ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 3, March 2017

Truss Optimization Using Different Techniques

[1]Priyanka Shingare, [2]Ankush Limbage
[1]P.G.Student, Department of Civil Engineering, SGGSIE&T, Vishnupuri, Nanded, Maharashtra, India,
[2]Assistant Professor, Department of Civil Engineering, SGGSIE&T, Vishnupuri, Nanded, Maharashtra, India

***Abstract:*— There are various techniques used for optimization. Here in this paper APMonitor language as well as Genetic algorithm is used for optimization purpose. Optimization of truss-structures for finding optimal cross-sectional size, topology, and configuration of trusses to achieve minimum weight is carried out using real-coded genetic algorithms (GAs). APMonitor language is also used for optimization purpose it gives the contour maps for functions weight, stress etc. It uses MATLAB software. APMonitor gives results faster in comparison with genetic algorithm.**

***Key word:--* APMonitor, Genetic algorithm, MATLAB, Optimization etc.**

I. INTRODUCTION

Optimization is a mathematical discipline that concerns the finding of the extremes of numbers, functions, as well as systems. The earlier epistemologist and mathematicians created its foundations by defining the optimum (as an extreme, maximum, or minimum) over several fundamental domains.

The area of design optimization continues to be an active area of research. Remarkable progress has been achieved in shape and topology optimization. Shape and topology optimization are concerned with finding optimal shape and topology of a structure by the iterative process. The structural optimization is a very interesting & important topic in the field of engineering. Optimal design of truss-structures has always been an active area of research in the field of search and optimization. Various techniques based on classical optimization methods have been developed to find optimal truss-structures. Optimization classified into three main categories: Size optimization, shape optimization, topology optimization.

Researchers working on various aspects of topology optimization applied to fluids, solids and structures. This optimization refers to the optimum distribution of material in order to achieve design objectives and simultaneously satisfying constraints.

II. LITERATURE REVIEW

Various techniques are used for optimization purpose. Truss structures for finding optimal cross-sectional size topology and configuration of trusses to achieve minimum weight using genetic algorithm. For configuration optimization of finite element structures one method is presented with reasonable geometry. Structural topology problems are solved by using genetic algorithm. Fexible as well as efficient algorithm is developed for algorithm

Combined sizing, shape, and topology design of space trusses. cross-sectional areas of the members are discrete and continuous.

III. SYSTEM DEVELOPMENT

Different types of programming languages as well as algorithms are used to solve the mathematics based program. Here one programming language and one algorithm is used in MATLAB software. Here MATLAB software is common. Three examples are solved here.

Example1: Two bar truss problem solved by using APMonitor language. End supports are fixed supports here. Diameter of each bar in in between 1 to 3, Height of the truss is 30, Weight density is 0.3, Modulus of elasticity is 30000, Load on the truss is 66, width of truss is 60 and thickness of truss is 0.15. figure 1 shows the two bar truss.

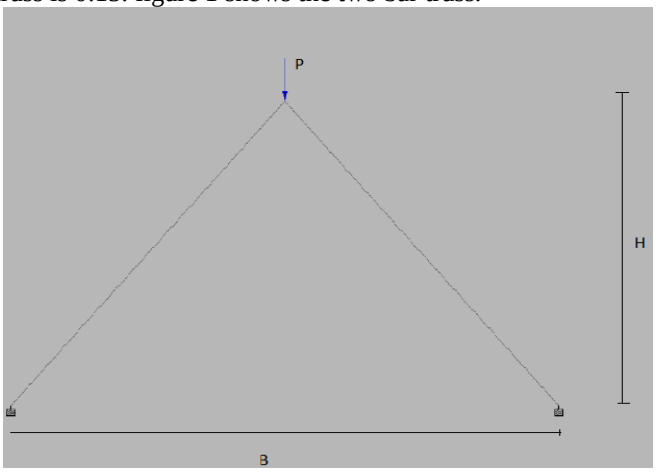

Figure 1 Two bar truss

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Example2: 2D truss problem solved by using APMonitor language.2D truss is as shown in figure 2. It is six node truss also known as ten bar truss. Member areas are in between 1 to 34 inches, width is taken as360 inch, load is 44lb, weight density is 0.1, modulus of elasticity is 10000, height of truss is 360 inch, thickness is taken as 0

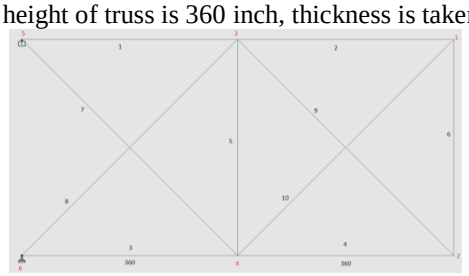

Figure 2 2Dtruss (ten bar truss)

IV. PERFORMANCE ANALYSIS

APMonitor language gives the results for weight optimization. Thickness, density and modulus as well as load remain same. Changing parameters are height, diameter as well as weight .slk_3, slk_4, slk_5 and slk_6 these are the results we get after running the program for given conditions. Conditions are as follows
slk_3 gives the condition for weight ,weight < 24
slk_4 is the condition for stress, stress < 100
slk_5 it is the condition for deflection, deflection < 2
slk_6 gives the condition for stress-deflection, stress-deflection < 0

Table1 shows the results for two bar truss.

Table1: For two bar truss

Parameters	MATLAB Results
Width	6.00E+01
Thickness	1.50E-01
Density	3.00E-01
Modulus	3.00E+04
Load	6.60E+01
Height	2.94E+01
Diameter	1.00E+00
Weight	1.19E+01
slk_3	1.21E+01
slk_4	7.14E+01
slk_5	0
slk_6	5.00E-02

Table 2 gives the results for 2D truss using APMonitor language. Here changing parameters and constant parameters are same but the conditions are different. Following are the conditions for 2D truss
slk_3, weight < 4981.7
slk_4, stress < 25
slk_5, deflection < 0
slk_6, stress-buckling < 0

Table 2: For 2D truss

Parameters	MATLAB Results
Wdth	3.60E+02
Thickness	1.50E-01
Density	1.00E-01
Modulus	1.00E+04
Load	2.00E+02
Height	3.60E+02
Diameter	3.00E+00
Weight	4.9817+03
slk_3	4.41E+03
slk_4	2.09E+01
slk_5	0
slk_6	0

Contour plots for 2D truss

APMonitor gives the contour plots for 2D truss Figure3(a) Shows the optimized weight .Here we are using the blue color to show the optimized weight . At X-axis we are taking the height and at Y-axis height. As our height of structure is 360 in. it is very large so scale is taken for the X-axis is 1:120.

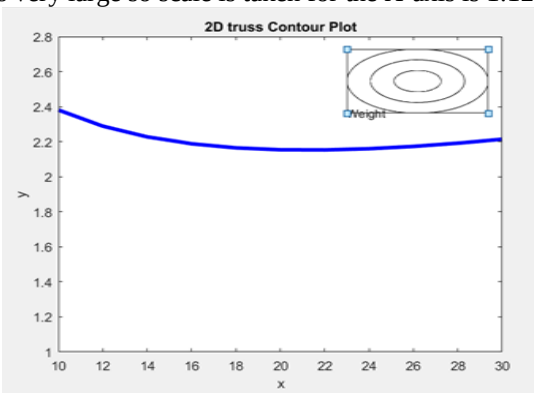

Figure3(a) contour plot for weight diameter v/s height

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Figure3(b) is for all the output values. Stress-buckling is zero which exactly co-insides with the weight optimization line shown by blue color. color. Red color shows the deflection. And neon color shows the stress. Stress.

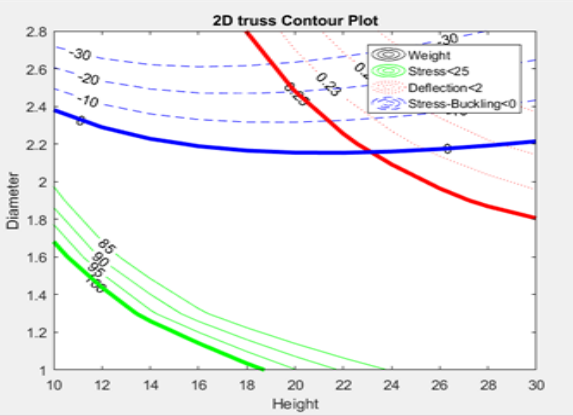

Figure3 (b) contour plot for weight diameter v/s height

Figure3(c) gives the weight of truss with respect to the input arguments height and diameter. Here the scale for X-axis is 1:120. For Z-axis scale is taken as 1: 1000

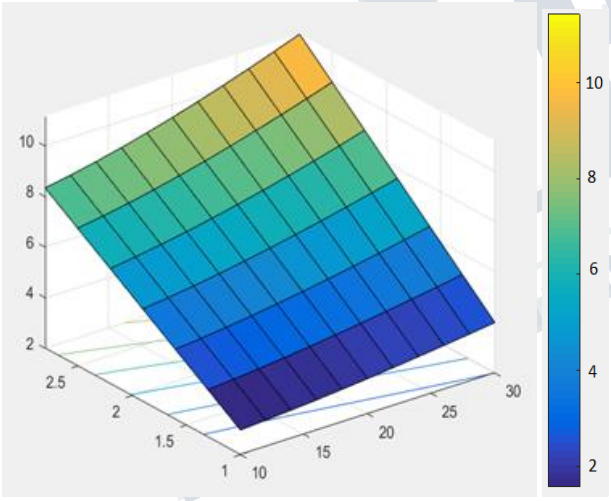

Figure3(c) surface plot for height, diameter and weight

Table3 gives the result by using genetic algorithm it optimizes the weight .Here the area of the members given in between 1 to 34 inches as per requirement but some members having zero area after running the program. Algorithm takes the 59 input values for run the program. These input values also known as chromosome size. Up to final solutions this program having 113 revolutions that are also called as generations.

Table 3: Results using genetic algorithm

Item	sizing and topology
Weight (lb)	4966.2
c/s area 1 (sq in.)	30
c/s area 2 (sq in.)	0
c/s area 3 (sq in.)	19.9
c/s area 4 (sq in.)	14.51
c/s area 5 (sq in.)	0
c/s area 6 (sq in.)	0
c/s area 7 (sq in.)	7.22
c/s area 8 (sq in.)	22.39
c/s area 9 (sq in.)	22.39
c/s area 10 (sq in.)	0
Chromosome size	59
Generations to final solutions	113

V. CONCLUSIONS

1.In this paper results by using APMonitor and genetic algorithm are compered.
2. APMonitor gives the faster and optimized results than genetic algorithm. In genetic algorithm fitness value decreases generation by generation. Optimized weight of 2D truss by using APMonitor is 4410lb. By genetic algorithm weight is 4966.2lb. Here generations are 113. Four members are reduced in genetic algorithm.
3. Figure3(a)shows optimized weight of truss. Diameters of the members getting reduced from 2.4 to 2.2 from the height 0 to 360.
4. Figure3(b) gives the contour plots for weight, stress, deflection and stress-buckling
5. Surface plot for height, diameter and weight is given by figure3(c). Weight of the truss is given with respect to the input arguments height and diameter.

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