Collapse analysis of transmission Tower

by

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Effect of Soil Structure Interaction on progressive Collapse analysis of transmission Tower

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ABSTRACT

Transmission towers play an important role in the operation of a reliable electrical power system that is considered as a lifeline system. Many studies and recent earthquakes investigations have revealed that, many structures mostly transmission towers performed poorly during wind and earthquake load. Besides many contributing factors for damage, Size, depth of footing and different type's soil mainly structures on soft soil has also massive effect on structures. In case of transmission towers it should be in a straight line at some fixed distance irrespective of soil at that particular place. It is common practice in many earthquake prone areas around the world to analyse the structure using fixed base analysis. This is mainly due to lack of awareness regarding importance of SSI. In order to understand this phenomenon, a study has been performed to show the difference in response when the structure is on soft soil compare to fixed base.

Two case studies have been performed to understand the above phenomenon. A 400 KV transmission tower has been design with proper section. In first case base of transmission tower assumed as fixed base. In second case a proper soil domain with infinite elements has been model using acoustic element which is good for wave propagation. Finally progressive collapse analysis (birth to death analysis) has been performed on both the case studies. Both the case studies reveal that there is great difference in response due to SSI. In second case, it was observed more number of elements is getting failed as compare to first case.

Keywords: Soil structure interaction, Finite element method, infinite soil elements, performance of transmission tower.

Results

In case of Fix base Earthquake has been applied at base of footing as shown in figure-3. But while in second case (where soil domain has been modeled) Earthquake can be apply at two places. Either it can be at top of the surfaces as shown in figure-4, or it can be at base of the soil after modifying time history at particular depth of the soil as shown in figure-5. In all three cases maximum stress value has calculated at three different heights i.e H=5m , H=25m and H=55m.

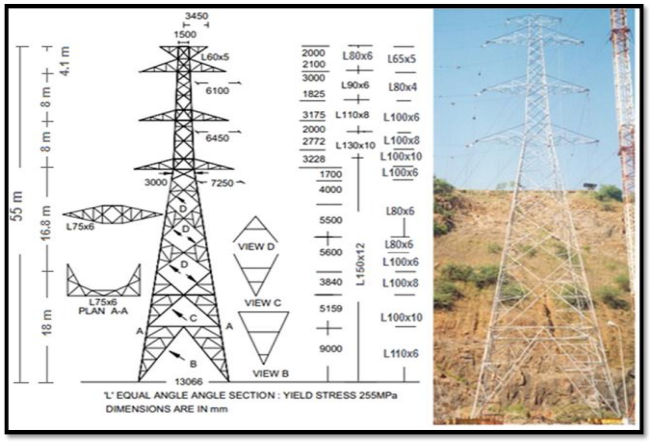

Figure-1 : 400 Kv transmission tower

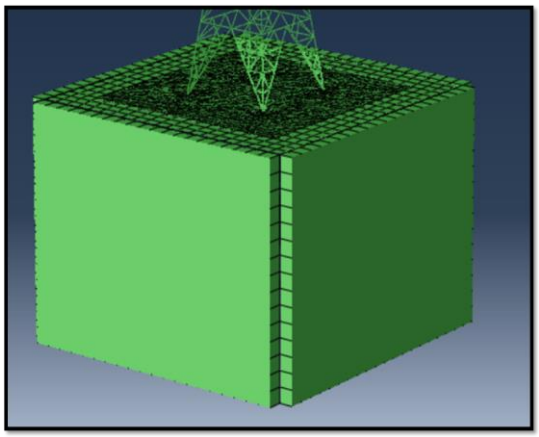

Figure-2: Infinite soil model

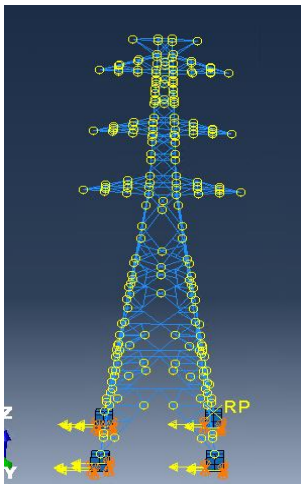

Figure-3

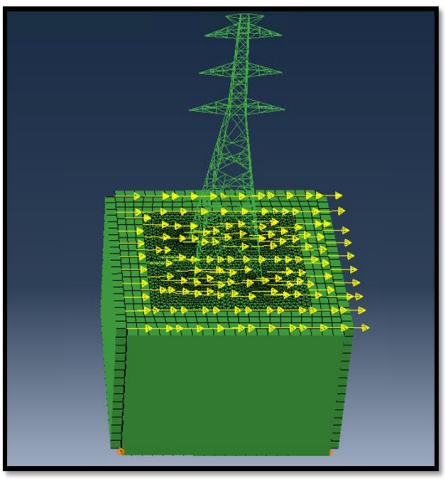

Figure-4

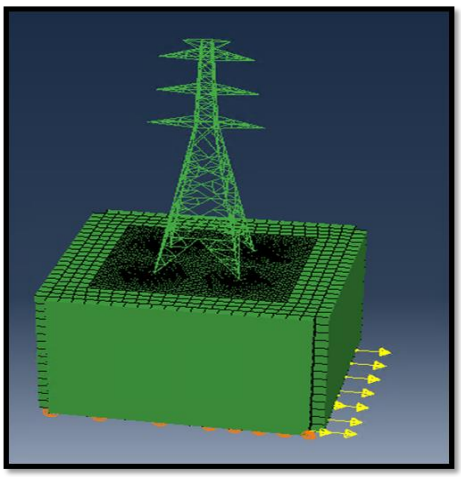

Figure-5

Table-1 : Stress values at different height in above cases.

Type	Stress at 5m(Mpa)	Stress at 25m(Mpa)	Stress at 55m(Mpa)
EQ applied at footing	340	180	22
EQ applied at top surfaces	220	80	15
EQ applied at top surfaces	320	260	25

In First case (earthquake is applied at footing) full force is transferred to footing and footing to tower. In third case (EQ applied at bottom surfaces) here also force is transferred from bottom to top and soil, effect the stress value mostly at mid height of transmission tower as shown in table-1. But in second case (EQ applied at top surfaces) here force is distributed in tower as well in soil that's why stress value is less compare to other cases.