Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 9, September -2017

VIBRATION AND BUCKLING ANALYSIS OF A CRACKED STEPPED COLUMN USING FINITE ELEMENT METHOD

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ABSTRACT:- *Segments with shifting cross-areas are most basic in structures and scaffolds and additionally in machine parts. The dependability of such auxiliary individuals subjected to compressive powers is a point of significant logical and handy intrigue. Decreased and ventured sections are especially helpful in auxiliary building in view of their diminished weight contrasted with uniform segments for the same hub stack conveying limit or clasping loadIn the present examination free vibration and clasping investigation of a broke two ventured cantilever segment is dissected by limited component strategy for different compressive burdens. Straightforward pillar component with two degrees of flexibility is considered for the examination. Firmness network of the in place pillar component is found according to standard methods. Firmness framework for split pillar component is found from the aggregate adaptability lattice of the broke shaft component by converse strategy in accordance with break mechanics and distributed papers by specialists. Eigen esteem issue is fathomed with the expectation of complimentary vibration investigation of the ventured section under various compressive load. Variety of free vibration frequencies for various split profundities and break areas is considered for progressive increment in compressive load. Clasping heap of the section is assessed from the vibration examination*

1. INTRODUCTION

1.1 Tapered or stepped columns

Components with varying cross-sections are most common in buildings and bridges as well as in machine parts. The stability of such structural members subjected to compressive forces is a topic of considerable scientific and practical interest that has been studied extensively, and is still receiving attention in the literature because of its relevance to structural, aeronautical and mechanical engineering. Tapered and stepped columns are very much useful practically in structural engineering because of their reduced weight compared to uniform columns for the same axial load carrying capacity or buckling load. Stepped columns are also frequently used in multistory structures where columns have to support intermediate floor loadsTo attain reduction in weight and decrease costs of steel carrying structures, the engineers tend to design steel columns as multi-stepped carriers with a non-uniform cross-section. Since columns are usually compressed by applied, self-weight, etc., one of the most important aspects of using such carriers is their elastic stability.

1.2 Cracks in columns

Columns are important structural members and their stability under different cases of loading is studied by many researchers to obtain critical buckling loads and critical stresses. The cracks may develop from impact, applied cyclic load, mechanical vibrations, aero-dynamic loads etc. Due to the effect of fault or weakness that occurred due to crack in a cracked section, the stability of column may be decreased. The critical buckling loads of cracked columns are affected by effect of depths, locations, and number of cracks. Cracked section is modeled as massless rotational spring.Since axial load and stiffness are not constant along the length of the column the analysis of a stepped column is usually much more complicated than uniform column. The change in the cross-sectional areas and distribution of loads generates discontinuity in deriving the deflection equation of a stepped beam. Connection between foundation of a structure and super structure is most vulnerable and damage locations during and after earthquakes. So, a stepped column is used to palliate or retrofit such disadvantage. Stepped column is used to substitute rigid connections between foundation and upper structure.The study of cracked structures and members are topic of study for decades and many researches are still going on the topic. A fault in the structure causes serious damage to the structure if left unchecked. When a structure is damaged due to crack, modal parameters assigned with the structure are greatly affected because due to damage to a structure the stiffness of the structure is decreased. Many researches are currently are concerned on damage location and damage size. The main study is concerned on extent of damage and location of damage. Many damage detecting methods use sensitivity method which uses natural frequencies. These frequency based method require a lot of computations especially for large and complex structures. Frequency changes alone are not sufficient to damage position. Similar frequency changes may occur for different damage positions. Vibration mode shapes can be heavily influenced by local damage. The greatest change occurs around the defect, thus offering the possibility of locating the damage.

COMPUTATIONAL PROCEDURE

To obtain the frequencies for vibration of beam for different crack locations, crack depths and different percentages of loading by using finite element method, a finite element computational software Matlab R12b is used. Matlab R12b is user friendly, its name is derived from its functioning formula translating system, and it is used for optimization of mathematical process. Matlab R12b is used in computationally intensive areas such as numerical weather prediction, finite element analysis, computational fluid dynamics, computational physics and computational chemistry.

4.1 Current study

Problem considered under current study is a 2 stepped column with each step 0.15m and total height of column 0.3m with depth of cross section of upper step is 10mm and depth of cross section of below is 10mm and the breadth is maintained a constant value of 10mm. the young"s modulus of the material is 68.215GPa, poisons ratio is 0.28, and the density of the material is 2569 kg/m^3.In the current study free vibration and buckling analysis of a cracked two stepped cantilever column is analyzed by finite element method for various compressive load. Simple beam element with two degrees of freedom is considered for the analysis. Stiffness matrix of the intact beam element is found, Stiffness matrix for cracked beam element is found from the total flexibility matrix of the cracked beam element by inverse method in line with crack mechanics.Eigen value problem is solved for free vibration analysis of the stepped column under different compressive load. Variation of free vibration frequencies for different crack depths and crack locations is studied for successive increase in compressive load. Buckling load of the column is estimated from the vibration analysis.First critical buckling load of the stepped column is obtained from the computational procedure by using Matlab R12b. Then frequencies of the stepped column by varying different parameters such as crack depth, crack location, loading are found.

RESULTS AND DISCUSSION

At a crack location 0.2L and for crack depth of 0.8d the decrease in percentage of the frequencies for the increase in load compared to intact beam under free vibration is due to presence of crack even at free vibration the decrease in 4th frequency is 16.8% at 20% of buckling load the decrease is 17.27%, at 0.4 Pcr the decrease is 100% and the percentage in decrease of frequency increase to 100% at 0.6P and it decreases by 100% at 0.8P. Because due to lateral load, column buckles due to greater crack depth where the effect of the crack is higher.

At a crack location 0.12m and for crack depth of 0.8d the decrease in percentage of the frequencies for the increase in load compared to intact beam under free vibration is due to presence of crack even at free vibration the decrease in 4th frequency is 0.27% at no load case and as load increase to 0.2P the decrease in frequency increase to 0.69% and with further increase in load to 0.4P the decrease in frequency becomes 1.12% and the decrease in frequency becomes 100% at a load of 0.6P and it becomes 100% at 0.8P. Because due to lateral load, column buckles due to greater crack depth where the effect of the crack is higher.
With a depth of crack 0.8d and at a crack location 0.18m the decrease in frequency of the cracked beam with respect to intact beam under free vibration for 4th frequency is 12.22% for no load case and the reduction in frequency becomes 12.82% for 0.2P and with increase in load to 0.4P the decrease in frequency becomes 100% and the decrease in frequency is further increased to 100% for a load of 0.6P and it becomes 100% for a load of 0.8P. Because due to lateral load, column buckles due to greater crack depth where the effect of the crack is higher. The decrease in % of 4th frequency with respect to frequency of intact beam at free vibration at a crack location 0.8L and crack depth 0.8d is 19.22% at no load case and it is decreased by 19.63% at 0.2P and the decrease in 20.03% of frequency at 0.4P and it increases to 100% at 0.6P and at 0.8P the decrease in frequency becomes 100%. Because due to lateral load,

CONCLUSIONS

1. The free vibration frequencies of a cracked stepped column decrease than the intact column for a crack of any depth and location in the column. However this decrease in free vibration frequencies is marginal for cracks of small depths and significant for larger crack depths. Thus the percentage of decrease in free vibration frequency increases with increase in crack depth.

2. 2.The free vibration frequencies are more influenced by the breaks display close to the settled end than free end. With the crack moving away from fixed end it loses its effect on free vibration frequencies and finally when the crack is near free end its effect is negligible.

3. When a crack in a stepped column coincides with the step of the column there is a severe drop in free vibration frequency. This is due to the fact that the section where the depth of the column decreases abruptly, there is a severe loss of stiffness of the cracked section.

4. The free-vibration frequencies under compression load decreases with increase in load than the free vibration frequencies under no load condition.

5. The load under which free vibration frequency vanishes or approaches zero can be assumed to be buckling load of the column.

6. The effect of the axial compressive load on the natural frequency can be considered linear for any value of crack depth.

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