EXPERIMENT AND DESIGN ANALYSIS OF TRANSMISSION TOWER SUBJECTED UNDER STRONG WIND LOAD: A REVIEW

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ABSTRACT-In light of field examination of a harmed transmission line , a disappointment investigation is performed to appraise the heap bearing limit of a transmission tower. Static nonlinear clasping examination and dynamic investigation are utilized to evaluate a definitive burden limit and the most weak pieces of the pinnacle. In the unique investigation, a pinnacle line (TL) coupled model is set up which represents individuals clasping limit. The two philosophies anticipated close wind load limit (35.8 m/s in static examination and 35 m/s in powerful analysis),while the disappointment modes and clasped individuals are different. While static investigation shows that the leg individuals clasped, dynamic examination uncovers that it is the slanting individuals that clasp. Reasons are clarified in this paper and ideas are given that the unique investigation ought to be embraced in vitally assessing a transmission tower, particularly when finding the clasped member. More, emphasis ought to be given to the plan of askew individuals.

Keywords: Transmission tower ,Failure analysis, Tower-line coupled system ,Wind load ultimate capacity

INTRODUCTION:

Transmission towers are essential parts of force transmission matrix. Restorationwork or recreation of a pinnacle force a significant stretch of blackout time which prompts bother of day by day life and extraordinary financial misfortune. Transmission towers are generally planned as tall cross section steel structure, this specific structure is delicate to wind load. News reports as of late have uncovered numerous occurrences of transmission tower disappointment during typhoons in China. Thus exact expectation of pinnacle execution and the weak pieces of the pinnacle under solid breeze is vital for the wellbeing evaluation of the force transmission framework [1]. Numerous specialists committed to discovering the disappointment component of transmission towers underwind burden and endeavored to uncover the exact disappointment mode by different strategies. Full-scale tower tests were embraced to research the legitimacy of customary shows and suppositions. Rao directed a full-scale trial of five distinct kinds of transmission line towers and contrasted the outcomes with a few plan principles. It was discovered that ASCE Standard and British Standard can overestimate a propping part's ability contrasted with test esteems for all scopes of thinness proportions [1–4]. Jacek introduced a fullscale analysis of a cross section media transmission tower, nearby mathematical flaw was estimated for chosen individuals and inferred that the pinnacle's general bearing limit relied upon the flimsiness of leg individuals [5]. In any case, the considered pinnacle is distinctive in the structure with transmission tower for it contains no auxiliary bracings which lead to huge slimness proportion of leg individuals. Xie planned three sets of subassemblages to contemplate the mechanical conduct and disappointment instrument of pinnacle structures under ice load [6,7]. In view of a past tower test result, Albermani received a nonlinear scientific strategy to mimic and evaluate a definitive primary reaction of latticed transmission towers, the technique was aligned to give precise forecast of disappointment mode and disappointment load [8]. Kim and Soheil investigate the clasping probability and the pliancy of pressure individuals by the abrupt expulsion of individuals [9,10]. As force transmission towers are straightforwardly associated with transmission lines, the collaborations between the pinnacle construction and conductors can't be ignored. Xie completed an air stream test on the air versatile model of an UHV transmission tower line systemto research the pinnacle line framework's dynamic conduct under wind stacks and inferred that the vibration of conductors can essentially increment the pinnacle reaction. While anticipating the

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disappointment of a transmission tower, it would be substantially more sensible to contemplate the pinnacle line framework overall as opposed to a disconnected transmission towers [11].

2 FIELD INVESTIGATION RESULT

At 1500 UTC of October third 2015, an extreme typhoon named Mujigae drew nearer to western shoreline of Guangdong territory and made landfall around there. Typhoon Mujigae seek after the record strength of Typhoon arrived over China since 1949, the close community wind speed is up to 50 m/s and least focal pressing factor is 940 hPa [16].

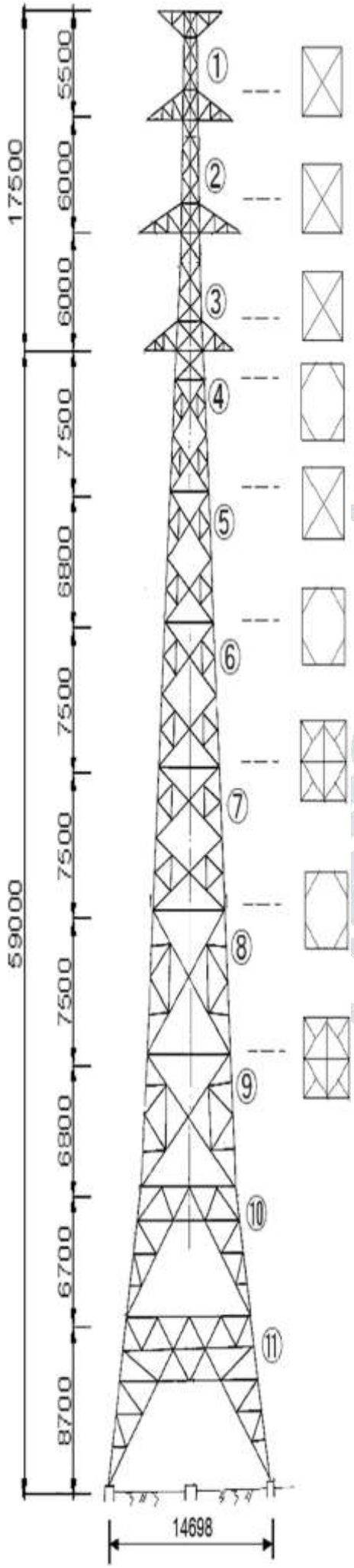
3 FAILURE ANALYSIS

3.1 MODELS DESCRIPTIONS

The examined tower used to serve in a significant transmission line associated straightforwardly to an enormous force plant. The range of the contiguous pinnacle is 490 m and 440 m individually. The breakdown of this pinnacle would be pulverizing. Pinnacle individuals are organized with equallegged points, the yield strength of leg individuals are 345MPa, askew just as repetitive individuals are with grades of 235 MPa. Schematic plan of the N7 tower is represented in Fig. 2. Stomach designs are likewise appeared at the comparing stature.

(a) collapse of tower N7

(b) neighboring collapsed tower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4.Fragility surface of transmission towers under combined wind and rain loads

Defnition of Fragility Surface

Delicacy of a framework is the likelihood that the framework reaction to outer heaps of indicated powers surpasses a basic worth (Kafali and Grigoriu, 2007). Delicacy bends address a connection between this exceedance likelihood and a scalar measure, and the likelihood of framework disappointment as a component of two measures. The relapse fit strategy dependent on a probabilistic interest examination (PDA), which has the benefit of high estimation effectiveness, is utilized to fit the delicacy surface in this investigation. The connection between middle designing interest boundary (EDP) and the chose IM yields a direct model (Nielson and DesRoches, 2007):

Influence of wind attack angle

For a transmission tower, the breeze may come from any course, and five breeze assault points of 0, 22.5, 45, 67.5, and 90 are chosen because of the biaxial evenness, as characterized in Fig. . A definite portrayal of figuring the breeze loads for each wind assault point can be found in important principles; hence, it isn't given here (ASCE-No.74, 2010; IEC60826, 2003). The LS records dLS of the transmission tower at different breeze assault points are additionally determined as given in Table 3. It tends to be seen that a definitive twisting limits of the utilized transmission tower at various breeze assault points are unique, and the basic breakdown uprooting at the breeze assault point of 0 is the biggest. In view of the introduced cycle of building the delicacy surface, the nonlinear unique reactions are assessed, and the relapse coefficients at different breeze assault points are then inferred as recorded in Table 4.
Therefore, the delicacy surfaces for various breeze assault points are gotten as demonstrated in Fig. . The states of every one of these delicacy surfaces are fundamentally the same as yet the scopes of essential breeze speed fluctuate broadly, demonstrating that the breeze assault point has incredible effect on the delicacy surface and the most horrible breeze assault point is 90. Likewise, it very well may be presumed that the breeze load relies upon the breeze speed as well as the breeze heading.

Ls indices Dls for the transmission tower at various wind attack angles (unit: m).

	DAMAGE STATE			
Wind attack angle In degrees	Slight(50% Dcollapse)	Moderate (75% Dcloppase)	collapse	
0	.3645	0.54675	0.729	
22.5	0.273	0.4095	.546	
45	0.215	.3225	.430	
90	0.227	.3405	0.454	

5.DYNAMIC ANALYSIS

A pinnacle line coupled framework that comprises of three pinnacles and two arrangements of wires was utilized to lead the unique investigation (Fig. 7), both pinnacle and transmission lines are demonstrated in full scale, among which just the halfway pinnacle is considered, towers at the two sides are displayed to mimic the limit condition. The pinnacles are demonstrated as bar section components. The component type is Timoshenko radiates which takes into account cross over shear disfigurement and can be exposed to enormous pivotal strains. The worldwide size of scattered components is around 0.58 m, leg individuals are partitioned into 12 components, askew individuals are partitioned into 16 components and repetitive individuals are apportioned into 3 components. Versatility is remembered for the component's reaction through a lumped pliancy model with kinematic solidifying, which licenses yielding just at the closures of the component. Material property including versatility and pliancy is addressed in a bi-direct structure, the modulus of flexibility is 206GPa. Since the most horrible breeze assault point is along the transvers bearing, the functioning state of every part is resolved. For the compressive individuals, locking qualities decided in Section 3.4 are considered as extreme strength, for the pliable individuals, extreme strength is the elasticity. For the two individuals isotropic solidifying state is addressed by an ideal plastic material. The ranges of the transmission lines are 490 m and 440 m individually, all conveyor wires and ground wires are partitioned into components with length of two meters. The wires are demonstrated as strain just support components, all pin-associated with the covers. The end associations of the covers with tower structure are likewise stuck finishes. Pinnacles have fixed associations on the ground. Prior to the embraced dynamic investigation, a modular examination was completed to assess the pinnacle line coupled framework include. The principal mode state of pinnacle is the horizontal gloabal twisting with the recurrence of 1.760 Hz, and the subsequent mode shape is bowing along the longitudinal bearing with the recurrence of 1.766 Hz, trailed by a progression

of neighborhood vibration mode shapes until the sixteenth mode shape with worldwide twist. In the interim, the initial two modular frequencies of conductors are 0.1173 Hz and 0.1277 Hz. The reproduced wind speed comprises of normal breeze speed and choppiness. The stature of the pinnacle is 76.5 m, wind attributes fluctuated essentially at such reach, Kaimal range is reasonable for the situation as it represent the trademark change along tallness. Choppiness wind speed time history is created through Kaimal range.

6.STATIC ANALYSIS

Albeit customary plan techniques see towers as support structures, ongoing examination has shown that leg individuals can move critical bowing second. Chan led exploratory examination on single point swaggers and contrasted the bearing burdens and those anticipated by configuration code formulae and mathematical investigation, and inferred that more exact extreme burden expectations could be given by considering the impact of joint fixity which was bigger than the stuck joint condition [17–19]. Jiang led full-scale model trial of cross section transmission pinnacles to decide the joint erraticism impacts and slippage impacts, results showed that joint models with fixity could foresee the pinnacle relocations with sensible designing exactness [20]. Leg individuals are associated either by gusset plates with various darting design or by covering the adjoining leg individuals, both association strategies can move the bowing second, in the interim corner to corner individuals and auxiliary bracings are associated with natural unusualness, second-request minutes can be sensibly thought to be through shaft components. Therefore, in the proposed analyzing technique here, the tower forces and bending moments to that of axial force, if transverse forces and bending moments are negligible small to the axial force, then the element is defined to be controlled by buckling strength.In the static investigation system, wind loads, just as the heaviness of transmitter wires and ground wires, were applied as direct powers toward the association locale on the cross arm. Gravitational loads and wind stacks that forced on the pinnacle structure were applied straightforwardly on the pinnacle structures. The pinnacle was partitioned into 11 boards and 4 cross arms,wind heaps of each panel were determined independently as per the Load code for the plan of building structures [21], and equitably applied on the four corner support leg individuals or straight forwardly to the cross arms. The breeze profile power law relationship is utilized to reenact the breeze load where the chose landscape is open territory with dispersed deterrents. Distinctive whirlwind were duplicated with wind loads as indicated by the difference in tallness. From the field perception, the most ominous breeze heading was opposite to transmission lines After separating the inward powers from static examination results, the proportion of cross-area powers to hub powers are in the scope of 0.4%~0.7%, first-request pressure brought about by minutes are much irrelevantly more modest than that. In such manner, wind safe limit of a pinnacle is dictated by clasping strength.

CONCLUSIONS

Transmission towers are powerless to fall under wind load. Following the annihilation brought by typhoonMujigae, a site examination was directed where disappointments of suspension tower was recognized. Subtleties of transmission line influenced by Typhoon Mujigae is acquainted concurring with the site examination. One common stream crossing tower, a 220 kV circuit suspension tower is broke down. By proposing the static non-straight clasping examination, a definitive limit and weak boards of the explored tower under measurement wind power are resolved. The basic clasping point of every part including leg part what's more, inclining part in tower body is determined by three codes, and the planned clasping strength of the part is thought about when playing out the powerful investigation. Results are well steady with discoveries of the site examination. The ends are drawn from the two mathematical systems as follows:

- Nonlinear investigation of pinnacle construction can anticipate the weak boards in a fast and straightforward manner, a definitive limit assessment results are additionally worthy. However, the assurance of weak part should be checked utilizing dynamic examination.
- Dynamic investigation ought to be embraced to anticipate the pinnacle conduct all the more precisely under wind load, the vibration of transmission line is remarkable that it changed the heap design applied to the pinnacle structure, delicate individuals controlled by powerful examination is diverse with the ones anticipated by the static nonlinear investigation.
- Diagonal individuals are routinely planned as parallel preparing for the leg individuals, nonetheless, as per the powerful investigation, slanting part ends up being the delicate part, accentuation ought to be laid on planning of askew individuals.

- An example size of 20 can give sufficient precision to produce arbitrary examples for the vulnerability tower model, and the connection among EDP and the chose IMs (wind speed and downpour force) yields a direct model.

- It can be seen from the delicacy surface that the breeze speed has more noteworthy effect on the delicacy likelihood than the downpour force. For lighter downpour forces, the delicacy surface changes unexpectedly, which ought to be focused harder.

- The delicacy bends at different downpour powers move to one side with expanding precipitation force. The moving distance is moderately huge for light downpour forces, while for weighty downpour powers bigger than 100 mm/h, the delicacy bends are extremely close.

- The greatest disappointment likelihood of the transmission line during tropical storm Hagupit is just 5.04e-12. Expecting a fixed downpour force of 100 mm/h during tropical storm Hagupit, the most extreme disappointment likelihood can reach 25.41%, demonstrating that the disappointment likelihood will increment altogether if heavier downpour powers and more grounded wind speeds happen simultaneously.
- With expanding precipitation force, the breakdown essential breeze speeds decline forcefully from the start and afterward tenderly. The breakdown essential breeze speeds with the downpour powers of 0 and 240 mm/h are 27.4 m/s and 23.7 m/s, individually. The thing that matters is generally huge, showing that the precipitation impact has a critical effect on the strength limit of transmission tower-line frameworks.

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