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Full Scale Test of Transmission Towers: Ultimate Strength

Détermination de la résistance ultime de pylônes à haute tension à l'aide d'essais

Grossversuch zur Bestimmung des Tragwiderstandes von Hochspannungsmasten

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1.INTRODUCTION

The construction of Ultra High Voltage transmission towers (Voltage: 1,000kv, Height: 100-150meters, Weight: 200-800tons/a tower) is one of the most noticeable projects in Japan. It is extremely important to confirm its ultimate strength and aseismic security considering the social influence. This study quantitatively clarifies how the slenderness ratios and the eccentricity ratios caused by the bending moments of the members contribute to the ultimate strength through the static loading test of a full scale tower shown in Fig.1.

2.EXPERIMENTAL RESULTS

The following items were drawn from the experiment under the lateral loadings (wind load) and the vertical loadings (snow load, conductor load) on a full scale tower.

2.1 Load-Deflection Characteristics

-The load-deflection characteristics of the bolted joints were modeled considering the factors such as the slip-load (Ps) and the bolt-clearance (δs) shown in Fig.2.
-The deformation capacity of the tower was influenced by the slip deflections of the bolted joints.

2.2 Ultimate Strength

-The relations between the buckling strength and the slenderness ratios (λ) and the eccentricity ratios (m) of the members were regulared as shown in Eq.(1),(2),Fig.3 through the static loading tests of the members.

$$Ncr = \pi^2 E/\lambda^2 \cdot [1 - \{(Ncr-0.8Ny)/0.2Ny\}^2] \quad (1)$$

$$Ncr/Ny = 2/\pi \cdot COS^{-1}(Mcr/Mp) \quad e = Mcr/Ncr,\ m = eD/2i^2 \quad (2)$$

-The method of estimating the ultimate strength of the towers using the buckling curve (Eq.(1)) and the yield curved surface (Eq.(2)) was established.
-The full scale tower collapsed at the end of lower column member shown in Fig.4, and the ultimate strength was in good agreement with the estimated strength and its value was more than 1.5 times the short-term design load (Po).

-The lowering of the ultimate strength by the bending moments was 0.05 Ny.

3.CONCLUSION

The accuracy of the estimating method on the ultimate strength was proved through this study. We are now pushing on application this way to the design method.

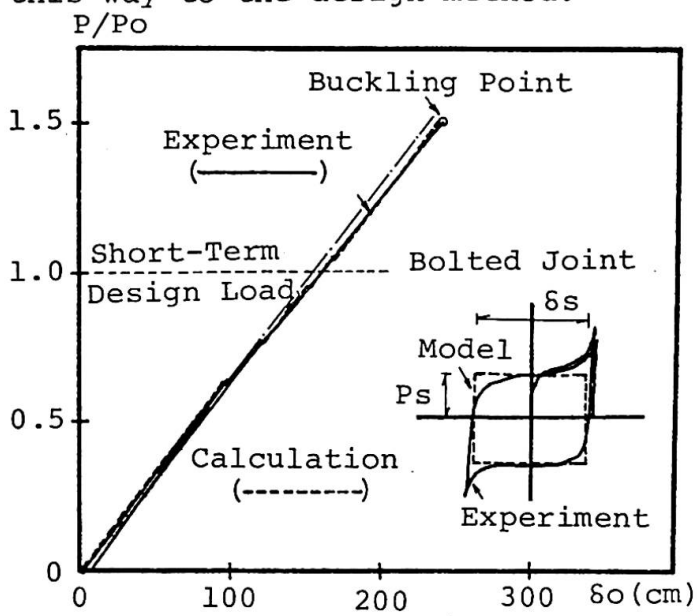

Fig.2 Load-Deflection Relationships

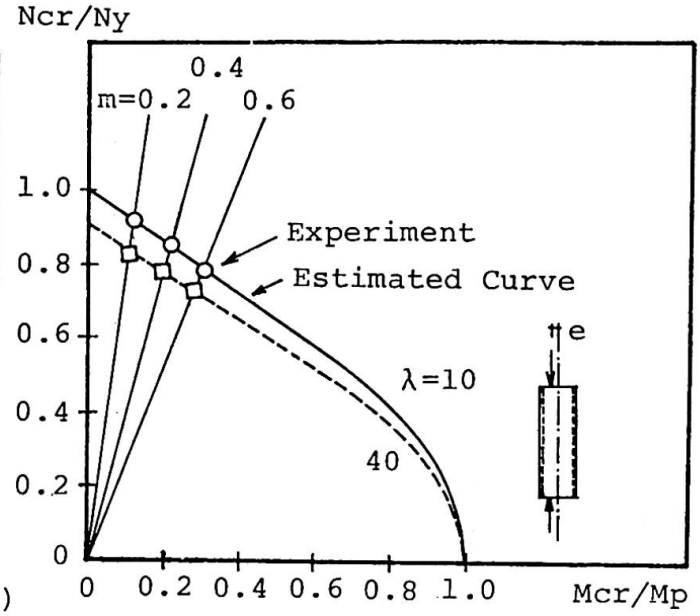

Fig.3 Ncr/Ny-Mcr/Mp Relationships

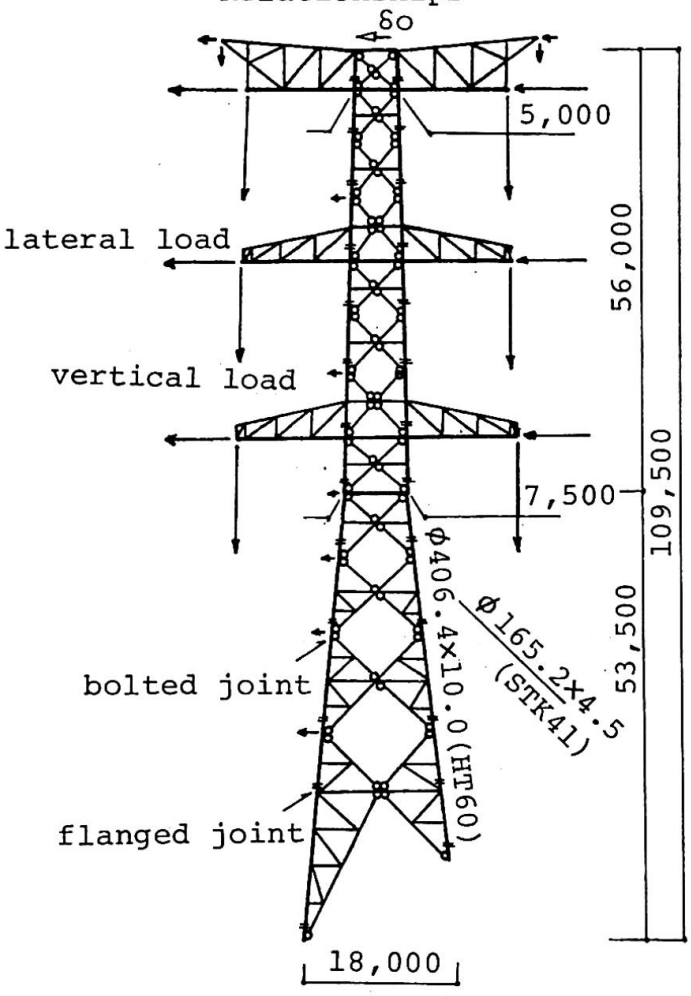

Fig.1 Structual Drawing