PROGRESSIVE COLLAPSE STUDY OF 220KVTRANSMISSION LINE TOWER WITH DIFFERENT BRACING PATTERNS

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Abstract

India has huge population spread all over the country. Electricity is vital for Residential, Commercial and Industrial areas. After power generation, power is transmitted through transmission line towers to distribution systems. Due to increase in power generation, there is an increase in transmission line systems. Progressive collapse is one of the most devastating types of structural failures, most often leading to expensive damages, multiple injuries and possible loss of life. Factors such as unexpected accidental loads, construction errors, miscommunication, poor inspections, or design flaws contribute to these progressive collapses, that have lead to many changes in building codes throughout the nation. To study the local failure, progressive collapse behavior of the structure is to be analyzed. Progressive collapse is a continuous spread and magnification of localized failure in structures, caused by an accidental load, resulting in a cascade of failure affecting a large portion of the structure. The main aim of this paper is to present a study on the progressive collapse behavior of transmission line tower with different bracing patterns namely K-bracing, X-bracing, (K-X) bracings. All the considered towers are analyzed for gravity and wind loads (IS: 875(Part-III)-2015). The tower is analyzed as space truss for different load combinations as per IS: 875(Part-V) and IS:456-2000. Based on the analysis of obtained results, a comparison between towers with different bracing patterns namely K-bracing, X-bracing, (K-X) bracings with different Progressive collapse conditions is made.

Key words: Transmission line tower, Progressive collapse, Local failure, Bracings, Load combination

1.Introduction:

Transmission line is an integral system consisting of Conductor subsystem, Ground wire subsystem and Insulator subsystem.

Transmission line towers are modeled using different bracing patterns. Axial forces, deflection and weight of towers vary with bracing pattern. Certain bracing patterns reduce weight of tower.

Transmission towers are used to pass signal wires and electrical current from place to place. They are usually made of steel and can run at times for long distances. Transmission towers are most often used when there is a large amount of electrical current to be distributed, usually between 115,000 and 765,000 volts. Several different designs of transmission towers are in wide use in the world today.

Transmission towers relay electric current, and come in several major types. Such as

Lattice Steel Towers, Tubular Steel Poles, Single and Double Circuit Towers, Guyed Towers, Suspension Straight Towers, Suspension Angle Towers, Anchor and Angle Tension Towers, Terminal Transmission Towers,

To optimize the weight of any steel tower, the following components are constrained on the basis of electrical requirements. The components of transmission line have their own electrical and mechanical characteristic. Consists of the following components.

- Cage of Transmission Tower
- Boom of Transmission Tower
- Body of Tower
- Cross Arm of of Transmission Tower
- Peak of of Transmission Tower

The Cage: The main vertical section of any transmission tower is named as cage. Normally cross section of cage takes square shape and the shape is also depending on the height of the transmission line.

Boom : Boom is a rectangular beam of the cross section in middle tapered in the end section and part of a horizontal configuration tower. Normally boom is connecting to lower body to support mechanically to the power conductors. **Body of Tower**: It is the main part of the tower which connects the boom and the cage to tower foundation on body extension or the leg extension. The shape of the body is square type and tower body consist two columns which connected at the end of the foundations.

Cross Arm: It is one of the key components of transmission line and it holds the power conductor. Cross arm can vary due to the location and power carried by the transmission line. Number of cross arms depend on the number of circuits consist in Transmission Line.

The Peak: It is mainly used for lay ground wire in suspension clamp and tension clamp in suspension and angle tower locations. Peak is a portion of the above vertical configuration of top cross arm. We can simply say that Peak is the section above the boom in case of the horizontal section of tower. The peak height depends on the specific angle of shield and clearance of mid span.

PROGRESSIVE COLLAPSE:

Progressive collapse initiated by the loss of critical structural components occurs over a short period of time due to high strain rate loadings such as blast or impact. Since the collapse of Ronan Point apartment building in 1968, progressive collapse has been an important issue in structural design and a significant amount of research has been conducted on progressive collapse response of building structures subjected to extreme loading scenarios Apart from building structures, the dynamic behavior of the tower structures subject to extreme loading scenarios (e.g. blast loadings) and critical member loss are currently of high interest to structural engineers and researchers. Towers are often subjected to severe conditions, such as wild weather, earthquakes, and even explosions. As a result of such extreme external loads, towers could suffer loss of some of their critical structural members and consequent collapse may occur. A progressive collapse is typically triggered by a sudden loss of one or more critical structural components. The disproportionate failures are the small initial local failures i.e. if a member is damaged and loses its functional property, the load of this member is redistributed to the remaining adjacent members. If the remaining members could not withstand the load severity, the tower will fail. Thus, the possible mechanisms of collapse are different compared to the buildings. The reasons causing the tower progressive collapse can be due to

(i) Unexpected events, such as collision with earthquake.
(ii) Degradation of structural performance due to corrosion of steel members.
(iii) Improper design or faulty construction methods.

2. Review of Literature:

Archana et. al .[1] (2013), conducted analysis on angular section is more economical and more effective section compared with other sections. The angular sections are found to have lesser amount of axial forces in comparison with the other section of tower. The angular section is found to have the lesser amount of displacement throughout the height of the tower as compared with the other sections. Gopi Sudam Punse et. al .[2] (2014), observed that narrow based steel lattice transmission tower structures have enhanced performance especially while considering eccentric loading conditions for high altitude when compared to other normal tower. The bottom tier members have more roles in performance of the tower in taking axial forces and the members supporting the cables are likely to have localized role. The vertical members are more prominent in taking the loads of the tower than the horizontal and diagonal members, the members supporting the cables at higher elevations are likely to have larger influence on the behavior of the tower structure. Halkude et. al .[3] (2014),concluded from his study that among „K‟ and „XBX‟ type of bracing systems, the width to height ratio between 0.153 and 0.167 is found to be economical for leg slope of 1/7 to 1/8. If the slope decreases, weight of the tower increases from 3% to 7%. For „X‟ type of bracing system width to height ratio 0.111 is found to be economical (for leg slope of 1/12). For „XBX‟ bracing system, adopt 4 and 7 numbers of panels to get optimum geometric configuration of the tower. Jithesh Rajasekharan [4] (2014),conducted wind analysis and observed that the increase in joint displacement is nearly 68% when tower height increases from 30m to 40m. When tower height increases from 40m to 50m the displacement is likely to increase by 60%. The change in stress when height increases from 30 to 40m is about 45% and for 40 to 50m is 39% on both cases of wind speeds. For an increase in wind speed from 50 to 55 m/s with no change in direction the displacement, the member stresses increase by 15% to 17%. In wind analysis the joint displacement is more for the tower with Y bracings whereas the member stress at bottom leg is more for the tower with XX bracing due to the absence of horizontal bracing. Jyotideep et. al .[5] (2016) researched on the need of electrical energy is increasing day after day the appropriate measures are becoming more necessary to overcome the problems of electrical power transmission lines, reducing the permitted distances, increasing network reliability with proper power quality with less chance of outage, reduction of power loss especially corona losses, communication disturbances reduction and many other issues. Lu C et. al .[6] (2016) researched on lattice transmission towers and line systems. The numerical modeling methods are reviewed from bolted connections and tower elements to individual towers and line systems. The research findings on static and dynamic behaviours of bolted connections have been summarized and discussed through the load-displacement curve and bolt pretension degeneration situation. The static structural behaviors and failure modes of non-reinforced and reinforced LTTs are reviewed. Nur Zawania et. al .[7] (2012) has done research on 132kV overhead transmission-line model using ATP-EMTP software for shielding failure pattern recognition. The model was essential for the investigation of lightning over-voltage performance on overhead transmission-line system. Shielding failure voltages obtained across insulator strings were investigated by injecting four different magnitudes of lightning-strike current into each phase conductor of the transmission tower. Preeti et. al .[8] (2013), studied Least weight of the tower implies greatest economy in the transmission line cost. Configuration of towers has revealed that all the three towers are having the same height but different base widths. Reliability, security and safety conditions have been kept the same for all the three towers. Wind loading is calculated for each tower. Renju Chandra.[9] (2015), analysed I section, channel section and circular section for stable microwave tower using ANSYS software. From model analysis, frequency and deformation for different sections (I, Circular and C) were obtained and further seismic analysis, was based on these results. From seismic analysis the displacement diagram and stress distribution diagram of microwave tower were obtained. Therefore it was concluded that circular section is the most stable steel section. Robert et. al .[10] (2002**)**, studied the development of progressive collapse analysis and damage assessment methodology of partially collapsed structures. The developed analytical methods will enable engineers to predict the type and range of possible progressive collapse in both the design stage and after incidents. This is the main reason to connect a progressive collapse analysis with a system identification procedure. This combined approach will be effective to prevent or minimize casualties and damage caused by the abnormal loads. SAI AVINASH et. al .[11] (2016), observed that the Displacement value is quiet higher i.e., 96.45mm in X-Direction in case of transmission tower modeled using ‘K’ Bracing when compared to ‘X’ Bracing i.e., 89.36mm. The Transmission tower modeled with ‘X’ Bracing found to be required lesser percentage of steel i.e., 6% when compared to ‘K’ Bracing. In the design aspect it reveals that by providing unique sectional property throughout the transmission tower leads to uneconomical design. Shivam Panwar et. al .[12] (2016) compared the same transmission towers with same bracing system at different wind zones viz. zone II and IV but same seismic zone i.e. zone IV located at Delhi and Panjim. The following conclusions are drawn on the basis of the research and analysis done through the STAAD.ProV8i and conforming the safety of same tower at both the mentioned places. Sonowal et. al .[13] (2013) opined that transmission line tower is a statically indeterminate structure and the manual analysis of such a structure is very complex. The development and application of computer analysis opened up a new and practically unlimited possibilities for the exact solution of these statically indeterminate structures with precise statically analysis of their three dimensional performance. However the adopted method of analysis presented in this paper considering linear behavior with two dimensional approaches gives satisfactory results which should be further verified with advanced software like STAAD Pro, Ansys etc. SRI HARSHA et. al .[14] (2014) attempted to provide an insight into the soil properties, design of foundation and STAAD analysis. Sudheer et. al .[15] (2013), studied the parameters like maximum compressive and tensile stresses in the tower members, axial forces in the members and maximum deflections of the nodes in X,Y and Z directions and compared in wind zones Iand V with wind speed 33m/s and 50 m/s respectively. Table 3 represents the maximum axial deflections of nodes in X,Y and Z directions in wind zones I and V with the base widths 5.5866 m, 6.704 m and 8.38m. The results presented and discussed include the maximum axial force in tower members in zone I and V with 3 base widths and the maximum compressive, tensile stresses in members in wind zones I and V with the base widths 5.5866 m, 6.704 m and 8.38m. Supriya et. al .[16] (2015), analysed and designed the transmission towers of hot rolled sections and cold formed sections with four wind speeds using STAAD-Pro V8i software. Tower model is pin jointed space 3D structure. Deflection is maximum at ground wire tip and minimum at leg base. Within the permissible limit, transmission tower of cold formed sections have 39.8%, 42.3%, 49.6% and 61.2% increased in deflection as compared to hot rolled sections for wind zones II, III, IV and V respectively. Uwe Starossek.[17] (2006), studied the Progressive collapse can be produced by various differing mechanisms. Based on a discussion of these mechanisms, five distinct types of collapse have been identified. The terms suggested for these five categories are pancake-type, zipper-type, domino-type, section-type, and instability-type collapse. These categories are relatively easily distinguishable through their respective features described here. Wang et. al .[18] (2012) studied a progressive collapse analysis procedure based on the FEM is proposed, by which the failure process of transmission tower-line system caused by the earthquake can be simulated to understand the collapse mechanism. During this procedure, the mass of the elements is still retained rather than removal after elements lose the load-bearing capacity. By applying the proposed approach, the progressive collapse analysis of a tower-line system is conducted.

OBJECTIVE OF THE STUDY:

The main objective of this study is to know the behavior of 220kV Double circuit Transmission Tower with three different bracing systems i.e. TTK (Transmission Tower K-bracing), TTX (Transmission Tower X-bracing), TT(K-X) (Transmission Tower (K-X)bracing) under different progressive collapse conditions.

SCOPE OF THE STUDY:

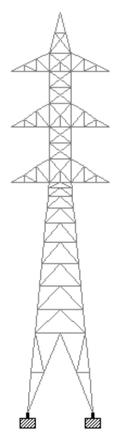
1) Study was conducted for three different bracings of transmission tower (K-bracing, X-bracing, (K-X) bracing).
2) Study was conducted for six progressive collapse conditions.

3 structural Description of the considered model: Table 1 presents the geometrical parameters of transmission line tower

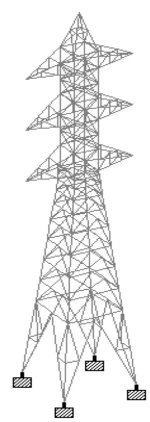
Table 1 Geometrical parameters of transmission line tower

Particulars	Dimensions (m)
Span of the tower	350
Height of the tower	46.82
Base width of the tower	3.88

Three different types of bracings are considered for the study. They are K-bracing (Fig 1), X-bracing (Fig 2) and (K-X)-bracing (Fig 3). Refer figure 1 to figure 3 for geometry of towers with different bracings considered.

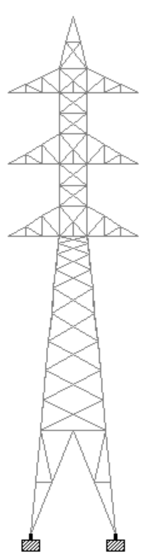


(a) Elevation



(b) Isometric view

Fig 1 Geometry of K-bracing transmission tower



(a) Elevation

(b) Isometric view

Fig 2 Geometry of X-bracing transmission tower

(a) Elevation (b) Isometric view

Fig 3 Geometry of (K-X) bracing transmission tower

3. 1 TOWER DATA CONSIDERED

As per the guidelines of Power grid co-corporation of India limited (PGCIL), the following parameters for transmission line and components are assumed from I.S. 802: Part 1: Sec: 1:1995, I.S. 5613: Part 2: Sec: 1:1989 and CBIP Manual No. "268" [19]

Transmission Line Voltage : 220 KV (A. / C.)

Number of Circuits : Double Circuit.

Angle of Line Deviation : 2°

. Insulator String configuration : Suspension.

Length of span considered : 350 m (IS 5613.Part-2.Sec-1-1985, cl 6.4.1).

Terrain Type considered : 1 (Exposed open terrain)

Return Period : 50 years.

Wind Zone: III

Basic Wind Speed: 44 m/s

Design Wind Pressure : 71.63 kg/ m^2

Steel used : Mild steel (IS: 2062-2006)

. CONDUCTOR SPECIFICATIONS: ACSR "Zebra" (54/3.18+7/3.18mm)

Ultimate Tensile Strength of Conductor (U.T.S.): 13290 kg

Overall diameter of the Conductor (d): 28.62 mm

Weight of the Conductor (w): 1.621 kg / m

Coefficient of linear Expansion : 19.3 × 10^{-6} per °C

Young's Modulus of elasticity (Final) (E_f) : 0.686 × 10^{6} kg / cm^2

Young's Modulus of elasticity (Initial) (E_i) : 0.4675 × 10^{6} kg / cm^2

Maximum temperature (Conductor): 75 °C

Minimum Temperature (Conductor):0 °C

Every day Temperature: 32 °C

Area of Cross section of Conductor (A):4.845 cm^2

Factor of Safety (F.O.S.) (at 32°C) : 4

Weight of Conductor per unit area (δ): 0.334571723 kg /m / cm^2

Earth wire And Its Specifications:

Ground wires are simple conductors supported at the top of transmission towers. They serve to shield the line and seize lighting stroke before it hits the current carrying conductors located below, supported by cross-arms. Ground wires usually do not carry current; so that consequently they are often made of steel.

Specifications of Earth wire:

This earth wire consists of 7 strands of steel with 3.18 mm diameter. The earth wire taken is EARTH0WIRE GALVANIZED STEEL STANDARD (7/3.18mm).

Ultimate Tensile Strength of Earth wire (U.T.S.): 5808 kg

Overall diameter of the Earth wire (d): 0.945 mm

Weight of the Earth wire (w): 0.43 kg / m

Coefficient of linear Expansion (α) :1.15 10^{-5}/ °C

Young's Modulus of elasticity (Final) (E_f): 1.90g / cm^2

Maximum temperature (Earth wire): 53 °C

Minimum Temperature (Earth wire): 0 °C

Every day Temperature : 32 °C

Area of Cross section of Earth wire (A): 0.5455 cm^2

Factor of Safety (F.O.S.) (at 32°C) :4

DETAILS OF INSULATOR ASSEMBLY

Insulator type: 1 string.

Number of Insulator Disc : 14.

Size of Insulator Disc : 225 mm Diameter, 145 mm thickness.

Length of Insulator String : 2340 mm.

Parameters of Insulators: Dimensions of Insulator Discs

Number of Insulator Discs : 14

Diameter of Disc : 0.225 m

Thickness of Disc : 0.145 m

Area of Insulator Disc : 0.032625 m^2

Wind load on Bottom Insulator: 37.49 kg

Wind load on Middle Insulator: 39.08 kg

Wind load on Top Insulator :40.24 kg

Vertical load of conductors:

Weight of Conductor (w) :1.621 kg/m

Weight span : 1.5×wind span

Vertical Weight of conductor: 851.025 kg

Total Weight of Insulator : 784 kg

Weight of lineman with tools : 150 kg

Vertical load of Earth wire:

Weight of Earth wire (w) :0.43 kg/m

Weight span : 1.5×wind span

Vertical Weight of Earth wire : 225.75 kg

Weight of lineman with tools : 150kg

4. Loads Considered For the Study

Wind loads on all the towers are calculated separately by developing excel programs by following Indian Standards. For finding the drag coefficients for the members of triangular tower, the solidity ratio is derived from Table 30 –IS-875 (part 3)-2015 in the similar fashion as prescribed in the IS- 826 (part-1/sec 1)1995.

$P_Z=0.6\times V_z^{2}$

Where, pz = wind pressure in N/m2 at height z,

and Vz = Design wind speed in m/s at height z.

Vz = Vb k1 k2 k3 k4

V_b = Basic wind speed

k1 = Probability factor (risk coefficient),

k2 = Terrain roughness and height factor,

k3 = Topography factor,

k4 = Importance factor for the cyclonic region.

5 RESULTS AND DISCUSSIONS

The Transmission Tower was analyzed for one support loss and five element load case scenarios. They are:

1. Progressive collapse condition 1- one support removed (PC 1)
2. Progressive collapse condition 2- one vertical member removed (PC 2)
3. Progressive collapse condition 3- one diagonal member removed (PC 3)
4. Progressive collapse condition 4- one horizontal member removed (PC 4)
5. Progressive collapse condition 5- one bracing member removed (PC 5)
6. Progressive collapse condition 6- two bracing members removed (PC 6)

5.1 Discussion of Results for each collapse case:

Case: 1 Lateral Displacement of Transmission Tower with different bracing patterns

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) is presented in Fig.4.

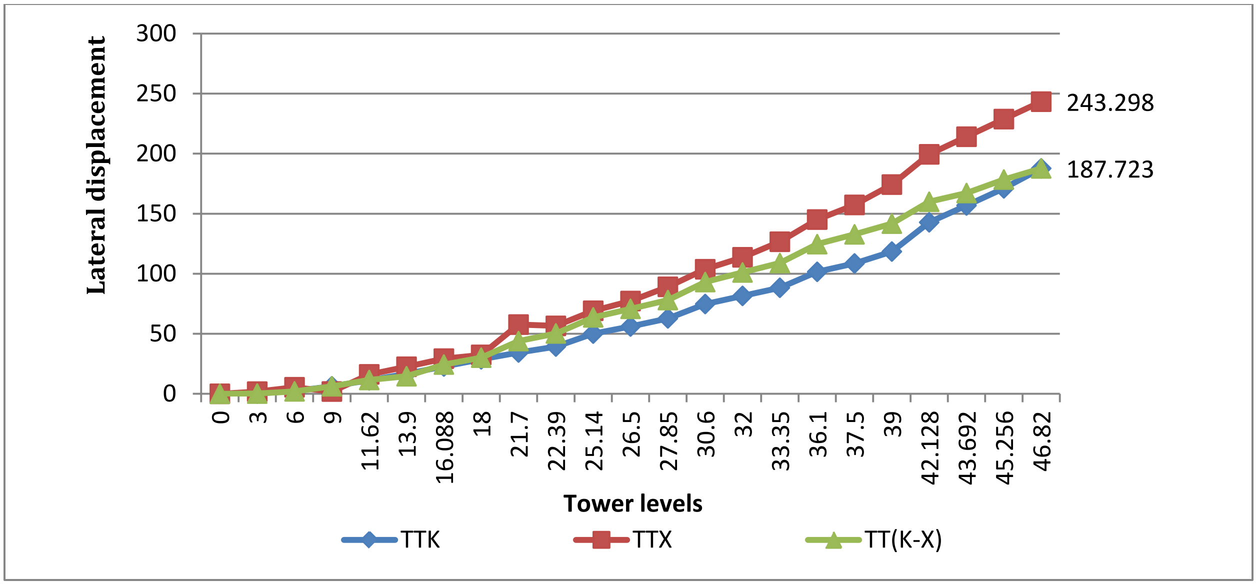


Fig.4. Lateral displacement Vs Tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 4, it is observed that lateral displacement is decreased by 22.83% for K-bracing and 22.84% for (K-X) bracing when compared to X-bracing at a level of 46.82m from ground level.

Case: 2 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 1

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 1is presented in Fig 5.

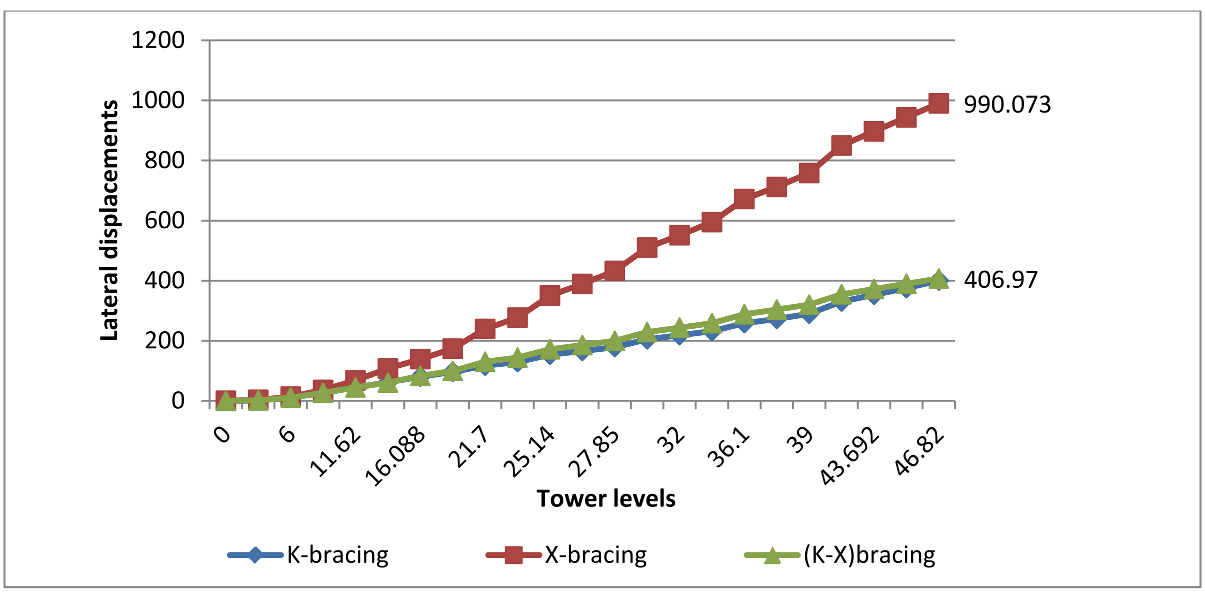


Fig.5. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 5, it is observed that lateral displacement is decreased by 59.56% for K-bracing and 58.9% for (k-X) bracing when compared to X-bracing at a level of 46.82m from ground level.

Case: 3 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 2

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 2 is presented in Fig 6.

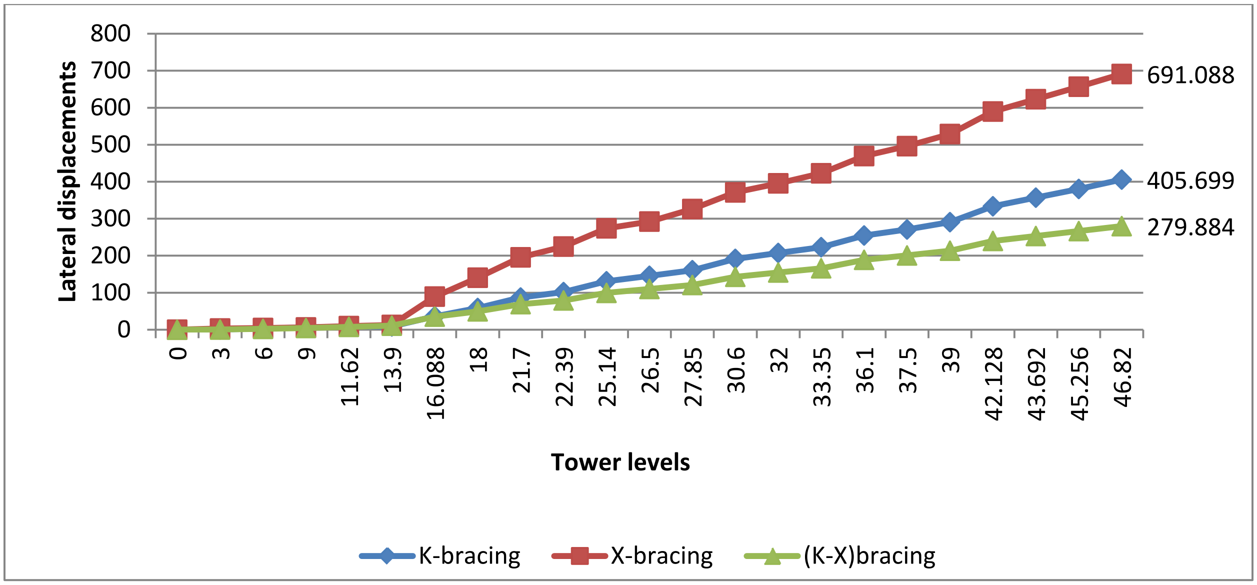


Fig.6. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 6, it is observed that lateral displacement is decreased by 59.5% for (K-X) bracing and 41.23% for K-bracing when compared to X-bracing at a level of 46.82m from ground level.

Case: 4 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 3

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 3 is presented in Fig 7.

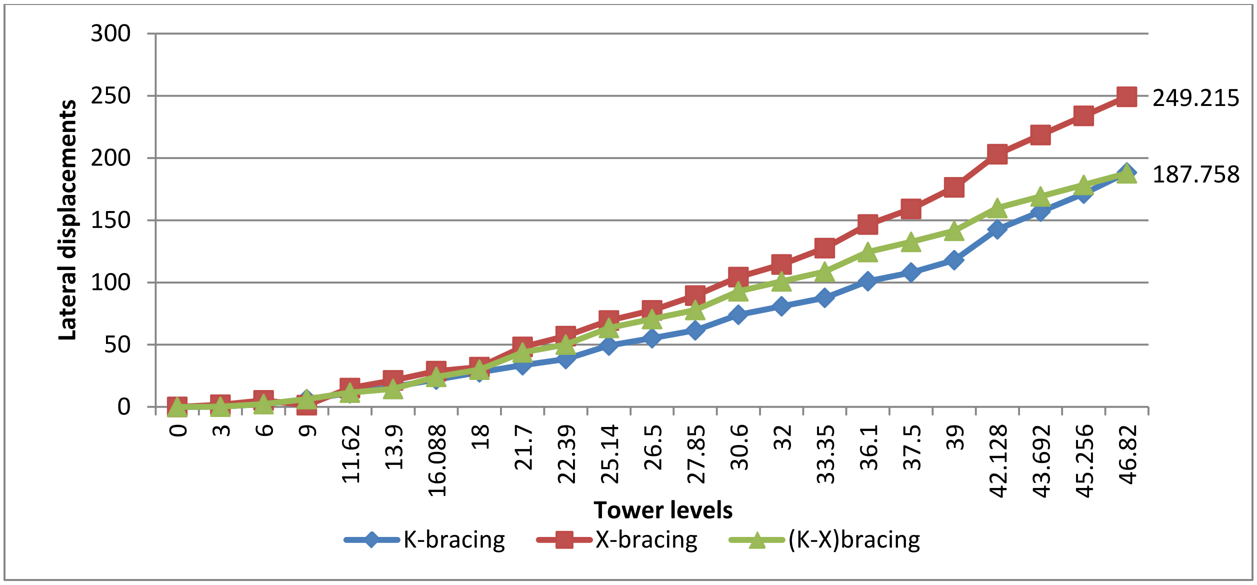


Fig.7. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 7, it is observed that lateral displacement is decreased by 24.66% for (K-X) bracing and 24.41% for K-bracing when compared to X-bracing at a level of 46.82m from ground level.

Case: 5 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 4

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 4 is presented in Fig8.

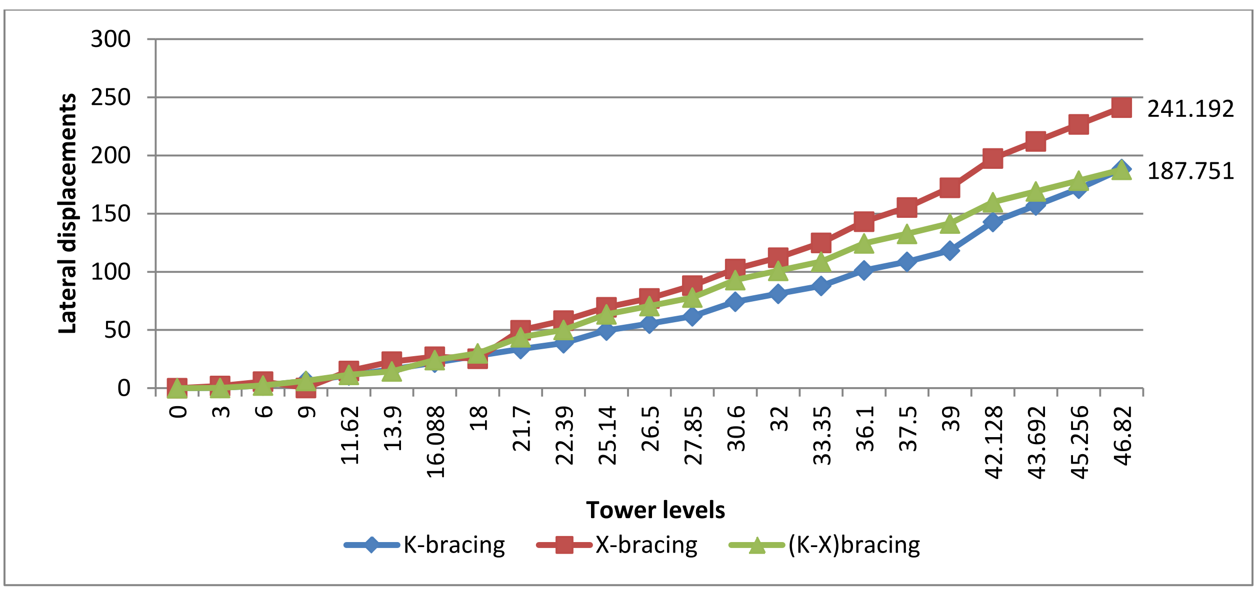


Fig.8. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 8, it is observed that lateral displacement is decreased by 22.92% for (K-X) bracing and 22.84% for K-bracing when compared to X-bracing at a level of 46.82m from ground level.

Case: 6 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 5

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 5 is presented in Fig 9

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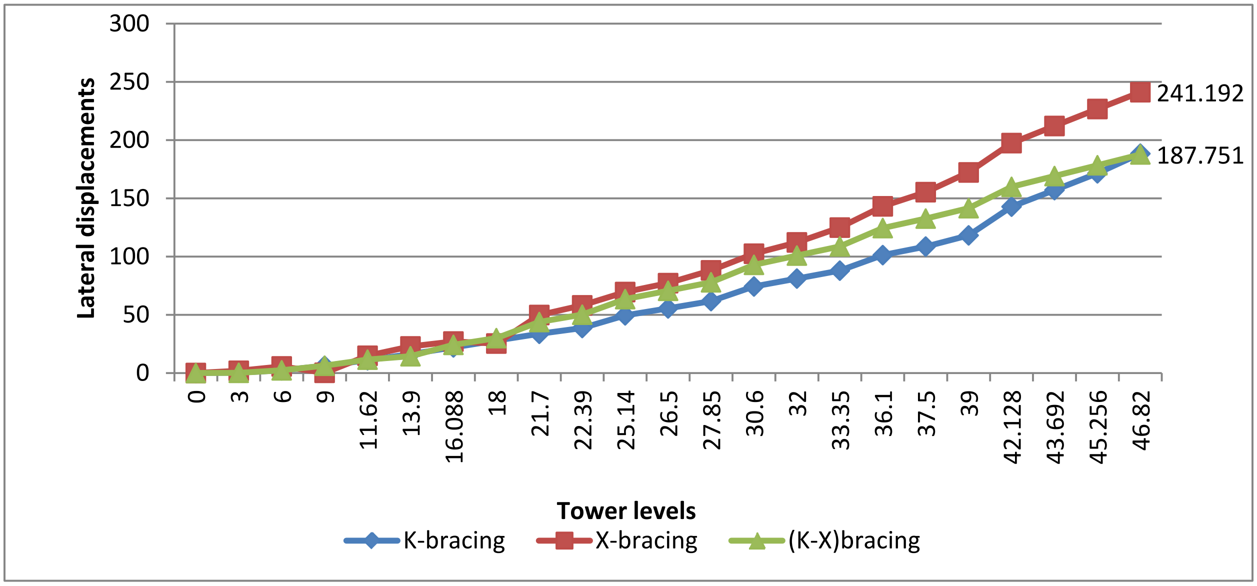

Fig.9. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 9, it is observed that lateral displacement is decreased by 22.16% for (K-X) bracing and 21.89% for K-bracing when compared to X-bracing at a level of 46.82m from ground level. **Case: 7 Lateral Displacement of Transmission Tower with different bracing patterns for Progressive Collapse Condition 6**

The lateral displacement at different tower levels due to wind load in X-direction with different bracing patterns namely TTK, TTX, TT (K-X) in progressive condition 6 is presented in Fig 10.

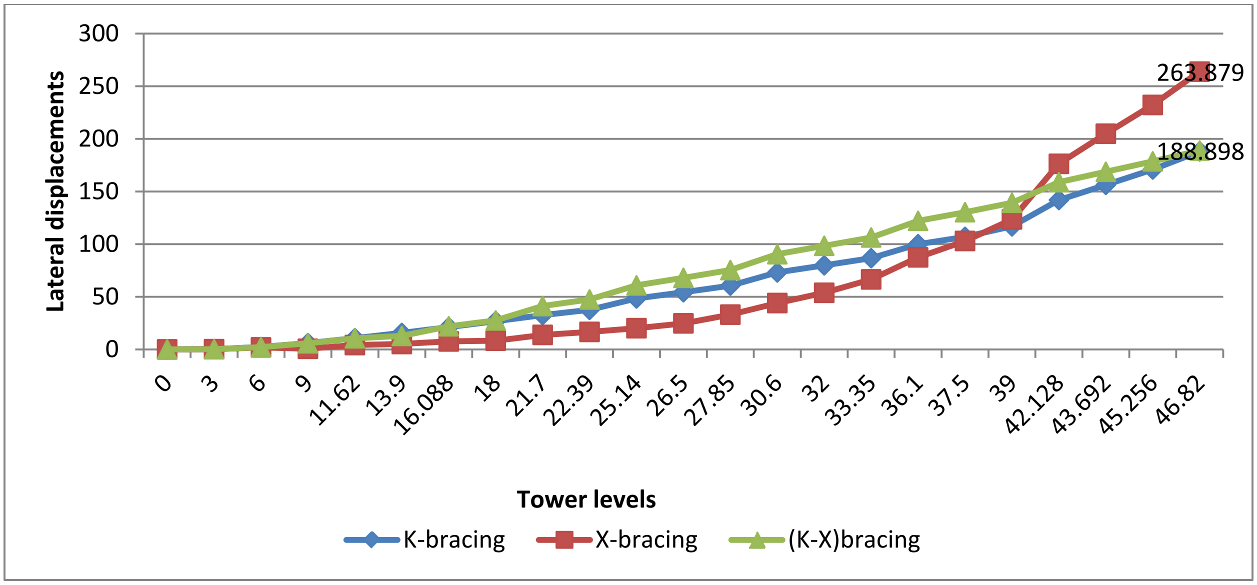

Fig.10. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 10, it is observed that lateral displacement is decreased by 28.73% for K- bracing and 28.41% for (K-X) bracing when compared to X- bracing at a level of 46.82m from ground level.

5.2 Comparison of lateral displacement of transmission tower in different bracing for different progressive collapse conditions

Case: 1 Lateral Displacement of Transmission Tower in K-bracing for different Progressive Collapse Conditions

The lateral displacement at different tower levels due to wind load in X-direction with different progressive conditions in K-bracing is presented in Fig 11.

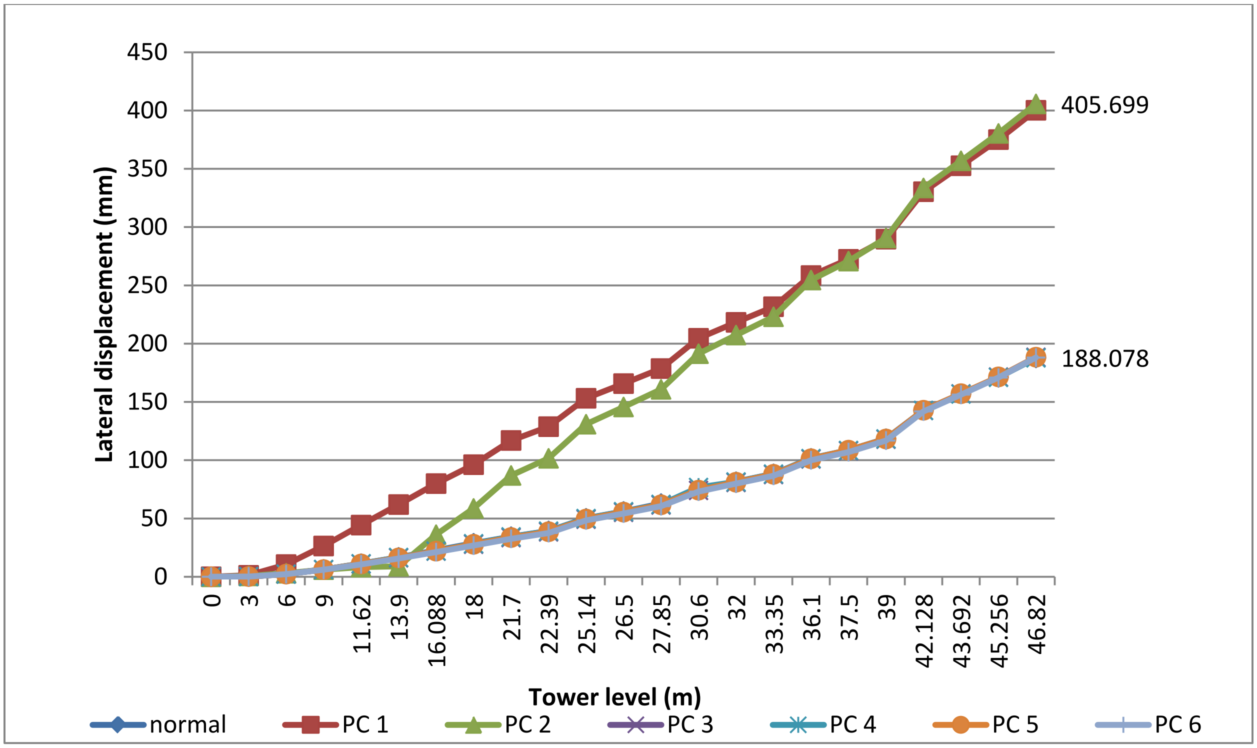

Fig.11. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 11, the lateral displacement in progressive collapse condition2 is 1.5% greater than that of progressive collapse condition1, 54%than that of progressive collapse condition 3, 54%than that of progressive collapse condition 4, 54%than that of progressive collapse condition 5, 54%than that of progressive collapse condition 6. It can be observed that the lateral displacement in progressive collapse condition 3, progressive collapse condition4, progressive collapse condition5, progressive collapse condition6 having no significant variation when compared to normal condition.

Case: 2 Lateral Displacement of Transmission Tower in X-bracing for different Progressive Collapse Conditions

The lateral displacement at different tower levels due to wind load in X-direction with different progressive conditions in K-bracing is presented in Fig 12.

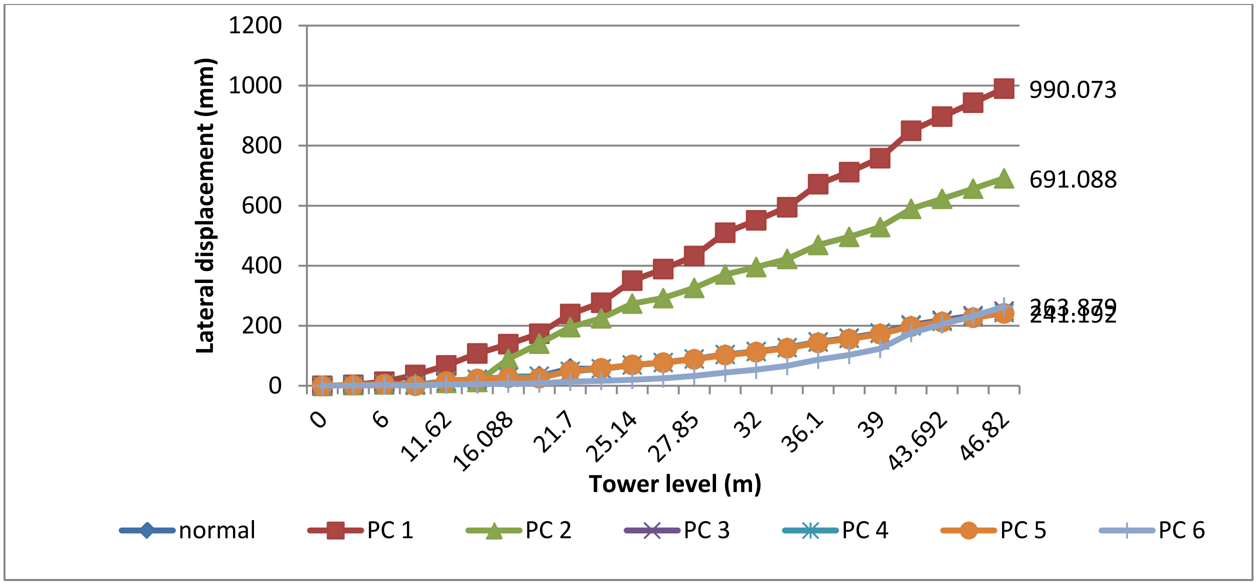

Fig.12. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 12, the lateral displacement in progressive collapse condition1 is greater than 30%then that of progressive collapse condition2, 75%than that of progressive collapse condition 3, 75%than that of progressive collapse condition 4, 75%than that of progressive collapse condition 5, 73%than that of progressive collapse condition 6. It can be observed that the lateral displacement in progressive collapse condition 3, progressive collapse condition4, progressive collapse condition5, progressive collapse condition6 no significant variation when compared to normal condition.

Case: 3 Lateral Displacement of Transmission Tower in (K-X)-bracing for different Progressive Collapse Conditions

The lateral displacement at different tower levels due to wind load in (K-X)-direction with different progressive conditions in K-bracing is presented in Fig 13.

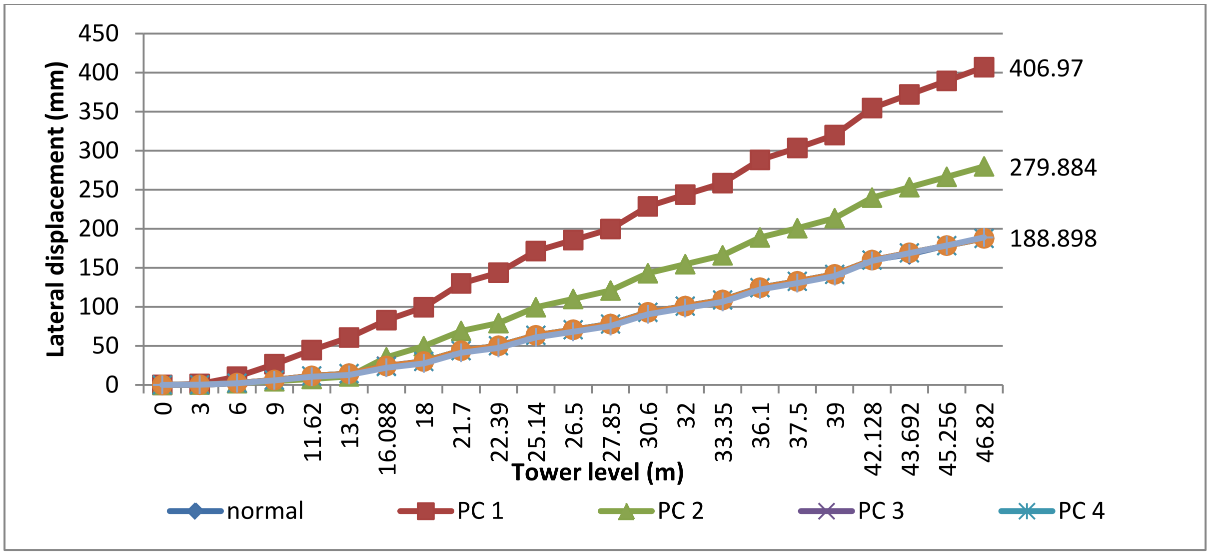

Fig.13. Lateral displacement Vs tower levels with different bracing conditions of 220kv Transmission Line Tower

From figure 13, the lateral displacement in progressive collapse condition1 is greater than 31%then that of progressive collapse condition2, 54%than that of progressive collapse condition 3, 54%than that of progressive collapse condition 4, 54%than that of progressive collapse condition 5, 54%than that of progressive collapse condition 6. It can be observed that the lateral displacement in progressive collapse condition 3, progressive collapse condition4, progressive collapse condition5, progressive collapse condition6 no significant variation when compared to normal condition.

6. CONCLUSIONS

This paper presents on computer aided investigation the lateral displacement of a 220KV transmission Line Tower using three different bracing systems for progressive collapse of transmission Line tower. From the study the following conclusions are obtained.

- Tower with K-bracing offer more resistance against lateral displacement when compared to (K-X), X-bracings.
- Lateral displacement is not changed significantly in Progressive Collapse conditions 3, 4, 5 and 6 when compared to the tower without Progressive Collapse Conditions.
- Lateral displacement is more in progressive collapse condition 1 i.e. one support removed condition when compared to other considered progressive collapse conditions.
- Remove of any support among the four supports or any vertical member of a tower leads to significant variation in lateral displacement.

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