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Study on Structural Optimization of truss members using Meta-heuristic Algorithms

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Abstract - *In this time of science and advancement, We are using much more technology than ever before to make our work more efficient. However this pace of tech-industry combination hasn't been caught well in the field of structural engineering. The main aim of this study is to provide additional information about use of Genetic Algorithm and Particle Swarm Optimization to optimize various structural member sections. The objective of this study was achieved through reading and understanding various research papers related to above mentioned topic. The study clarified how the algorithm helps to optimize the structure and which optimization algorithm performs more efficiently.*

Key Words: **Genetic Algorithm, Particle Swarm Optimization, Structural Optimization**

1. INTRODUCTION

Skeletal structures are widely used as benchmark testing for structural efficiency as they can accommodate a large number of design flexibility and limitations. Thus for better results in term of efficiency and productiveness, Majorly truss structures are used.[1]

It has been in exposure, That the development of the building has grown into a challenge, demanding The size of the building, the geometry and topology that will make the building as economical as possible while maintaining its performance characteristics within permissible limits. In general purpose, Stress and Deflection of structural member are used as the permissible limit criteria.[2]

One can use many techniques to optimize the structure, but nonetheless there are only 3 major methods that guides to perform optimization.(i) sizing, (ii) configuration, and (iii) topology optimization. Therefore in this study these methods combined with GA and PSO have been performed.[3]

1.1 Need of study

Technological advancement are the base pillar of any growing scientific field. Thus it has become important to study sufficient tech like Evolutionary Algorithms, Bio-mimic Algorithms, etc. For the purpose of optimization.

1.2 Objective of the study

The study's objectives are as given below:

1. To programme a Genetic Algorithm for minimizing a truss structure.
2. To programme a Particle Swarm Optimization algorithm to minimize a truss structure.
3. To compare these above mentioned algorithms and modify it if needed.

2. LITERATURE REVIEW

By concentrating on writing audits from different writers some were finished up which are follows:

2.1 Genetic Algorithm

Kalyanmoy Deb (2001). Ideal plan of bracket structures has generally been a functioning area of examination in the field of search and enhancement. K. Deb invented a crossover method called simulated binary crossover (SBX) and a parameter-based mutation operator. Author classified nodes into two categories: (i) basic nodes, which are utilized to help the

bracket or to apply a load, (ii) non-basic nodes, which don't uphold the support nor they bear any load. In conclusion we can say that the These outcomes recommend the utilization of the proposed procedure in other support structure plan issues, where a total enhancement with ideal sizing, topology, and configuration is desired.

A. Kaveh (2002). In this article, the force method is utilized for the calculation. The upside of involving this technique lies in the way that the networks relating to specific and reciprocal arrangements are shaped autonomously of the mechanical properties of individuals. These networks are involved a few times during the time spent the consecutive investigations, speeding up advancement. The second element of the current strategy is the programmed idea of the forecast of the helpful scope of segments for a part from a rundown of profiles with countless cross-areas. The third element comprises of a withdrawal cycle created to expand the effectiveness of the GA by which an ideal plan for the primary sub-string related with part cross-areas is acquired.

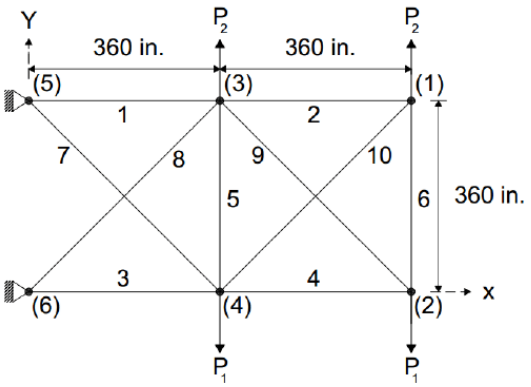

Fig -1: Benchmark Problem for Optimization

Razvan Cazacu (2013). This exploration presents a strategy and a product application to enhance the geography, size and state of plane supports utilizing a genetic calculation and the limited component investigation to assess the wellness work. The paper portrays the streamlining procedure, issue encoding and wellness assessment. Author concludes that the encoding method proposed in this paper showed great outcomes in any event, when used to the standard benchmark calculation. The first code executed in MATLAB was tried on a few issues, showing the adaptability of the way to deal with tackle different bracket conformity and all the while advance their geography, size and shape. The enhancement of the benchmark issue gave an answer near others found in the writing. To work on the arrangements and to speed up the union, more complex GA administrators may be useful.

Reza Najian Asl (2016). Author used a genetic-based hybrid algorithm that combines the exploration power of Genetic Algorithm (GA) with the abuse limit of a phenotypical probabilistic nearby hunt calculation. However not restricted to a certain class of streamlining issues, the proposed calculation has been adjusted to work especially proficiently on the ideal plan of planar and space structures, a class of issues described by the huge number of plan factors and imperatives, serious level of non-linearity and large number of local minima. Author concluded that the Hybrid outperformed other algorithms, in some cases noticeably, both regarding arrangement ideal and computational expense.

Hirad Assimi (2017). This paper presents a genetic programming approach for synchronous advancement of estimating and geography of truss structures. It plans to view as the ideal cross-sectional regions and networks of the joints to accomplish least weight in the pursuit space. The methodology approved in some different truss structure issues and gotten lighter bracket structures than the accessible arrangements in the writing In conclusion, This study thought about the primary load as the goal work for enhancement, however further investigations are recommended to utilize this methodology for multi-objective bracket designs and enormous scope underlying improvement issues.

2.2 Particle Swarm Optimization

Yancang LI (2013). Author stats that To beat the untimely intermingling imperfection of the fundamental molecule swarm advancement (PSO) calculation and give a compelling strategy to shape and measuring enhancement of support structure, a better PSO was proposed. The irregular heading strategy was utilized to deliver top notch starting populace, the fluffy framework was applied in the unique versatile change of boundaries of the PSO, and the Metropolis models were used to work on the exhibition of PSO. Author has concluded that All together to beat the weakness of the untimely

combination in the normal calculations, he proposed a novel PSO and acquainted it with the shape improvement of a support structure. This study gives a promising technique to the structure enhancement.

Hongyou Cao (2017). This article presents an improved molecule swarm enhancement (EPSO) calculation for size and shape enhancement of bracket structures. The proposed EPSO brings a molecule arrangement system into the molecule swarm enhancement (PSO) to dispense with superfluous underlying examinations during the enhancement interaction and work on the computational productivity of the PSO based underlying streamlining. This study proposes an EPSO calculation in view of a molecule (particle) classification component to work on the computational proficiency of the standard PSO for the weight enhancement of designs.

S.H. Sun (2017). In this paper, another methodology is created for primary shape advancement, which comprises in coupling the molecule swarm enhancement (PSO) calculation and the isogeometric limit component technique (IGA-BEM). The IGA-BEM depends on the blend of the isogeometric examination (IGA) and the limit component strategy (BEM), where Non-Uniform Rational B-Splines (NURBS) are utilized as shape capacities for math definition and guess of the field factors. In conclusion, As a rule, the assembly speed of inclination based streamlining calculations is quicker than that of the wise enhancement calculations like PSO, yet more coarse lattice with PSO can be utilized than the cross section with angle based advancement.

Ms. Vishakha A. Metre (2018). Author believes that Particle (Molecule) Swarm Optimization (PSO) is a new, progressed, and most impressive enhancement approach that performs exactly well on a few advancement issues. It is the widely utilized Swarm Intelligence (SI) motivated streamlining calculation utilized for tracking down the worldwide ideal arrangement in a diverse hunt district. Author concludes In this manner, we suggest a half breed calculation including Subtractive Clustering calculation and Boundary Restricted Adaptive PSO which is named as SC-BR-APSO calculation for text, mathematical and picture information grouping. For future scope, author writes that future work predicts to accomplish minimal grouping result with expanded intermingling rate and diminished blunder rate when contrasted with existing calculations for picture datasets through picture handling strategies.

Yulong Sun (2021). Author believes that Improvement systems are being used in different underlying planning practices to tackle size, shape also geography improvement issues. This article contributes in ad lib in the support structure plan soundness while decreasing the designing expense by proposing the HPSO (Hybrid Particle Swarm Optimization) approach. Fundamentally, the essential standard of the first PSO calculation is introduced, then the pressure factor is laid out to work on the PSO calculation, and a sensible boundary setting esteem is introduced. The author concludes that the HPSO runs quicker than the first calculation and has better in general enhancement impact and steadiness. The exploratory assessment laid out the time-viable capacities of the proposed system, as the program running time is almost 50% of that of customary HPSO calculation.

3. CONCLUSION

Below are the conclusions from the review study:

1. There is very less research being done on comparison of GA and improvised PSO for RC member optimization problem.

2. There is a future scope in solution of stagnation problem due to premature convergence in PSO.

3. The EPSO works well in sizing optimization but there is scope on topology optimization using Enhanced Particle Swarm Optimization.

4. There should be a Multi-Objective optimization of topological and shape constrains for optimization problem in building truss structure using HPSO.

5. To eliminate the shortcoming of the inauspicious mix in the typical computations, author proposed an original PSO and familiar it with the shape improvement of a help structure. This study gives a promising method to the design upgrade.

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