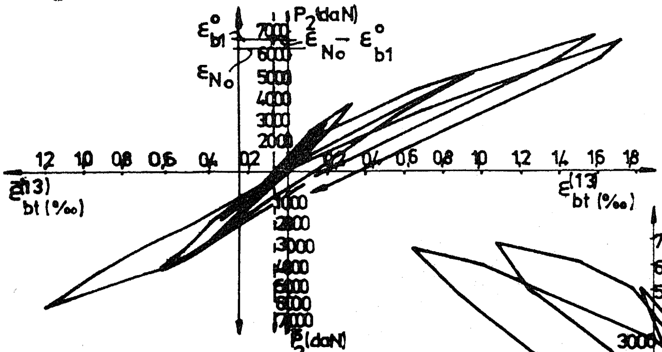

Fig.2 P_2- ε_{bt} relationship for adjacent concrete fibre to adherent strand.

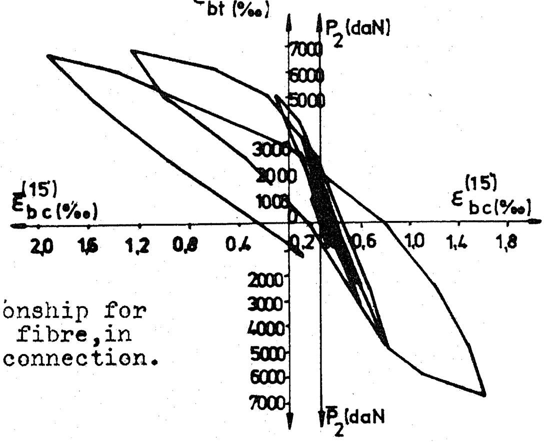

Fig.3 P_2- ε_{bc} relationship for upper concrete fibre,in girder-girder connection.

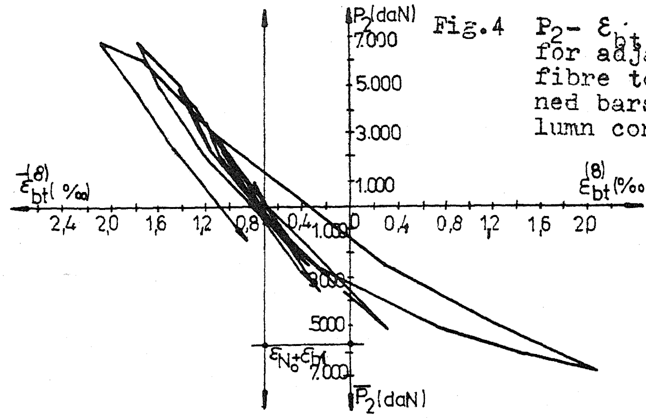

Fig.4 $P_2 - \varepsilon_{bt}'$ relationship for adjacent concrete fibre to post-tensioned bars, in column-column connection.

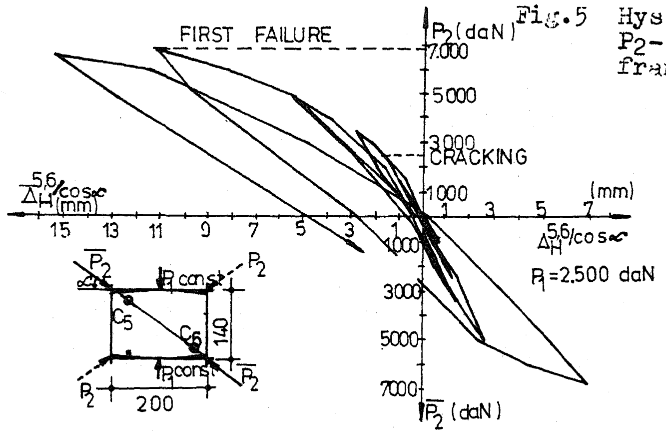

Fig.5 Hysteretic curves $P_2 - \Delta_H/\cos\alpha$ for model frame " C1".

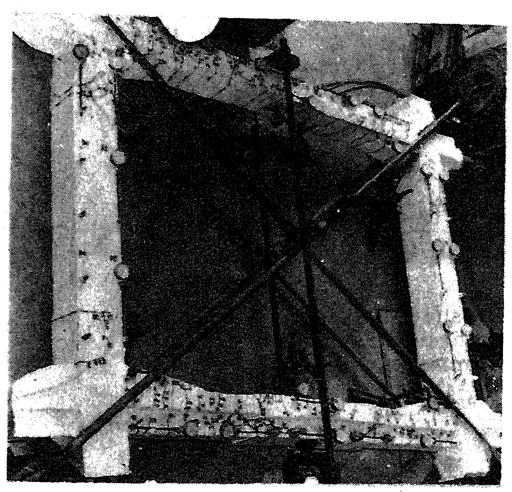

Fig.6 Aspect of the model frame at ultimate load.