Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 60 (1990)

Artikel: Composite shells for Television Tower Prague

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DOI: https://doi.org/10.5169/seals-46557

Composite Shells for Television Tower Prague

Voile mince mixte pour la tour de télévision à Prague

Verbundschalen für den Fernsehturm Prag

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SUMMARY

This paper deals with the design of composite shells for the Television Tower Prague. Shells have been created from contact moulded polyester Glass Fibre Reinforced laminate. Response to wind loading has been analyzed by the finite element method.

RÉSUMÉ

Cet article donne un aperçu du projet des voiles minces pour la tour de télévision à Prague. Ces voiles minces ont été fabriqués par moulage de stratifiés de polymère. Leur réaction sous charge due au vent a été calculée par la méthode des éléments finis.

ZUSAMMENFASSUNG

In diesem Beitrag wird ein Überblick über das Projekt des Fernsehturms in Prag gegeben. Die Schalen wurden aus Polymerkompositen hergestellt. Die Beanspruchung aus der Windbelastung wurde mit der Methode der Finite Elemente berechnet.

1. INTRODUCTION

TV Tower Prague is nowadays under construction in Prague 3, Mahler Gardens. The structure of TV Tower is 216 m high and consist of three steel cylinders of 4.8 and 6.4 m with internal liner from concrete /fig.1/.

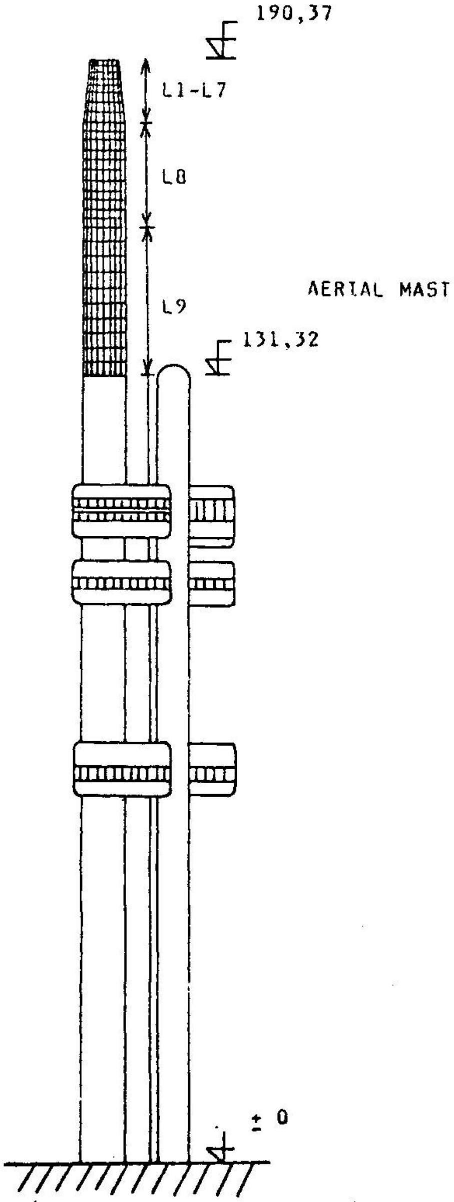


Fig. 1 TV Tower Prague - scheme

The highest part of TV Tower, aerial mast, which is about 60 m long, will be covered by composite shells of special form /Fig.2/. Shape of the shells is determined by the demands on transmission of electro-magnetic waves and by stiffness needs.
GRP covers then consist of 9 shell types of different shape and support. Shells are joined to steel cylinder of aerial mast by filament-wound beams and created by contact moulded method from polyester resin Viapal H 452 EMT, with gel-coat resin Viapal 920B/9010.

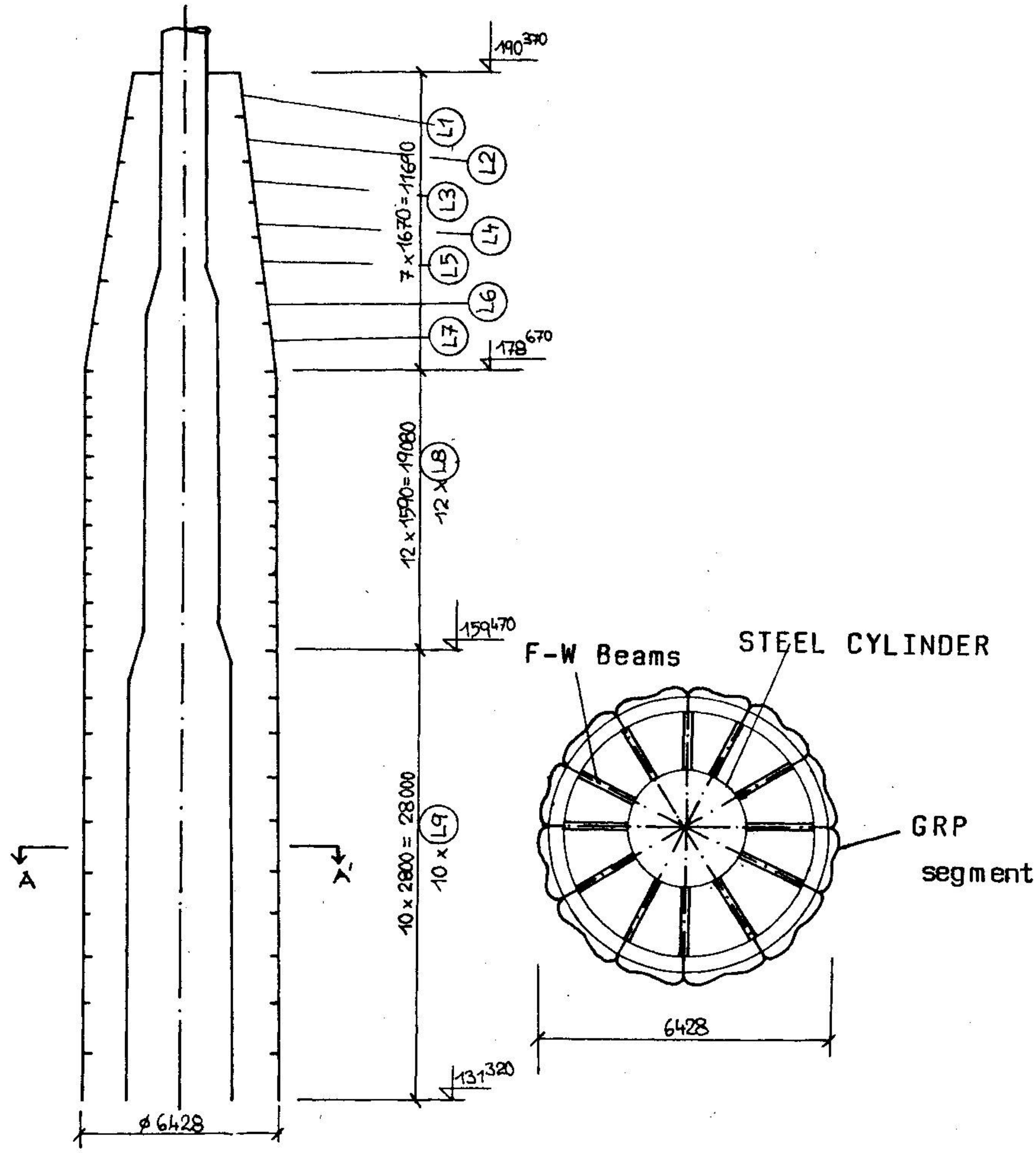


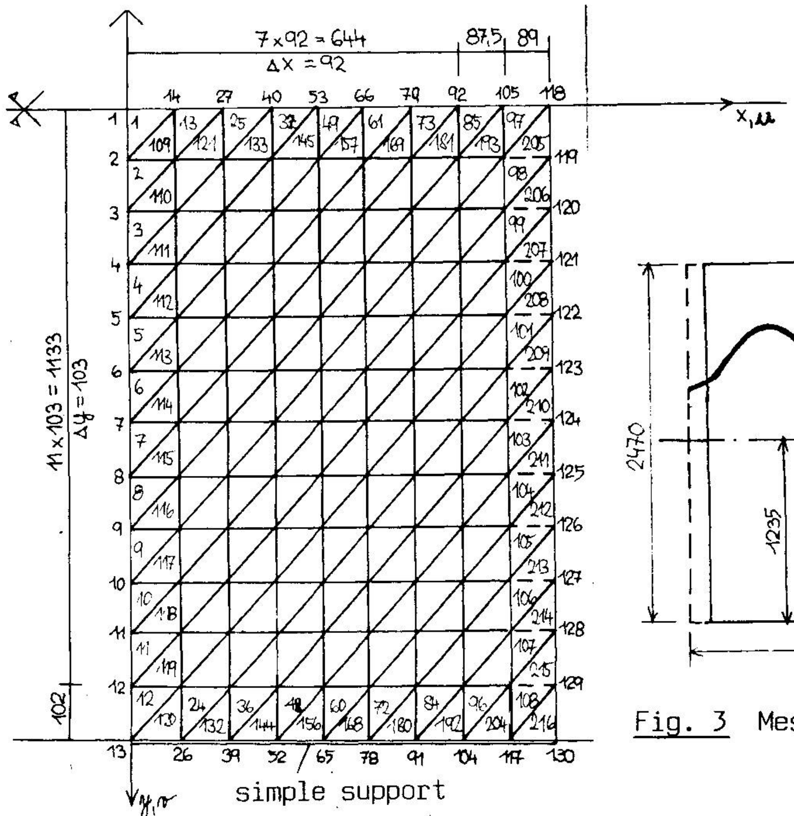
Fig. 2 Aerial mast.

2. ANALYSIS OF COMPOSITE SHELLS FOR TV TOWER BY THE FINITE ELEMENT METHOD

Regarding the complex form of shells the analysis has been done numerically by the finite element method.

The loads considered were static and dynamic part of wind pressure, dead load and thermal load. Shape of shell has been approximated by flat shell triangular elements, which has been recently developped /1/. Bending part of stiffness matrix is obtained from Mindlin bending theory of plates introducing Kirchhoff hypothesis along the element boundary, membrane part includes drilling freedoms what enables good accurary of resulting internal forces.

The displacements, rotations and internal forces, bending moments for shells L1 - L9 have been calculated. Some results of static response of structure on wind pressure are presented below (wind velocity up to 200 $km.h^{-1}$). The shell L9, one of shells constructed over cylinder is simply supported along line sides. Mesh of elements and some results are shown in Fig. 3 and 4.



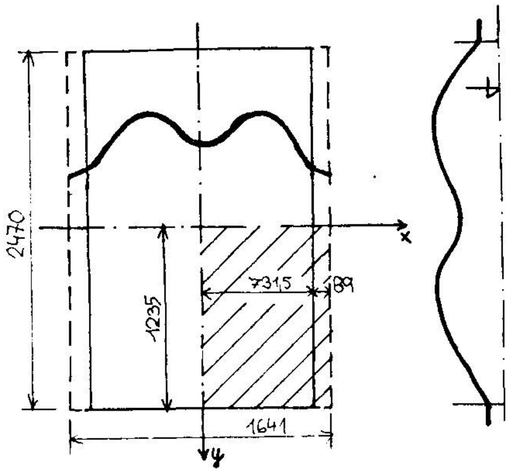


Fig. 3 Mesh of elements

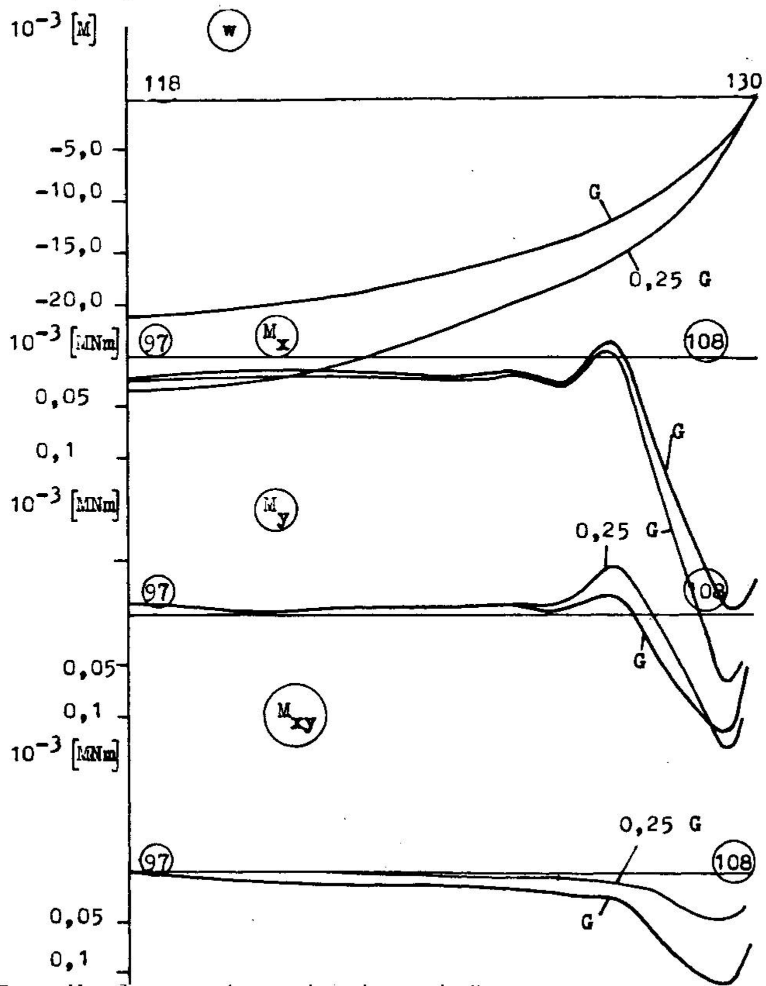


Fig. 4 Shell L9 - displacements and internal forces

3. DESIGN OF SHELL SEGMENTS ON LIMIT STATES

Shells are designed on ultimate limit state corresponding to rupture caused by exceeding the ultimate strength [3].

Results of stresses

Element N°	N_x [MN]	M_y [MNm]	$\lvert\sigma^{t}\rvert$ [MPa]	$\lvert\sigma^{b}\rvert$ [MPa]	$\lvert\sigma\rvert$ [MPa]
61	$-0,5200.10^{-1}$	$-0,1117.10^{-3}$	7,76	14,9	22,66
108	$0,3475.10^{-1}$	$0,1832.10^{-3}$	5,19	24,49	29,68

The condition of reliability then can be formulated in terms of stress [4].

$$\sum \sigma_j(t) \leq \gamma_R \cdot \gamma_t \frac{1}{\gamma_{sR}} R^n$$

where γ_i are material coefficients
R^n is characteristic strength

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