International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

FINITE ELEMENT ANALYSIS BASED DESIGN AND OPTIMIZATION OF A GAIT FREQUENCY STRUCTURE

Ruchita S Gawande[1], Dr Subim N Khan[2]

[1]*Student, Mechanical dept, RSCOE, Pune, Maharashtra, (India)*

[2]*Professor, Mechanical dept, RSCOE, Pune, Maharashtra, (India)*

ABSTRACT

Gait Frequency is the frequency a person generates while walking or running. if the frequency of the structure matches this frequency then the structure will resonate, and vibrate, and create discomfort for the person In this application however a structure is to be purposefully design at Gait frequency, the idea is that the structure will be used for training for emergency rescue personnel, who need to be ready to navigate an unstable structure The challenge is that the structure should be unstable in vibration but should be stable in stress, i.e. it should vibrate yet it should not fail and should be structurally sound. To optimize a model of beam structure static analysis and modal analysis are used. After optimization the structure is enhance its stiffness and reduction in weight. In this application however a structure is to be purposefully design at a prescribed frequency. Modal analysis of the structure in Ansys 16 workbench is done[1].

Key Words : CAE, Simulation, Kinematic Function

I. LITERATURE REVIEW

By carrying out the modal analysis of gait frequency structure, we obtain the first 6 mode shapes. Critical conditions can be identified and further optimization can be done. The modal analysis gives the required data for the design optimization, decrease time for design procedure, to target the optimised excitation frequency, for obtaining the resonance, increase durability and service life of structure

The optimization process has got as utmost importance as that of structural analysis. The objective functions and design variables are finalised in optimization process. Then we decide the range of variance for the variables. The data is tabulated for every trial. The tabulation helps reduce trial time. this procedure is followed to optimize the design. The final goal optimization is to compare the results of original model with the optimized one. The ESO method for structural optimization is used which is the most reliable one used in recent times for CAE analysis

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

II. INTRODUCTION

A key concern for manufacturing companies is developing the ability to design and produce a variety of high quality products within short timeframes. Quick release of a new product into the market place, ahead of any competitors, is a crucial factor in being able to secure a higher percentage of the market place and increased profit margin. As a result of the consumer desire for variety, batch production of products is now more the norm than mass production, which has resulted in the need for manufacturers to develop flexible manufacturing practices to achieve a rapid turnaround in product development.

A tool for supporting the design of workplaces is likely to find its way to the production departments for the reason of speeding up the development process in the context of concurrent engineering. There is currently on the market a variety of different programs for simulation of production, workplace layout and graphic conceptualization of the human body (Nilsson, 1994). Work is going on in Europe to standardize the characterization of computer manikins(3rtengren, 1992).

A computer program that would allow the production engineer to design a computer representation of the workplace and test various aspects of manufacturing of products in it not only promotes a sound workplace and work process. It also provides a means to assess and improve the design of the products to be manufactured by revealing, at an early stage, inappropriate features that make the production more difficult and expensive. The design and optimization of acquired structures can be done using simulation software. One being used for this study is ANSYS 15.0[1].

III. COMPUTER AIDED ENGINEERING

Computer-aided engineering (CAE)is nothing but the engineering with the help of computer based engineering software. It includes Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), Multi body dynamics (MBD), and optimization. The software which is developed to support the engineering analysis are termed as CAE tools.

The use of CAE made easy for the product developers minimize product development costing and duration while enhancing the safety, comfort, and durability upto the desired value. The estimated capacity of CAE tools has increased to the level where most of the verification for design is now carried out using computer simulations instead of actual testing of physical prototype.CAE accuracy depends on all proper considerations as inputs and recognize critical inputs. Although CAE has developed with the course of time, and it is regularly in use for the engineering field, actual testing of physic1al prototype is considered as final because CAE cannot predict all variables in complex assemblies (i.e. metal stretch, thinning)[2][6].

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

IV. MATHEMATICAL CALCULATIONS

various equations are used successively with equation numbers in parentheses. Most of the systems which fall under the study of engineering are probably described in terms of differential equations formulated by using their continuum mechanics models. Solution of differential equations under various conditions such as boundary or initial conditions leads to the understanding of the system and recognizes the future of the phenomena (determinism). Exact solutions are generally difficult to obtain for differential equations as far as today's advancements considered. Numerical methods are developed to obtain approximate solutions for differential equations. Some of the these numerical methods, those which approximate continua with infinite degree of freedom by a discrete body with finite degree of freedom are called "discrete analysis.".Via these methods of discrete analysis, differential equations are formed to simultaneous linear algebraic equations and then the solution is obtained numerically.

1.Classical dynamic differential equilibrium equations:

$[\mathbf{M}]\{x''\}+[\mathbf{C}]\{x'\}+[\mathbf{K}]\{x\}=\{F(t)\}$……….(1)

Among them, [M] is Mass matrix , [C] is Damping matrix , [K] is Stiffness matrix , {x "} is Acceleration vector , {x '} is Velocity vector , {x} is Displacement vector , {F (t) } is Vector force .

2.Undamped modal analysis is a classical eigen value problem, dynamic differential equations can be simplified as :

$[\mathbf{M}]\{x''\}+[\mathbf{K}]\{x\}=\{0\}$………………(2)

3.Structural free vibration is harmonic vibration, the displacement is sine function, namely:

$x = x \sin(\omega t)$ …………………(3)

Bring it into type 2:

$([\mathbf{K}] - \omega_2[\mathbf{M}])\{x\} = \{0\}$ ……………(4)

Type 4 is a classic eigen value problem; characteristic of this equation is ω_i, ω_i is the circular frequency of vibration, vibration frequency $f = \omega_i/2\pi$. Eigen values ω_i corresponding eigenvectors {x}is the natural frequency $f = \omega_i/2\pi$ corresponding vibration mode[3]

V. TOOLS AND TECHNOLOGIES USED

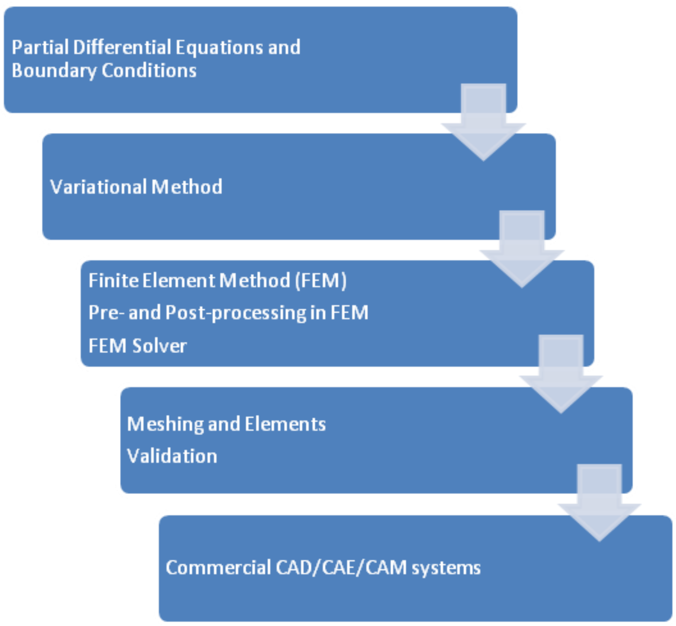
The tools used for CAE (computer-aided engineering tools) are very important in product development and process designing. The simulative experience enhances the productivity by encouraging employees for implementing various tools available.

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

• For simulations of kinematic function, CAE programs like Solid Edge, Unigraphics/I-DEAS are preferred.

• For part design, selection of materials, coding for calculations tools used are ANSYS, Unigraphics/I-DEAS, Moldflow PartAdviser[4].

5.1 Steps in CAE



5.2 ANSYS As a Powerful Simulation Tool

ANSYS is a pioneer in the discipline of linear and non linear analysis.Simulation has been identified as one of the key pillars of the next industrial revolution, known as Industry 4.0. With the advent of the Internet of Things all products are getting smarter, new advanced materials are enabling lighter, stronger and more sustainable designs, and additive manufacturing enables users to 3-D print anything they can imagine. Unlocking the power of these trends is impossible without simulation tools' ability to virtually explore these vastly increased options to arrive at the winning designs of tomorrow.

ANSYS 17.0 delivers solutions faster so engineers and designers can make more informed decisions sooner in the product development cycle. That enables organizations to rapidly innovate and bring products to market faster, while getting more productivity from their existing engineering assets.

Through tighter integration of semiconductor and electronics simulation solutions, ANSYS 16.0 delivers a comprehensive chip-package-system design workflow. New capabilities for automated thermal analysis and integrated structural analysis deliver an unequalled chip-aware and system-aware simulation solution. With the

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

advent of the Internet of Things, more products and engineers will rely on these capabilities [7].

VI. DESIGN

The process of designing undergoes three stages as follows

1. Conceptual design
2. Detailed Design
3. Prototype Making

The conceptual design is as defined by term is the original concept or a drawing. Figure 1 shows the conceptual design of a beam structure.

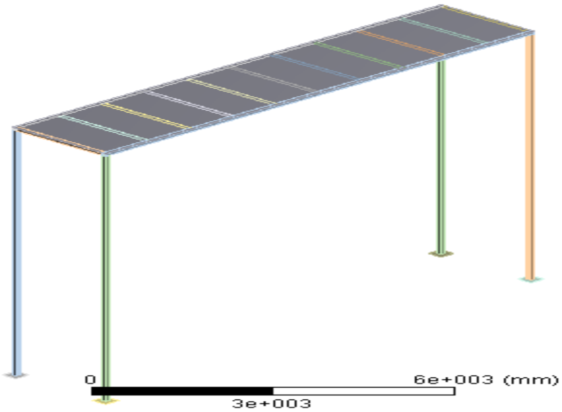


Fig 1 Conceptual Design of a Beam Structure

The dimensions and material properties are chosen later on in detailed designing. Figure 2 shows the detailed design of a beam structure.

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

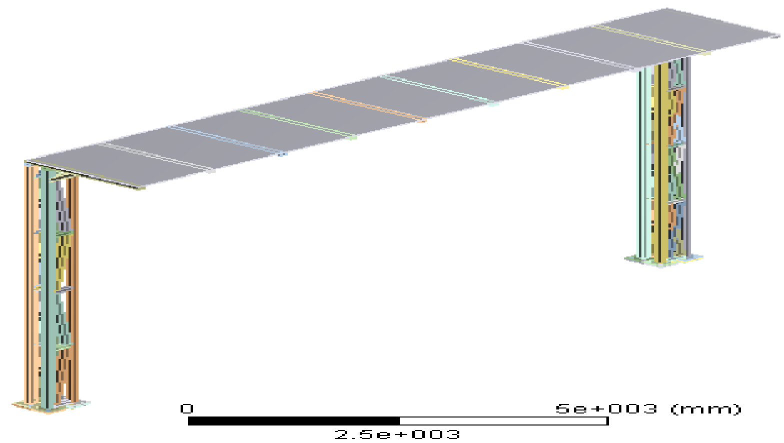


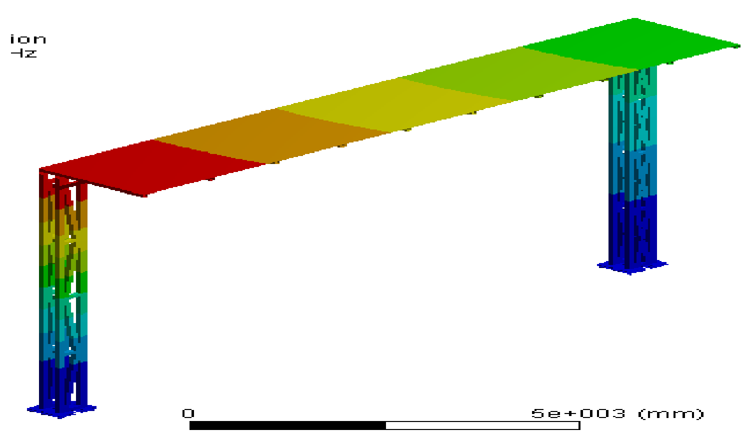
Fig 2 Detailed Design of a Gait Frequency Structure

The last and most important stage is prototyping where the optimization of design and material is done by trial and error methods

In practical structure design, it is very important and useful that finite element method integrates with the parameter model. So The Second Development Base on the Ansys is necessary. In general, the secondary development tools of Ansys include APDL (ANSYS Parametric Design Language) and other programmer like Visual Basic[5].

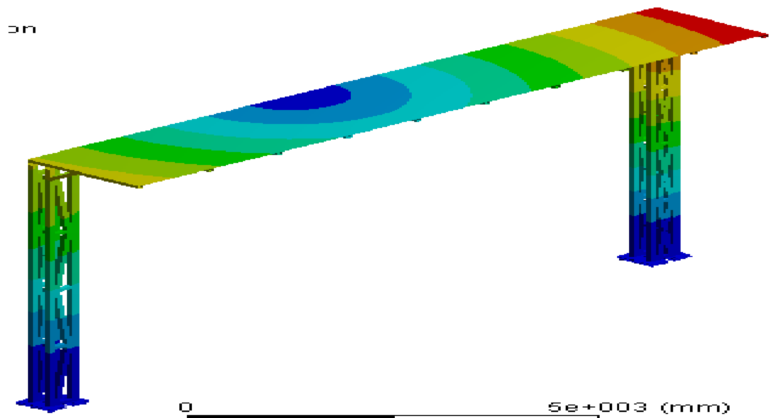
VII. VERIFICATION OF RESULTS

The prototype is optimized and verified for final design with the suggestion of all the fellow designers. The verification is done such that the specified need are met with without compromising the original concept. This is very important stage as it is followed by the actual prototype manufacturing.



International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

Fig 3 Analysis Showing 1st mode shape of Beam



Structure

Fig 4 Analysis Showing 2nd mode shape of Beam Structure

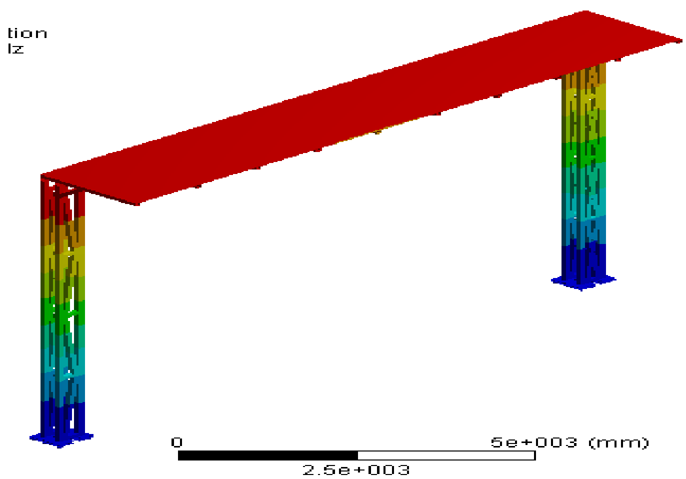


Fig 5 Analysis Showing 3rd mode shape of Beam Structure

The result is tabulated as follows:

Sr No	Mode Shape No	Frequency	Maximum Deformation
1	1St Mode shape	0.97154	0.7301
2	2nd Mode shape	2.1685	0.93481

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

3	3rd Mode shape	3.9106	0.55994

Table 1: Mode shapes and maximum deformation

VIII. DISCUSSION

Considering the propensity in the last decades of using lightweight materials and in some sense extraordinary structures, one can realize the importance of dynamic loads resulting from human motion. Although not vulnerable regarding structural capacity and integrity in most cases, such structures may experience extreme levels of vibrations. When we tal1k about public buildings or structures which may be loaded by significant number of people, for instance concert halls, grandstands, long-span floors, staircases in malls etc. the issue concerning vibrations induced by humans becomes strongly pronounced – there is not only possibility of disturbing vibrations but the danger of destruction because of resonance, as well.

The dynamic features of a structure are significantly influenced by its stiffness. Lowering the structural stiffness, aiming to impart an attractive outlook to a building, leads to lowering the fundamental frequency and hence deteriorating the dynamic performance of the structure. Reducing the fundamental frequency makes it close to the frequency of any types of rhythmic motion. As an example of the above statement pointed out can be the measurements of Dr. J. Dickie (Manchester University, 1988) at the London Docklands Arena. He measured a fundamental sway frequency 2.5 Hz, when the grandstand was empty, compared with a frequency 1.7 Hz, when the grandstand was full of spectators.

The required structure is needed to posses the prescribed frequency so that it meets its purpose. While training the personals of rescue team it should simulate the actual environment of the scenario at the sight of calamity. The structure should attain is resonance while it should not collapse.

IX. CONCLUSION

The practice indicated that, grasping the practical project analysis technology is important link for the advanced digitized manufacture. Depending on in the international leading technical platform and the effective technical route carrying ont he secondary development base on Ansys will speed up design and enhance the product the quality and the performance. It isthe technology innovation shortcut also.

REFERENCES

[1] Optimization design for beam structures of rail weld CNC fine milling machine based on Ansys Workbench Mao HuajieShu Min Li Chao and Zhang Baojun, Applied Mechanics and Materials Vols 716-717 (2015) pp 817-824 Submitted: 2014-11-13 Trans Tech Publications, 2014-11-13doi:10.4028/www.scientific.net/AMM.716-717.817

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

[2] Finite Element Analysis and Structural Optimization of the Box on the ANSYS Workbench Kun Cheng Advanced Materials Research Vols 211-212 (2011) pp 434-439 Online: 2011-02-21 Trans Tech Publications, Switzerland doi:10.4028/www.scientific.net/AMR.211-212.434

[3] Ansys Workbench case is proficient in engineering application [M]. Beijing: electronic industry press, Chen Yanxia, Chen Lei. 2012:96

[4] Towards Complete Product Development Teaching Employing Combined CAD_CAM_CAE Technologies Hector Lorenzo-Yustos, PilarLafont, Andres Diaz Lantada, Antonio Fdez-FlorezNavidad, Jose Luis Mun˜ Oz Sanz, Juan Manuel Munoz-Guijosa, Julio Mun˜ Oz-Garcia, Javier Echavarri OteroDepartment of Mechanical Engineering, Universidad Politecnica de Madrid, Madrid 28003, Spain Received 6 March 2008; accepted 19 July 2008

[5] Computer aided workplace design: An approach to create a toolfor the production engineer J. Laringa,c,*, K.-J. Falk b, R. Kadeforsa,c, R. Ortengren c International Journal of Industrial Ergonomics 17 (1996) 323-330

[6] Ansys Second Development Method and Application in Computer Aided Engineering Sun Yuantao, Wang Shaomei Department of Logistics Engineering, Wuhan University of Technology, China,

[7] ANSYS ADVACED ANALYSIS TECHNIQUES GUIDE, AnsysInc, 1998