National Journal of Multidisciplinary Research and Development
www.nationaljournals.com
ISSN: 2455-9040
Received: 26-06-2022, Accepted: 14-07-2022, Published: 27-07-2022
Volume 7, Issue 2, 2022, Page No. 12-13

A review study on stepped beam using spectral finite elements

Nitesh Kumar[1], Sandeep Pannu[2]
[1] Department of Civil Engineering, (Structural Engineering), Maturam Institute of Engineering and Management, Rohtak, Haryana, India
[2] Assistant Professor, Department of Civil Engineering, Maturam Institute of Engineering and Management, Rohtak, Haryana, India

Abstract
The spectral element method provides a frequency dependent dynamic element stiffness matrix without regard to the element's length or size. After this Stiffness Matrix has been formulated for an element, the global Dynamic Stiffness Matrix can be obtained by following a procedure that is comparable to that of the Finite Element Method (FEM). The fact that even higher frequencies of a structure may be attained by examining just a small number of the matrix's components, hence reducing the amount of computing that has to be done, is one of the matrix's primary benefits. One may acquire the higher mode natural frequencies of a stepped beam by this method. Only two spectral components were to be taken into consideration in order to determine the natural frequency of a stepped beam up to the tenth mode.

Keywords: dynamic, stiffness, matrix, spectral, elements

Introduction

Because of the consistent input demands, issues with wave propagation might have significant short-term repercussions. Only by using a very short wave length and a very fine mesh size will you be able to produce mode shapes and natural frequencies. "It is conceivable to use time marching techniques in the context of the finite element," said the researcher. An investigation is carried out over a certain time frame, which is just a portion of the total amount of time for which response histories are necessary" [2]. It is difficult to tackle concerns relating to wave propagation when using certain time marching methodologies because of the constraint placed on the time step. The FE wave propagation model requires a large apparatus in order to capture all of the higher modes, which makes it difficult to simulate from a computing standpoint. The wave equation is used, as a matter of course, in order to solve the field variables, such as displacements, so that these difficulties may be conquered. Only by supposing that there is a solution at some point in time is it possible to solve the equation that governs waves. It is expected, while working in the frequency domain, that the governing equations can be solved in the correct manner. It is possible that the governing equations may benefit from the addition of a frequency parameter in order to make the issue easier to solve. A more recent example of an integral transform method is the wavelet transform. Other examples of integral transform techniques are Laplace and Fourier. These revised equations are substantially simpler to solve than the original partial differential equations (PDEs). When it comes to the amount of time spent computing, this system is superior than the FEM. These frequency-domain-transformed solutions make use of data derived from many waveforms.

Review of Literature

When SEM was initially discussed in full, Nariyanan [1] was the one who did it. For the purpose of performing dynamic analysis on planar frame systems, the dynamic stiffness matrix of the beam element was accurately constructed using FFT. Spectral analysis was often used in the domains of fluid dynamics, aeronautical engineering, and other related disciplines. Abdelhmid and McConnell [1] were the ones who came up with the idea of non-stationary field measurements originally.

Doeyle [2] gave a presentation about the "propagation of rods' longitudinal waves." His preliminary research was focused on the spectrum component of the problem. Doyle refers to the method of spectrum element analysis that is based on DFT and FFT as SEM. A comprehensive summary of the work carried out by the study group and other researchers up to the year 1998 may be found in Doyle's book [6]. A FFT-based Spectral Analysis Methodology was provided, in addition to information on "longitudinal and flexural waves" in the rods and beams of the structure. The author explains each of these topics in depth. In this article, you can also find some examples of the formulation of bar beam and plate plate spectral elements. Ferris conducted research on the beam flexural wave propagation by using the spectral formulation of the finite element.

By counting how many natural frequencies of a bending beam are clamped-clamped, an elegant and efficient alternative procedure was presented by Banerjee and Williams [5], which enabled the Welliams technique to be used simply for determining the natural frequencies of structures that included such members [4].

Advantages of Spectral Element Analysis

The SEM is a very effective instrument because it combines the adaptability of the FEM with the accuracy of the spectral technique. Because of the use of the SEM, the dynamics of elements of any length may be exactly solved for them. Simply simply making a change to the spectrum relation, you may quickly and easily include the effects of material viscoelasticity and damping. It is possible to include higher-order beam or rod theories into a system without resulting in an increase in the total number of degrees of freedom. It is possible to finish the assignment in reverse order. If one understands where to look, they will be able to find the disturbance that triggered the response and follow it back to its source.

Aspects that can't be left out of the investigation under any circumstances. It is possible to find a solution in the time domain by using the inverse transform. The use of Fourier transforms makes it possible to do very precise numerical differentiation. [Case in point:] [Case in point:] Spectral finite element technique, also known as FFT-based spectral finite element technique, is one example of this kind of technology. Utilizing the FFT in time, the first phase of the FSFEM process involves transforming the controlling PDEs into spatial ODEs. This is done by transforming the PDEs. According to the findings of study [5] "ODEs are solved accurately and utilised as interpolating functions" while generating FSFEs. [Citation needed] When using FSFEM, it is possible to directly extract the wave characteristics from a formulation, which leads to a decrease in the overall size of the system. This results in a smaller computational footprint. However, the Fourier transform is at its most useful when it is used to stationary signals that have an endless amount of coherence time. Although the Fourier transform has a broad number of applications in the scientific world, it is best known for its role in Fourier analysis. Because Fourier analysis can only provide access to global information, it is often used in the process of locating localised patterns.

Spectral Finite Element Approach

Facets that are absolutely necessary for the research. By using the inverse transform, one may arrive at a solution in the time domain. The use of Fourier transforms allows for the possibility of very accurate numerical differentiation. One example of this is a method known as FFT-based spectral finite element technique. In the first step of the FSFEM process, the controlling PDEs are transformed into spatial ODEs by making use of the FFT in time. When constructing FSFEs, "ODEs are solved precisely and employed as interpolating functions," according to [5] research. When employing FSFEM, it is feasible to directly extract the wave characteristics from a formulation, resulting in a reduction in the total size of the system. The Fourier transform has a wide variety of uses in the scientific community; nevertheless, it functions most effectively when applied to stationary signals that have an unlimited amount of coherence time. Only global information can be obtained by Fourier analysis, which is why it is used to identify compact patterns.

Conclusion

The natural frequencies of uniform beams with up to ten distinct modes have been shown by using two distinct numbers of spectral elements in a single experiment. It has been proven that the natural frequencies of stepped beams may be determined up to the ninth mode by analysing two components that have different cross-sectional areas. On this page, the natural frequencies of stepped and uniform beams under a variety of boundary conditions are shown for up to ten distinct modes of operation. In order to attain higher mode natural frequencies at a reduced overall computational cost, the spectral finite element approach is a method that has shown to be particularly efficient.

References

1. Banerjee JR, Williams FW. Vibration of composite beams-an exact method using symbolic computation. Journal of Aircraft,1995:32:636-642.
2. Banerjee JR, Williams FW. Exact dynamic stiffness matrix for composite Timoshenko beams with applications. Journal of Sound and Vibration,1996:194:573-585. 1996.
3. Banerjee JR, Williams FW. An exact dynamic stiffness matrix for coupled- extensional-torsional vibration of structural members. Computers and Structures,1994:50:161-166.
4. Banerjee JR, Williams FW. Coupled bending torsional dynamic stiffness matrix for Timoshenko beam elements. Computers and Structures,1992:42:301-310.
5. Banerjee JR, Williams F.W. Exact Bernouli-Euler Dynamic Stiffness Matrix for a ranged of Tapered beams. International Journal of numerical Methods in Engineering,1985:21:2289-2302.
6. Banerjee JR, Williams FW. Coupled bending torsional dynamic stiffness matrix of an axially loaded Timoshenko beam element. International Journal of solids structure,1994:31:749-762.