Establishment of "Recommendations for Wind Loads on Transmission Towers (2005)" − Development of Simplified Method on Equivalent Static Wind Loads and Design Support Tools −

Background

After the attack of typhoon 19 in September, 1991, which caused damage to some power transmission towers, CRIEPI held the "Local wind resistant design committee" (FY1992-FY1998) and "Wind resistant rationalization committee" (from FY1999 to FY2001)" and provided "Recommendations for wind load on transmission towers - a draft" in June 2002. This introduced the directional design wind speeds and equivalent static wind loads considering the dynamic effects of tower and conductor. However, this recommendation had the problem that wind load evaluation is more complicated than the current design standards and advanced knowledge is needed to set the design conditions. Therefore, the improvement of use was indispensable to apply this recommendation to practical design. Based on this recognition, CRIEPI organized the "Practical wind resistant design committee" and performed the development of simplified load evaluation method and design support tools.

Objectives

The purpose is to establish "Recommendations for wind loads on transmission towers (2005)" on the basis of the research result regarding the improvement of estimation method for design wind speed, the expansion of coverage of wind loads and the development of simplified wind loads evaluation method.

Principal results

1. Improvement of estimation method for design wind speed

In the design wind speed estimation study, we devised the new directional basic wind speed maps by diminishing the effects of the roughness change from sea to land (Figure 1). We also developed the objective roughness category evaluation method by using land use data and the simplified prediction method of topographical speed-up ratio based on the numerical results of speed-up ratio to the two dimensional escarpments with each slope angle (Figure 2).

2. Establishment of recommendation

Reflecting the above results and considering the practical design, we established "Recommendations for wind loads on transmission towers (2005)" as a revised edition of "Recommendations for wind loads on transmission towers - a draft". The improvement in this revision is the ability to select the design method by introducing the simplified wind loads estimation method for which current design software is available (Figure 3). The concepts of the simplified method are as follows;

① The maximum value of the directional design wind speed is used for the design wind speed of simplified method.

② Several tables of the mean wind pressure value and gust effect factors needed for calculation of the wind loads are provided as a function of design wind speed. Also, the non-simultaneity reduction coefficients corresponding to each tower type were given with the constant.

③ 0 degree, 60 degree, 90 degree directions to longitudinal direction are used.

3. Development of design support tools and numerical simulation codes

To contribute to reduction of design work, we developed the design support tools (①Reading tool of directional basic wind speeds, ②Roughness category evaluation support tool, ③Prediction tool of wind speed-up ratio by topography, ④Equivalent static wind load calculation tool (detailed method/simplified method) (Figure 4), which conformed to "Recommendations for wind loads on transmission towers (2005)". Also, the numerical simulation codes (①Air flow simulation code, ②Dynamic response analysis code) were upgraded for practical use.

Main researcher: Tomomi Ishikawa,
Research Engineer, Structural Engineering Sector, Civil Engineering Research Laboratory (E-mail: iskw@criepi.denken.or.jp)

Reference

Ishikawa, T. et al., 2003, "Evaluation techniques of wind load and gust response for overhead transmission lines" CRIEPI review No.48, (in Japanese)

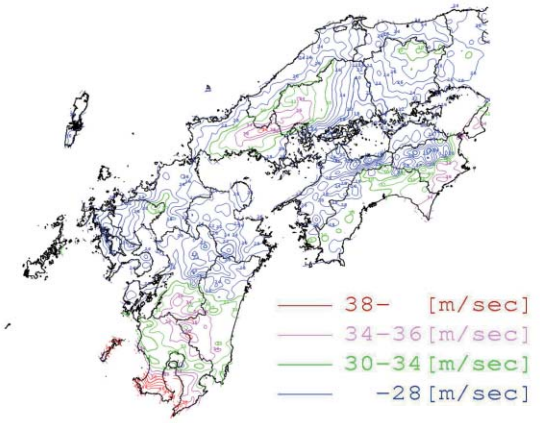


Fig.1 Directional basic wind speed map (South wind, high temperature season)

We devised the new directional basic wind speed maps by diminishing the effects of the roughness change from sea to land.

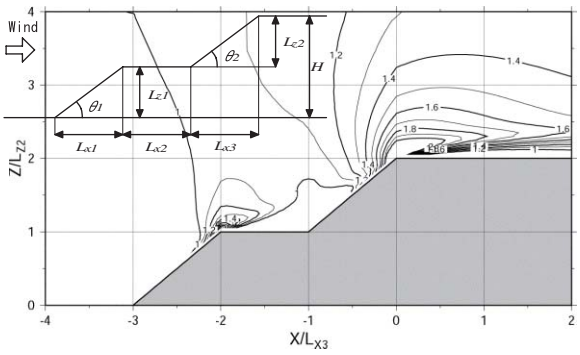


Fig.2 An example of speed-up ratio over 2-dimensional escarpment

We developed the simplified prediction method of topographical speed-up ratio based on the numerical results of speed-up ratio to the two dimensional escarpments with each slope angle.

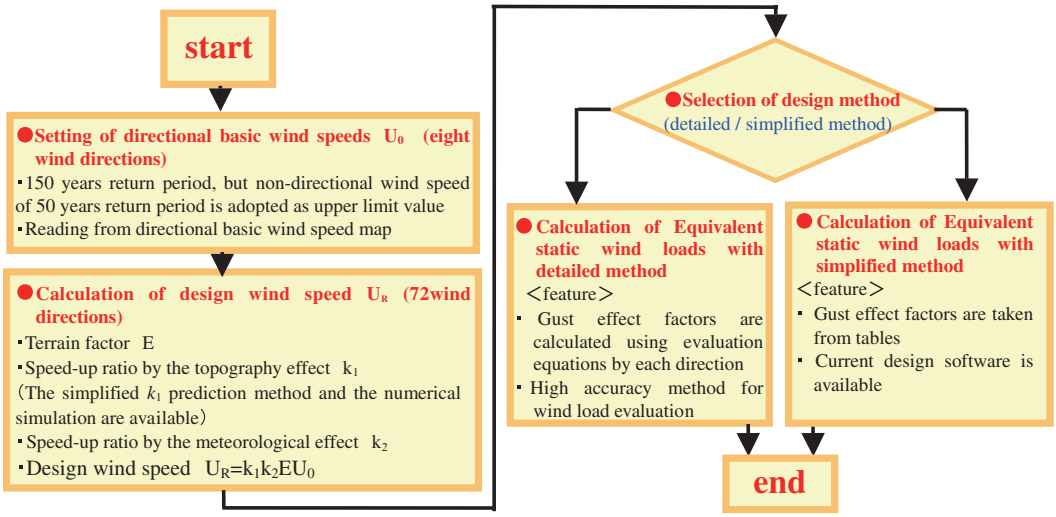
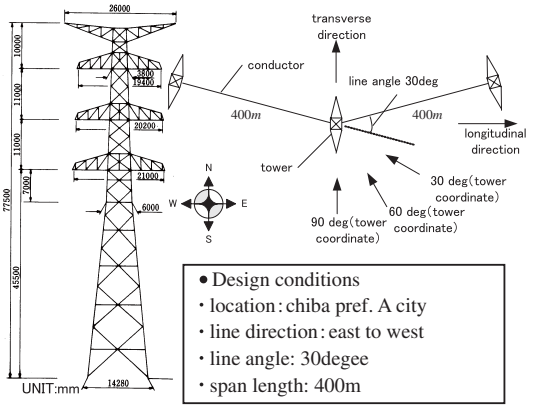
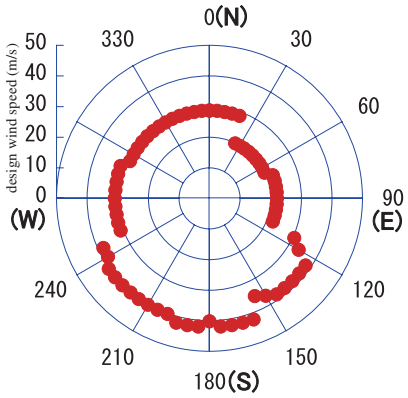


Fig.3 Flowchart of evaluation of wind loads

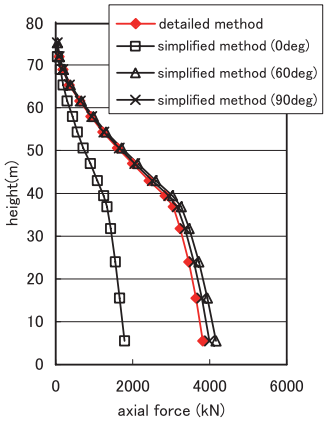
We improved the currently used equivalent static wind load so that this can be used for standard 2 cct, 4 cct and terminal towers. Also, we constructed the simple wind loads estimation method for which current design software is available by providing several tables of the mean wind pressure values and gust effect factors.



【Analysis model (500kV, tension tower)】



【Design wind speed】



【Axial forces on main leg members】

Fig.4 Design support tools

We presented design support tools that are able to calculate the design wind speeds, equivalent static wind loads (the detailed method, simplified method) and load effect on structural members in terms of each wind direction based on the proposed guideline automatically.