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QUESTION N° : 1.7

B2-10629 Latest Design Standard on Structures for Overhead Transmission Lines in Japan

Two papers (B2-10629 & B2-10974) highlight adoption of new criteria and methodologies for design of overhead lines. B2-10629 describes revised design standard for overhead line structures being considered for adoption in Japan. It covers specific criteria & special design aspects incorporated in the standard keeping in view line failures & previous natural disaster experiences. Paper B2-10974 covers study of changes in design ice loads in Norway due to climate change and future predictions for consideration in design of OHL
Question 1.7 : B2-10629 presents new standard criteria for overhead line design in Japan inter-alia proposing use of directional basic wind maps, seismic design aspects etc. Could the authors explain how these criteria would be actually used for new line construction? Whether tower at each location would be designed differently depending upon wind speed & its direction or optimum utilization of standard designs shall be done during spotting of towers considering directional wind maps & topography? Also, would the experts for other countries/utilities share information regarding consideration of seismic loads in design of towers?

A1.7: Design process by JEC-5101 and the practical application design of towers

1. JEC-5101 Features

The structural features of the transmission tower that supports the overhead wire mean the wind direction impact significantly on the tower response and the action wind speed, in turn, is significantly affected by the topography and surface roughness. To rationalize the tower design, JEC-5101 adopts a design wind speed that takes wind direction into consideration. As the wind load, an equivalent static wind load is adopted taking dynamic effects like wind turbulence and the resonance effect into consideration.
The snow load is calculated from the snow accretion weight on the overhead line based on the newly created basic snow thickness map and the equivalent static wind load based on the directional design wind speed.
The seismic load is calculated by the layer shear force coefficient method based on the modified seismic coefficient method using the basic acceleration map.

2. Design method according to JEC-5101

In Japan, certain legal standards regarding strong wind design and ice and snow design must be observed. Conversely, JEC is a rational design method that functions as a complement to legal standards and takes reliability and economic efficiency into consideration to a greater extent.
In the actual JEC design, the load is calculated based on the unique point information of the construction site using various pre-prepared numerical information databases. The numerical information databases are listed in Table 2.

Table 1 Design conditions and directions

Design condition		Design direction	Note
Legal regulation	Wind	3-direction	Normal and cut of wire
	Ice	3-direction	Normal and cut of wire
	Snow	2-direction	
JEC-5101	Wind	72-direction	
	Snow	72-direction	Balanced and unbalanced snow accretion between the front and rear spans
	Seism	2-direction	

Table 2 Numerical information database to calculate the design load of JEC-5101

Database	Mesh size
8-directional basic wind speed map	5km
Elevation database	50m
Wind speed-up ratio database	100m
Land use database	5km
Basic snow accretion map	5km
Basic acceleration map	1km

JEC-5101 is premised on computer design due to the use of a numerical database and the complexity of the tower design. Currently, the TC-LOAD2 (CRIEPI) user support system corresponding to JEC-5101 has been developed and the numerical information required for load calculation can be obtained from the pre-prepared database by inputting the longitude and latitude of the construction site. In addition, setting the tower shape and overhead wire conditions and using the acquired data paves the way to calculate the design load and evaluate the stress of the tower members.

Tower members shall be selected to satisfy the required strength against the maximum value of member stress under all design conditions. Design systems, including member selection, are currently under development.

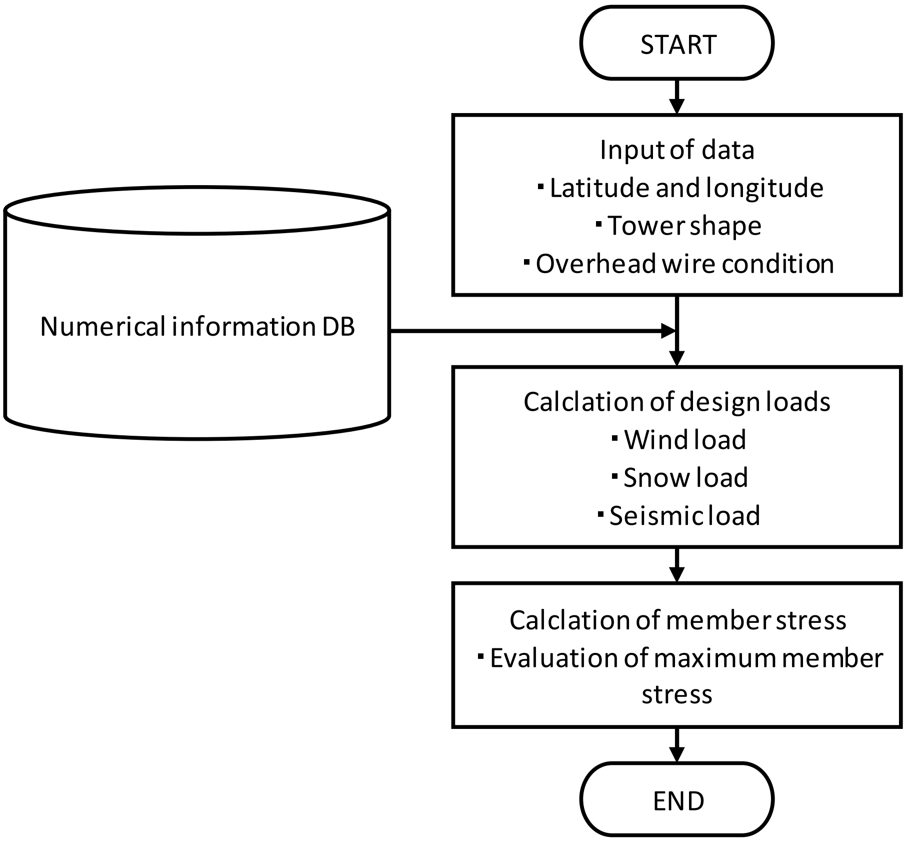
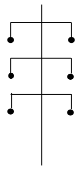
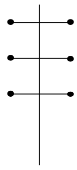
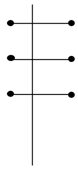
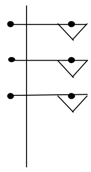


Figure 1 Stress calculation flow by the TC-LOAD2 user support system (CRIEPI)

3. About the application design of the towers in practice

Constructing a new transmission line may involve dozens or hundreds of towers. At that time, the total tower weight can be minimized by designing each tower under individual local conditions. In particular, making the tower lighter would make transporting and assembling the members more affordable. However, this would be impractical in terms of time and cost, given the high number of towers to be designed and the time and effort required to manufacture them. Accordingly, it is desirable to set a common tower type by examining the tower shape, including the arm and design load level (as determined by the load span, horizontal angle, etc.) and to apply multiple towers with a single type.
Conversely, in JEC-5101, the load and stress are evaluated according to the conditions of each construction site and wind direction, meaning the tower type at the member stress level has to be selected. Accordingly, as well as the abovementioned tower shape, the tower member stress level has to be evaluated and examined and the optimum tower type applied.
If the existing line is to be rebuilt independently in line with the new design standards and due to the tower deteriorating or failing, it will be designed individually with a design load in line with local application conditions.

Table 3 Example of tower type selection

Insulator	Shape	Type	Stress level
Suspension	A 	A1	Small
		A2	
		A3	
		·	
		·	Large
Tension	B 	B1	Small
		B2	
		B3	
		·	
		·	Large
	C 	C1	Small
		C2	
		C3	
		·	
		·	Large
	G 	G1	Small
		G2	
		G3	
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