

Rayleigh Frequency Calculation



[Bhawna Thuley](#) *over 10 years ago*

Hi

I am using STAAD 2006 to analyse and design Generator Foundation of a power house. If during load application , I add

"CALCULATE RAYLEIGH FREQUENCY" COMMAND what difference would it bring to the analysis results. I have found that there is no difference in the results even if I dont add the above command.

Please suggest me usefulness of using CALCULATE RAYLEIGH FREQUENCY"

command.

Thanks & regards

Bhawna



[saraswathi.l](#) *over 10 years ago*

You would get an additional item in the output file similar to the following :

***** * * * RAYLEIGH FREQUENCY FOR LOADING 1 =

3.13870 CPS * * MAX DEFLECTION = 1.21727 INCH GLO X, AT JOINT 7 * * *

There would be no other difference



Sue Kalyanam *over 6 years ago in reply to saraswathi.I*

I did the same as bhawna@delhi but did not see any additional item in my output file. Am I missing something? Where should I be looking for this output?



Offline Sye *over 6 years ago in reply to Sue Kalyanam*

The analysis output file should have an output similar to the one below

```
*****
*
* RAYLEIGH FREQUENCY FOR LOADING    2 =  32.04902 CPS *
* MAX DEFLECTION = 0.03071 INCH GLO Y, AT JOINT    21    *
*
*****
```

If you are unable to find it, from inside the output viewer, choose the top menu item Edit > Find and in the search box type "Rayleigh" and click on Find Next. First it would highlight your input command. Click on Find Next again and it should take you right to the location where the frequency output is.



Sue Kalyanam *over 6 years ago in reply to Sye*

Thanks! What also helped was entering the command "PERFORM ANALYSIS PRINT STATICS CHECK" right after the RAYLEIGH command. The same output that you show above populates.



Offline Sye *over 6 years ago in reply to Sue Kalyanam*

Yes. You have to have a PERFORM ANALYSIS command for an analysis to be carried out in STAAD.Pro and for any kind of analysis output to be available.



Anonymous *over 10 years ago*

The mentioned command will calculate fundamental natural frequency of foundation. You can say that this is natural frequency of foundation of first mode as foundation is assumed to vibrate in static vibrated shape. As you are doing generator foundation you will need this frequency to avoid any resonance with machine frequency.

Hope it helps.



Offline sureshprsharma *over 8 years ago in reply to Anonymous*

If Raleigh frequency is the natural frequency of the first mode of vibration then why does it not match with the 1st mode frequency obtained from the command "modal calculation requested". I shall be glad to receive the views of all who can share.



SKLose *over 8 years ago in reply to sureshprsharma*

The Rayleigh method isn't guaranteed to provide a frequency that resembles that of the first mode.

The frequency from the Rayleigh method will match the lowest mode's frequency only if the structure is loaded in such a manner that the displaced shape resembles the shape of the lowest mode.



Offline sureshprsharma *over 8 years ago in reply to SKLose*

I vaguely understand that Rayleigh Frequency should be close to the frequency obtained from more than 90% participation of the mass of structure in the first mode. Is it correct? The structure with shear wall will never have 90% participation after any number of cut off mode, Does it imply that Response Spectrum method of analysis is not valid for frames with shear wall?

I request one and all to clarify



Atilio Andrade *over 8 years ago in reply to sureshprsharma*

RAYLEIGH METHOD : Method based on energy conservation

During the oscillation of the system the sum of the kinetic energy and elastic energy remains constant.

When the kinetic energy is maximum the elastic energy is zero (1) and backwards

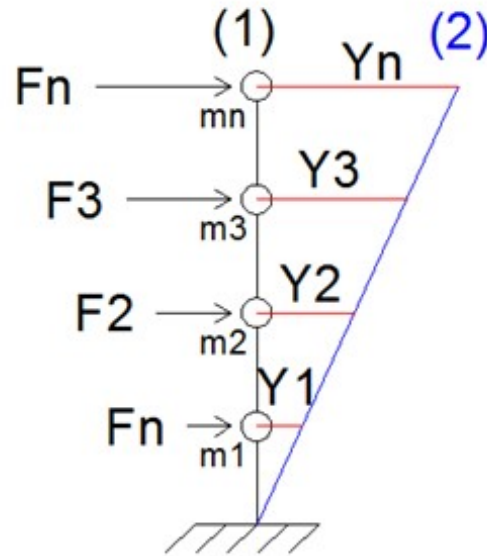
(2).

In (1) $E_k \max = \frac{1}{2} \sum m_i \times v_i^2$ and $E_e = 0$

In (2) $E_e \max = \frac{1}{2} \sum F_i \times Y_i$ and $E_k = 0$

Energy remains constant so : $E_e \max = E_k \max$

$$\frac{1}{2} \sum m_i \times v_i^2 = \frac{1}{2} \sum F_i \times Y_i \quad (\mathbf{A})$$



This method is used to obtain the approximate frequency of the first mode of vibration, then the frequency to be determined is w_1 and displacement are similar to the first mode.. That said that we use a vertical distribution of the force similar to the first mode (linear deformation in this case some codes suppose a parabolic deformation)

Where :

$F_i = f_i \times h_i / \sum f_i \times h_i$ where $f_i = m_i \times g$ (Distribution of the force assuming a linear deformation)

m_i = mass at i level

Y_i = displacement produced by the forces F_i

And

$$V_i = Y_i \times w_1 / 2\pi \quad (\mathbf{B})$$

w_1 = frequency of the first mode of vibration (all the masses vibrate with the same frequency)

Replacing (A), (B) and ordering:

$$w_1 = (1/2\pi) [(\sum F_i \times y_i) / (\sum m_i \times y_i^2)]^{1/2} \quad \text{(RAYLEIGH FREQUENCY)}$$

So i think that you can use when you have regular structures, the shear wall change the participation factor but I think taht this is a good method for participation factors of up to 60 percent in the first mode (regular geometry and stiffness of the memebers) , I dont know wat kind of deformation STAAD suppose for the first mode (Linear or parabolic).

I atach an example

At 8 mts column with a concentrated weight of 10 KN in three levels.



It's a Concrete column of 0,20x0.40 mts

STAAD CALCULATION

The Rayleigh frequency for this load case in the z direction, using STAAD is 2,48496 CPS

```
*****
*
* RAYLEIGH FREQUENCY FOR LOADING      1 =      2.48496 CPS  *
* MAX DEFLECTION =  5.19892 CM  GLO Z,  AT JOINT      3  *
*
*****
```

MANUAL CALCULATION

Wi (KN)	mi(Kg)	hi(m)	Fi(KN)	Yi(m)	Fi*yi	mi*yi ²
10	1.01936799	6	0.5	0.002175	0.0010875	4.8222E-06
10	1.01936799	4	0.33333333	0.001166	0.00038867	1.3859E-06
10	1.01936799	2	0.16666667	0.000348	0.000058	1.2345E-07
0	0	0	0	0	0.00153417	6.3316E-07

$m_i = W_i / g$ ($g = \text{gravity} = 9,81 \text{ m/s}^2$)

$h_i = \text{height (m)}$

$F_i = W_i \times h_i / \sum W_i \times h_i$



$y_i = \text{displacement because of } F_i \text{ forces}$

$w_i = (1 / 2\pi) [(\sum F_i \times y_i) / (\sum m_i \times y_i^2)]^{1/2}$

$w_i = 2,477423 \text{ CPS}$

Difference between STAAD And manual calculation = 0,30 %

I HOPE THAT THIS WILL BE HELP YOU (SORRY FOR MY ENGLISH)

ING. ATILIO ANDRADE



Offline [sureshprsharma](#) over 8 years ago in reply to [Atilio Andrade](#)

Mr. Andarde,

i) How have you calculated the value of Y_i in the table. Is it the displacement caused by the force F_i ?

ii) The unit for F_i in the table is KN but in the fourth line above the bottom the unit of F_i is CPS. I trust this is typographical error. I believe ω_i (omega i) has been mis typed as F_i . Further I feel that the factor 2π should come in the denominator in lieu of numerator if the unit is CPS i.e. cycle per second i.e frequency

Please elaborate.



Atilio Andrade over 8 years ago in reply to [sureshprsharma](#)

i) Yes Y_i is the displacement caused by F_i . I generated the column and then I apply the F_i forces at the different levels, so I get the displacements.

ii) Yes F_i are the forces and ω_i the frequency and 2π is really $(1/2\pi)$ I fix this, I considered this previously in the calculation but I forgot to correct in the development

Sorry for the errors

Regards

Atilio

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