# Effect of Cyclonic Importance Factor on Industrial and Post Cyclonic Importance Steel Roof Truss

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*Abstract*— Considering the probability of cyclonic wind speeds are often exceeding the regional basic wind speeds in the coastal region, revised IS 875 Part 3:2015 presents the K4 factor (Cyclonic Importance factor) for increasing the design wind speed ($V_z$) with numerical values 1 .15 and 1.30 for Industrial structure and post-cyclone importance structures respectively (Such as school, Hospital, Communication tower etc.). Considering the randomness in the direction of wind – wind direction factor $K_d$, Considering area of structure - area averaging factor $K_a$, and combination of pressure and suction combination factor introduce in IS 875 part 3: 2015. This paper attempts to explore the impact of the $k_4$, $K_d$, $K_a$, $K_c$ factors on A-type steel trusses for 12 and 18 meter span with roof slopes 1 in 3, 1 in 4 and 1 in 5 for various building permeability conditions . The permeability conditions consist normal, medium and high building openings. The trusses have been modelled in STAAD. pro software. The results were generated for both industrial and Post cyclone importance structures. Comparisons were carried out for IS 875-1987 wind code and 2015 wind code with k4 factor including $K_d$, $K_a$ and $K_c$ factor.

***Key words:*** Cyclonic importance factor, $K_d$, $K_a$ and $K_c$ factor

## I. Introduction

Despite the improvements in regulations and design provisions for buildings, the economic impact and loss of life as a result of wind induced damage is still significantly high. Post hurricane investigations have repeatedly reported that wind and wind –driven rain have been the cause of extensive damage to building components. Very strong winds more than 80 km/h are associated with the cyclonic storms IS 875Part3:2015. Studies of wind speed and damage to buildings and structures point to the fact that the speed given in the basic wind speed map is often topped during the cyclones IS 875 Part3:2015. In order to ensure better protection of structures in the cyclonic region, the IS 875-Part3:2015 introduced the $k_4$ factor /Importance factor for enhancing the design wind speed calculations.

The wind direction factor $K_d$ recognize that the fact of reduced the probability of maximum wind coming from any direction and reduced probability of the maximum pressure coefficient occurring for any given wind direction.

It is well recognized that the incoming wind become increasingly uncorrelated as the area considered increased. Such that, the reduced correlation is deemed to be accounted for introducing the area reduction factor $K_a$.

When taking wind loads on frames of clad buildings it is reasonable to assume that the pressures or suctions inside and outside the structure shall not be fully correlated. Therefore the combined effect of wind loads on the frame, a reduction factor of $K_c$ (Combination factor) may be used over the building envelope when roof is subjected to pressure and internal pressure is suction, or vice-versa.

Industrial buildings, a subset of low- rise buildings are normally used in steel plants, automobile industries, utility and process industries, thermal power stations, warehouses, assembly plants, storage, garages, small scale industries, etc., and these buildings require large column free areas. A-type Steel trusses are commonly used in all industries and hospitals, laboratories for spans ranging from 9 m to 30 m.

This study attempts to explore the impact of the $k_4$, $K_d$, $K_a$ and $K_c$ factor on A-type steel roof trusses for 12 and 18 meter span with roof slopes 1in 3, 4 and 5 for various degrees of building permeability conditions. The permeability conditions consist normal, medium and high building wall openings. The trusses are modelled in STADD.Pro software. The general loading on these trusses have been adopted from IS 800-2007 Code Provisions. The results were generated for both industrial and Post cyclone importance structures. Comparisons were presented with the existing code for wind load.

## II. Methodology

Load calculation carried out as per IS 875 – 2015 (part 3)

### A. *Wind Load Calculation*

Design Wind Speed (Vz)

$$V_z = V_b * k_1 * k_2 * k_3 * k_4$$

Where,
$V_z$ = design wind speed at height z, in m/s (see fig. 1 IS 875 2015)
$k_1$ = probability factor (risk coefficient) (see 6.3.1)
$k_2$ = terrain roughness and height factor (see 6.3.2)
$k_3$= topography factor; and (see 6.3.3)
$k_4$ = importance factor for the cyclonic region (see 6.3.4)
Design Wind Pressure (Pd)
$P_z = 0.6*V_z*V_z$
Where,
$P_z$ = wind pressure at height z, in N/m$^2$; and
V= = design wind speed at height z, in m/s.
The design wind pressure $P_d$ can be obtained as,
$P_d = K_d\, K_a\, K_c\, P_z$
Where,
$K_d$ = wind directionality factor, (see 7.2.1)
$K_a$ = area averaging factor, and (see 7.2.2)
$K_c$ = combination factor (see 7.3.3.13)
The value of $P_d$, however shall not be taken as less than 0.70 $P_z$.
Wind Pressures and Forces:
F = (Cpe – Cpi) A $P_d$
Where,

$C_{pe}$ = external pressure coefficient, (see 7.3.2.1)
$C_{pi}$ = internal pressure coefficient, (see 7.3.2.2)
A = surface area of structural element or cladding unit, and
$P_d$ = design wind pressure.

### *B. Dead Load Calculation*

The dead load is due to sheeting or decking and their fixture, insulation, weight of purlins, and self-weight of truss. The self-weight of roof truss should be calculated by formula: ((span/3) +5)*10 N/m$^2$. Weight of roofing sheet (AC, GI sheet) should be taken 131 N/ m$^2$. (as per IS – 875 (part 1): 1987, and some miscellaneous load 35 N/ m$^2$.

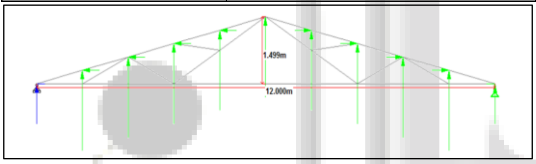
### *C. Live Load Calculation*

The design of live load should be done by IS: 875 (part 2): 1987.
Live load = 2/3 * (750-20(α-10)) N/ m$^2$

## III. MODEL DESCRIPTION

A type steel roof truss is modelled and analyses in STADD pro. By following data:

| | |
|---|---|
| Span | 12m, 18m |
| Pitch | 1:3, 1:4, 1:5 |
| Wind Speed | 44 m/s |
| Permeability | Normal, Medium, High |
| Eaves height | 6 m |
| Spacing of truss | 6 m |
| Spacing of purlins | As per nodal joint spacing |




## IV. ANALYSIS AND RESULTS

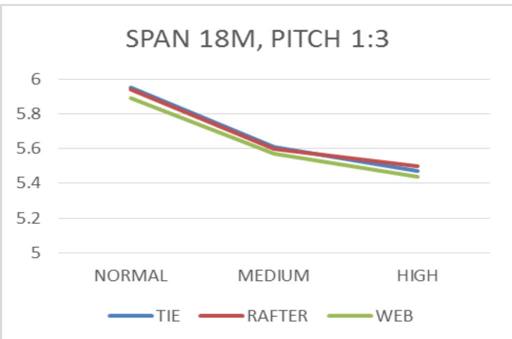
Models with variation of span of truss, pitch of roof and different permeability condition are analysed in STAAD.pro and response of axial force in TIE, RAFTER and WEB by considering industrial building and post cyclone important structure as follows:

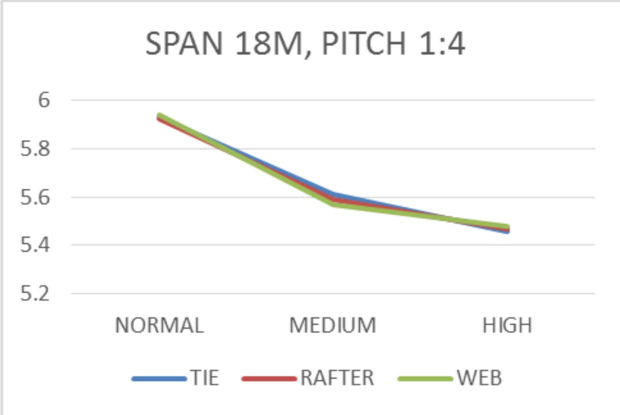
Variation in member forces of rafter, tie, and web, by considering wind load calculation as per IS 875: 1987 and IS 875: 2015 is found out by following formula:

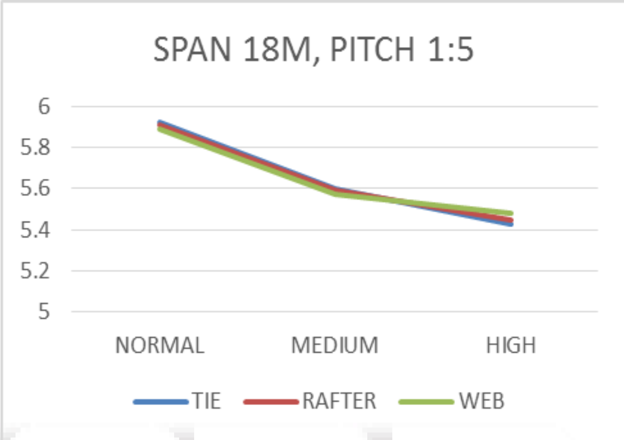
Percentage variation =

$$\frac{(\text{Axial force as per IS 875:1987})-(\text{Axial force as per IS 875:2015})}{\text{Axial force as per IS 875:1987}} \times 100$$

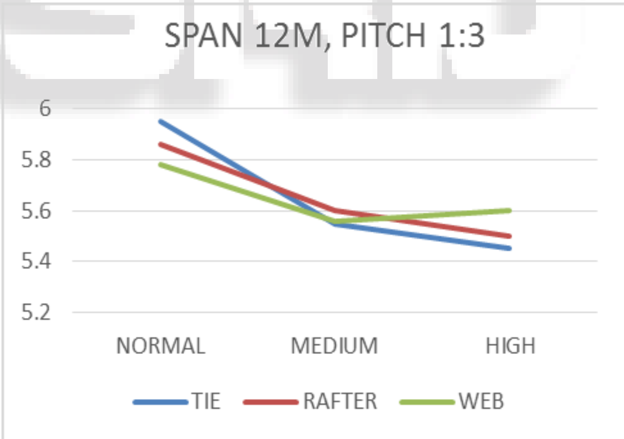
### *A. Variation pattern in axial force on 18m span in industrial building is as follows*

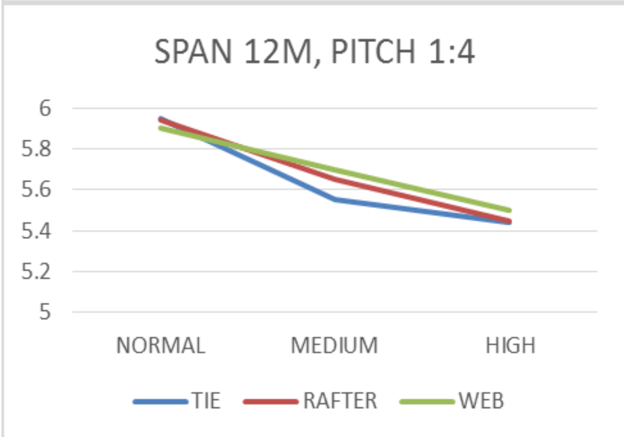


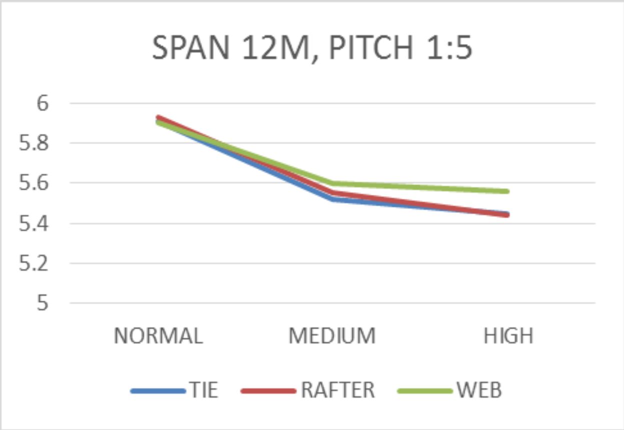




### *B. Variation pattern in axial force on 12m span in industrial building is as follows*

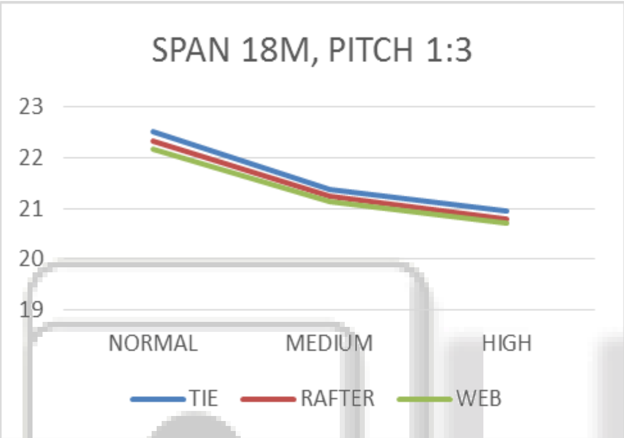


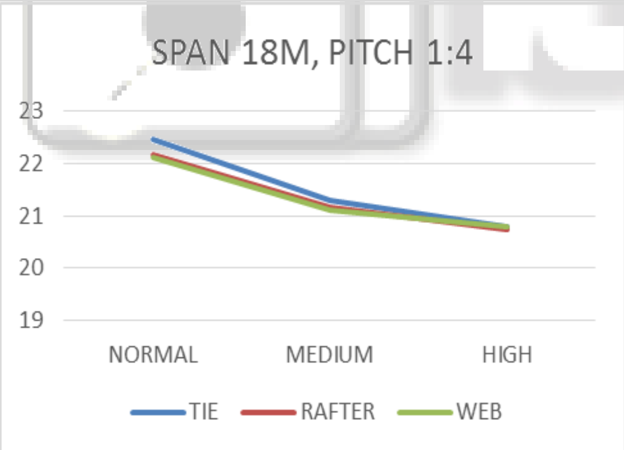



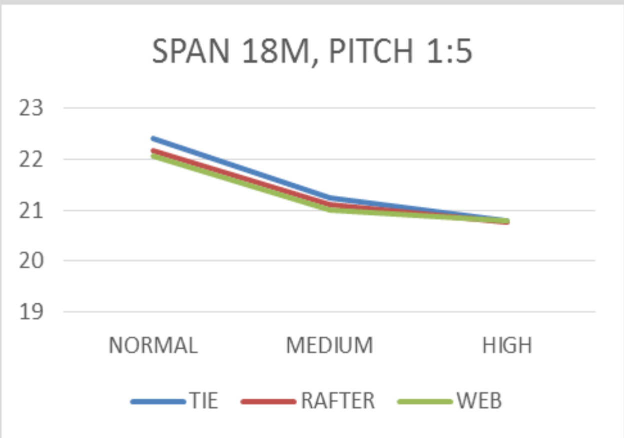

 



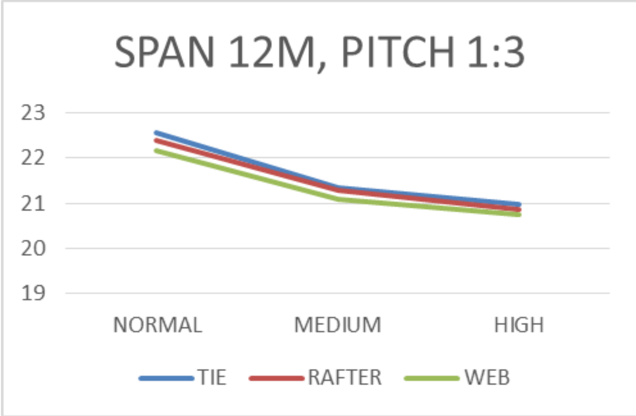

*C. Variation pattern in axial force on 18m span in post cyclone important structure is as follows*

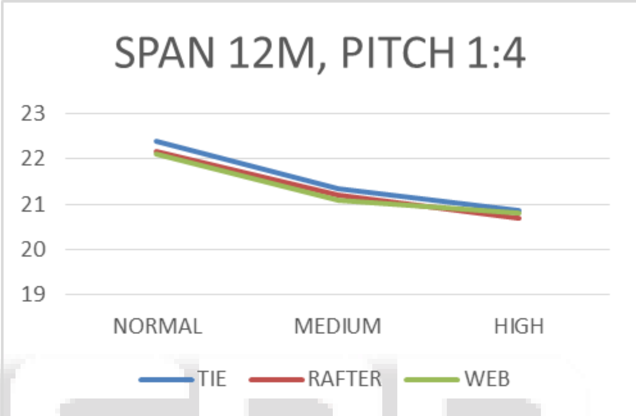


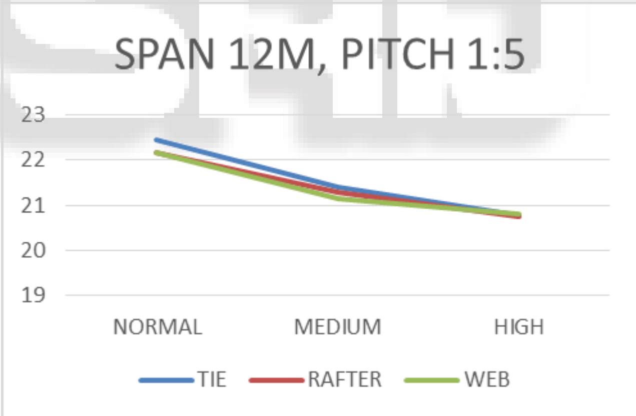




*D. Variation pattern in axial force on 12m span in post cyclone important structure is as follows*




## V. CONCLUSIONS

- As per analysis result we can conclude that the variation in member force for industrial building is increased by 5% to 6% and for post cyclone important building the value increased by 20% to 23% considering new IS 875: 2015 part 3.
- The variation in the result is independent to the span and pitch of roof truss.
- It depends on permeability, if permeability increases the value of variation in member force decreases, which is shown in variation graphs.

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