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Response of Structural Dynamics by Wilson Method- A Review

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Abstract: This paper deals with a comprehensive review of the Wilson method employed to study the structures which are subjected to dynamic loads and response of structures under varying loads in vibratory state. These structures are computed analytically examined and by considering various methods such as the Newmark β, the Wilson θ approach, etc. by many researchers. The equation of motion of structure is derived using the principle based on the Wilson method. The review is carried out with an emphasis to present the displacement, velocity and acceleration using different theories proposed by several researchers. The accuracy of variation of algorithms, type of loading, boundary conditions, and the effect of nonlinearity on the behavior of vibration is discussed in brief.
Keywords: Structural dynamics, Explicit, Natural Frequency, B-spline polynomial function, Direct integration method.

I. INTRODUCTION

A review paper cannot merely be a catalogue of all the articles [1-5] published on a subject, and can't include contributions of all the authors in a single paper. Therefore, this survey paper concentrates only on those contributions that are considered to be a milestone in the area of computational analysis of response of structure under dynamic loads. Importance of dynamic analysis for civil engineering structures have been increasing drastically these days, especially with regard to seismic loading, there has been a resurgence of interest in approximate methods for integrating the equations of motion. Step-by-step time integration algorithms are very famous for the computational analysis of structural dynamics. Efficient and accurate numerical integration methods have an inherent simplicity in solving Multi-Degrees-Of-Freedom (MDOF) problems of structural dynamics. Nonlinear problems in structural dynamics and for dynamic analysis of very large structures the time integration methods are the most suitable methods. Now a day, researchers are mostly concentrating in those numerical methods which not only provide better accuracy and stability, but also solve a problem in the least possible time.

Step-by-step integration methods can be categories in two basic parts those are Explicit and Implicit. If the current time - step is being used in determining the current step displacement in the equation of motion that method is called explicit if not used it is called implicit. Numerical stability can be obtained by the implicit algorithms which permitting large time steps, and parallel the cost per time step is high particularly in MDOF problems. Other than, explicit algorithms are inexpensive per step, can be implemented quite easily and require less storage as compared to the implicit algorithms, but numerical stability requires that small time steps be employed. Central difference methods are widely being in use in the step-by-step computational procedure. Nonlinear problems in structural dynamics are frequently solved by application of explicit time integration methods. Explicit is conditionally stabile that its main disadvantage that means there is a critical time-step, Δt_{cr}, which should not be exceeded in the analysis. The magnitude of this critical time-step depends on the largest natural frequency of the linearized system, and hence, on the size of the smallest elements in the structural model. There are so many researchers have given their methods for the computational analysis of structural dynamics, i.e. Newmark β, the Wilson θ approach, the Houbolt and the Wilson methods, etc. Now a day we are looking for straight forward and simple step-by-step method so for most applications, B-splines have become a widely accepted standard because of their flexibility and computational efficiency. Caglar et al. in a series of papers [6-7] used B-splines with various degrees to solve several mathematical Boundary Values Problems (BVPs). Liu [9-10] has employed using piecewise second or third-degree Lagrange polynomial, and piece wise Birkhoff interpolation polynomials for the solution of the dynamic response of a MDOF system.

This chapter reviews the past and present developments in the area of structural dynamics for finding the response, i.e. displacement, velocity and acceleration by using different-different methods. Researchers have found that all the methods can

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differentiate in two parts, i.e. Explicit and Implicit, where Implicit is for linear problems and for nonlinear problems Explicit is pertinent. Therefore, the developments related to structural dynamics methods have been mainly discussed in this chapter.

A. *The Wilson family of method*

Earthquake analysis of a large, complex structure is presented by Wilson et al. [[3]] in 1966. They have used finite element method to solve the system equilibrium equations. They have compared their results with various 'direct integration methods' and have proposed improved version of theta algorithms. By doing this they conclude that 'in step-by-step integration the Wilson method with θ=1.4 is much more accurate than the earlier reported averaging scheme and they have proposed that the method can be used for nonlinear analysis. In 1973 stability and accuracy analysis of direct integration methods in structural dynamics has presented by Wilson et al. [[4]]. They have used amplitude decay and period elongation as the basic parameters in order to compare various integration methods. They have studied the Newmark generalized acceleration scheme, the Houbolt method and the Wilson-θ method. The advantages of each of these methods have discussed. They have presented that a systematic and fundamental procedure for the stability and accuracy analysis of direct integration methods. They have applied to the Newmark β generalized acceleration method, the Houbolt method and the Wilsonθ method, which was optimized for integration accuracy. They have concluded that all of these methods will yield accurate results for certain types of problems. In addition, the relationship between direct integration and mode superposition has discussed with them. They have emphasized that the discussion of direct integration methods presented has been limited to linear problems while difficulties arise with the stability and accuracy of numerical methods applied to nonlinear systems, and further research is needed concerning such cases.

II. STRUCTURAL DYNAMICS BY FINITE ELEMENT TOOLS

In 2014 Harak et al. have developed a virtual freight wagon vehicle using virtual prototyping computer tools. They have considered freight wagon as open type wagon "BOXN25" of the Indian Railways. The freight wagon vehicle considered by them comprises of a car body structure and two bogies. They have used Solid works modeling the freight wagon and the geometry has exported to finite element tools, ANSYS. The structural dynamic response for the virtual freight wagon has determined and shown in fig. 2.1. They have shown that the car body deformation is influenced by its elastic underarm and side walls. The influence of different modes of vibration which describe local deflection on the comfort level and stability of laden goods had been discussed. Mode shapes up to a frequency of 30 Hz have considered by them. In 2014 Kiros has simulated a two degree of freedom nonlinear system with zero memory has, modeled and analyzed to show their behavior for different conditions. To achieve that results simulation of dynamic systems has used and analyzed using MATLAB by them. That was done by using sweeping sinusoidal function of force as an input and controlling the amplitude specially when determining the limits of chaos. In 2014 Soukup et al. have presented new algorithm by applying higher degree of freedom of the motion equation of the mechanical system of the vertical vibration of the vehicle. Mechanical model had been presented which is composed of three spatially elastically supported and bounded bodies. Model represents the chassis of railroad vehicle with elastic and dissipative elements. They have given the method which can determine the vertical displacement of the arbiary point of the system.

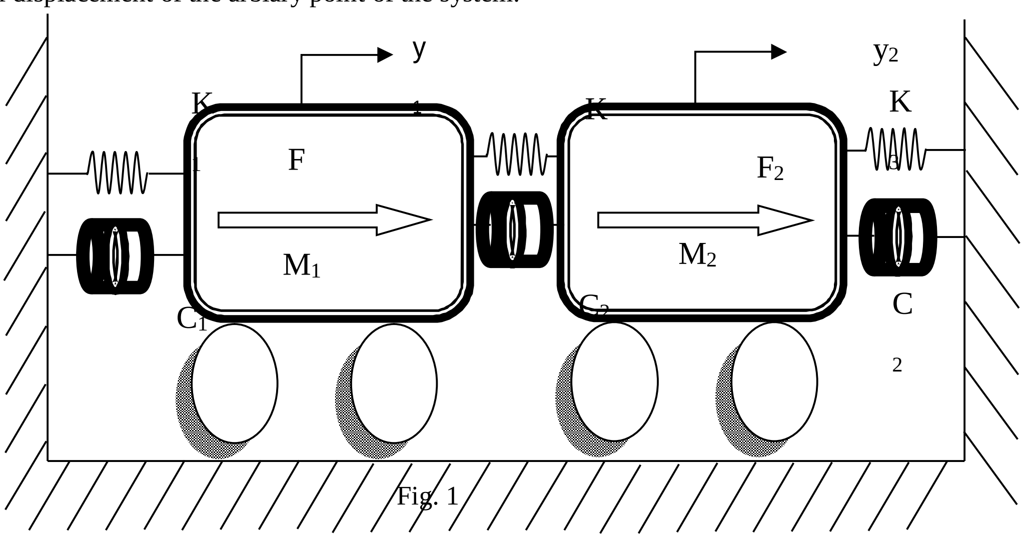

Fig. 1

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III. CONCLUSION

A thorough review of the existing literature on the time integration method used in determination response of structure under dynamic load was made.

A. Many researchers have used explicit as well as Implicit for finding response of structure under dynamic load for linear and nonlinear problems.

B. Implicit algorithms are accurate and stable but very time taking process and Explicit are easy to calculate but the problem is that Explicit is not stable, many researchers are trying to find stability and accuracy in Explicit.

REFERENCES

[1] Subbaraj K. and Dokainish M. A., 'a survey of direct time-integration methods in computational structural dynamics-II Implicit methods', Computers & Structures, Vol. 32, 1387-1401, (1989).

[2] Taylor W., Silva M. and Bezerra L. M., 'performance of composite Implicit time integration scheme for nonlinear dynamic analysis', Mathematical Problems in Engineering, Vol. 2008, 1-16, (2008).

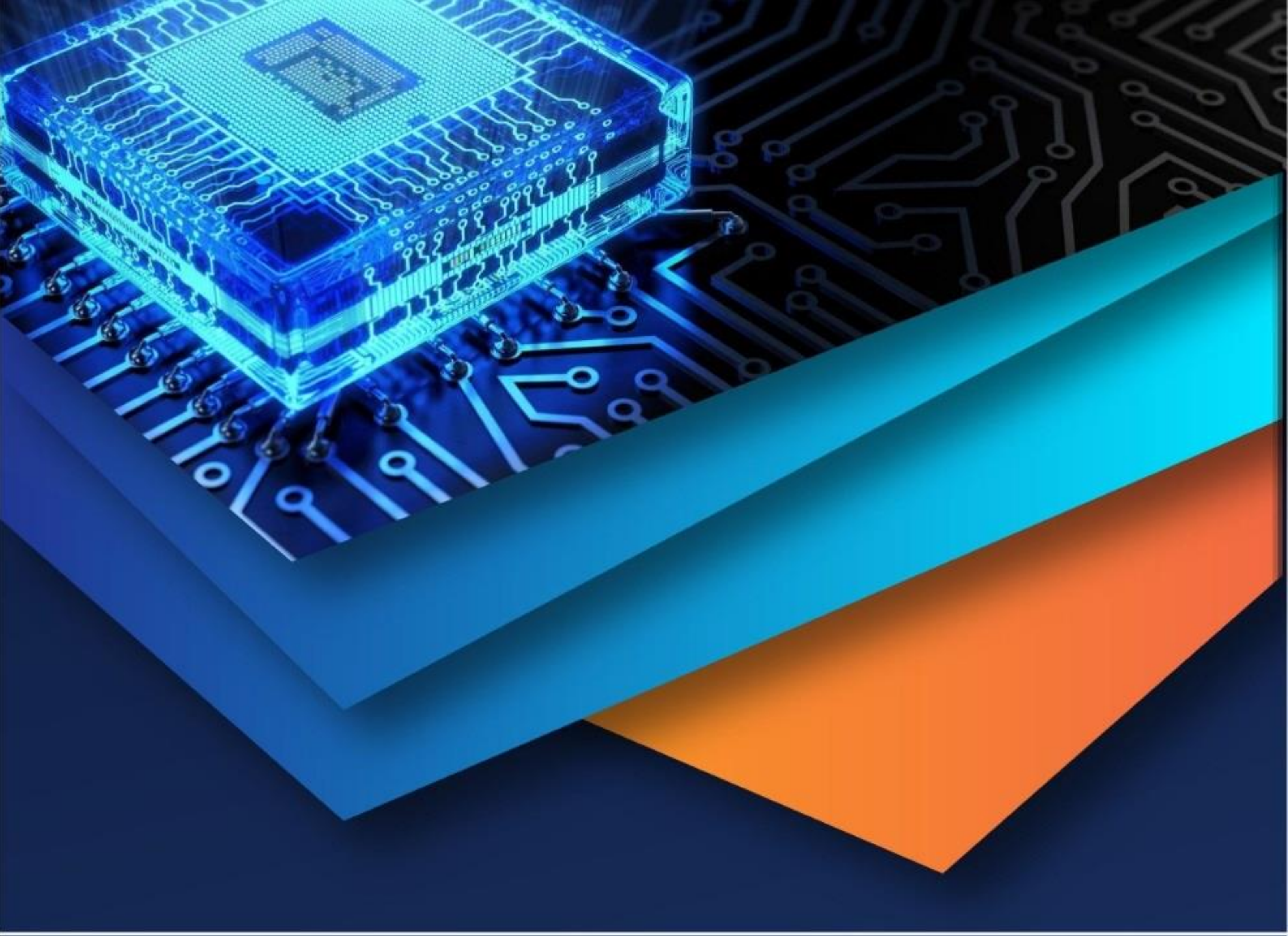
[3] Bathe K. J. and Wilson E. L., 'linear and nonlinear earthquake analysis of complex structures', Earthquake Engineering and Structural Dynamics, Vol. 1, 190-199, (1966).

[4] Bathe K. J., Farhoomand, I. and Wilson, E. L., 'nonlinear dynamic analysis of complex structures' Earthquake Engineering and Structural Dynamics, Vol. 1, 241-252 (1973).

[5] Bathe K. J. and Wilson E. L., 'stability and accuracy analysis of direct integration methods', Earthquake Engineering and Structural Dynamics, Vol. 1, 283-291, (1973).

[6] Noels L., Stainier L. and Ponthot P., 'energy conserving balance of Explicit time steps to combine Implicit and Explicit algorithms in structural dynamics', Comput. Methods Appl. Mech. Engrg., Vol. 195, 2169–2192, (2006).

[7] Miller K., Joldes G., Lance D. and Wittek A., 'total Lagrangian Explicit dynamics finite element algorithm for computing soft tissue deformation', Commun. Numer. Meth. Engg., Vol. 23, 121–134, (2007).



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