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COST OPTIMIZATION BEAM BY GENETIC AND PARTICLE SWARN METHOD

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ABSTRACT

Optimization techniques play an important role in structural design, the very purpose of which is to find a designer or a decision maker can derive a maximum benefit from the available resources. The basic idea behind intuitive or indirect design in engineering is the memory of past experiences, subconscious motives, incomplete logical processes, random selections or sometimes mere superstition. This, in general, will not lead to the best design. This is a novel approach that can easily be used to optimize the design of various types of large RC structures and also account for constraints imposed by the design standards. Particle swarm Optimization (PSO), as a robust met heuristic, was used to solve the combinatorial optimization arising from the structural optimization problem. Numerical examples for certain spans of simply supported beam are presented to demonstrate the robustness and practicality of the methodology and algorithms. The results were compared to results of the same optimization problem, optimized using genetic algorithm method. In proposed approach PSO gives significant reduced cost with the help of global and local optimization. It also converges in time because of eight parameters of beam.

Keywords: Beam, Genetic Optimization, MATLAB,Partical Swarn Optimization.

I INTRODUCTION

Development method play a significant role in the design of structures, the objective which is to find super ways or techniques by which the designer or the decision makers can generate the maximum profit from the existing resources at hand. An engineer's main aim is to progress with an 'optimum design' for the concerned design job. An absolute solution usually demonstrates a beneficial structure without destroying the useful purposes. There is huge number of promising beam sizes and increased ratio's that outcome for the same moment of struggle, then it became tough tasks to achieve the least-cost construct by knowable iterative prospective. The mechanism of optimization can help designers to grab the best design.

The main idea behind indirect architecture in engineering is the past experiences, inspire behind design, unfinished logical processes, or sometimes irregular environmental conditions. This therefore doesn't lead to best design or optimum design. This shortcoming of this type of indirect design can be overcome by adopting optimum design approach, which of only logical decisions. In this the designer sets out the pressure and then minimizes or maximizes the objective functions like cost, weight or merit. The structural optimization techniques can also be according to the construct philosophy employed. The purpose function is attained by calculating each event and multiplying it to the respective possibility. The total of all such entries will be the total purpose function.

Optimization is defined as the act of magnificent outcome under the given circumstances. The crucial objective is either to reduce the hard work necessary or to maximize favoured profit. It is a permissible truth that one of the outmost human activities is resolution making. Optimization methods play a significant role in structural design. The specific objective is to find the supreme method so that a designer can derive a maximum benefit from offered assets. The deficiency of the unplanned design can be overcome by acquiring optimum design method. The advantage of optimal design is that it composed of only sensible decisions.

II LITERATURE REVIEW

M.Z Cohn and A.J Macrae (1984) in their paper developed the approach that permits the expansion for many feasible merit functions, acknowledge all important limit state design restraints by any of the design code. This is valid for reinforced pre stressed, and moderately pre-stressed concrete members. Problem formulation and non-linear programing techniques for its solutions are explained.

H.Moharrami and D.E. Griesrson (1993) in their paper provide an effective computer aided technique for the finest design of the concrete building formworks. The dimensional parameters of width, depth and longitudinal reinforcement of members are taken as design variables. Both the member capacity sensitiveness and structure ability sensitiveness are taken into deliberation while formulating all the strength constraints. The techniques shows that it provides an efficiency way to optimise with iterative optimization which converges in a few cycles to a least cost design of reinforced concrete frameworks satisfying all relative requirements of the design codes.

C. A. C. Coello et al (1997): In his paper developed a simple Genetic algorithm for the design of supportive concrete beams; organise an optimization model for the design of rectangular reinforced concrete beams subject to a particular set of constraint. Their model is more materialistic than published formerly because it reduces the cost of the beam on fortifying design procedures, although the cost of concrete, steel and shuttering is also examined. Thus their design proceeds to very practical design. There is a number of unlimited numbers of possible beam dimensions and yield a same moment of struggle. An efficient search technique is favoured over the more traditional alternate methods. They also engage a simple genetic algorithm as a search engine. They also compare the results with those achieved via geometric programming. However the adjustment of parameters in a genetic algorithm is a significant issue for any application, they represent their own methodology to deal with this issue.

K.C Sarma and H.Adeli (1998) in their research say that as the construction of the concrete designers includes at least three separate materials namely concrete, steel and formwork. Thus the design optimization of concrete structures should not base on weight optimization, but instead on cost optimization. In this study analysis of numerous papers on cost optimization of concrete structures is accessible. The conclusion from it states that three is requires to research on cost optimization of three dimensional structures especially where huge savings can be made. Also supplementary research on cost optimization based on life cycle of structures, where instead of the initial cost of the structures, the life cycle cost is minimized.

C.C. Ferreira et al (2003): In this approach, finest design of reinforced concrete T-sections in winding present optimization of the steel area and the steel localization in a T-beam under bending is performed in the current work. The expressions giving the equilibrium of a single and double reinforced T-section in the various stages introduced by the non-linear behaviour of the steel and concrete are derived ones. The final material behaviour is defined accordingly to the designs codes alike EC2 and Model Code 1990. The objective is to gain the analytical optimal design of reinforcement of a T-section in terms of the unlimited design. The established expressions are applied to examples and design abacuses are supplied. A judgment is made with the available practice technique as indicated in CEB.

V. Govindaraj and J. V. Ramasamy (2005*)* in this paper presented the optimum design of reinforced concrete regular beams using genetic algorithms as per the design deliberation of the Indian standard codes. The optimum design is such designed that it observes with all the serviceability, ductility, durability, and all other design constraints of the code. In this examine only the cross sectional dimensions of the beam are considered as design variables. An example issue is illustrated and the results are presented.

B. Saini et al (2006): Studied Genetically, improved artificial neural network on the basis of optimum design of single and double fortify concrete beams, research optimum design of singly and double support beams with uniformly dispersed and concentrated load has been done by compromising exact self-weight beam. On the basis of steepest descent, flexible and malleable and back-propagation learning a technique, this design is skilful has also been composed of genetically optimized artificial neural network. With the use of limit state design, the initial solution has been achieved.

A.B Senouci and M.S Ansari (2009): This paper is about cost optimization of composite beams using genetic algorithm. It is based on the load and confrontation factor design specification of the AISC. The cost of concrete, steel beam and sheer studs are involved in the establishment of model. In this proposed model two designs are studied to illustrate its ability in optimizing composite beam design. The outcome achieved shows that the model is able to attain cost saving. Research has also been done to analyse the effects of beam spans.

A.C Galeb and Z.F Atiyah (2011): In this paper optimum design of supplement concrete waffle slabs dealt with the optimum design to strength concrete waffle slabs with the use of genetic algorithms. Two case studies have been explained: the first is a waffle slab with solid heads and next is the waffle slab with band beam throughout the column centre lines. The limitation involves the restrictions on measurements of the rib and limitation on the top of the slab wideness, the constraint on the areas area of steel reinforcement to gratify flexural behaviour and deliver sufficient concrete cover an the restriction on the longitudinal reinforcement o band beams. A computer program is written with the use of MATLAB to evaluate the structural investigation and design the waffle of slabs by the direct design techniques. The optimization procedure carried out by using built in genetic algorithm toolbox of mat lab.

S.T Yousif and R.M. Najem (2012) in their study discussed the application of genetic algorithms in the cost optimization of the protected concrete beams based on the ACI standard stipulations. The resultant optimized design fulfils all the strength, serviceability, ductility, durability and all other constrains connected to design and detailing requirements. In this study the dimensions of the reinforcement steel were introduced as a variable taking into account flexural, shear and torsion influence on the beam.. The forces, moments and deformations require in the Genetic algorithm constraints will be found by examines. The optimum results were calculated and then compared to the results in the previous literature.

III PROPOSED METHODOLOGY

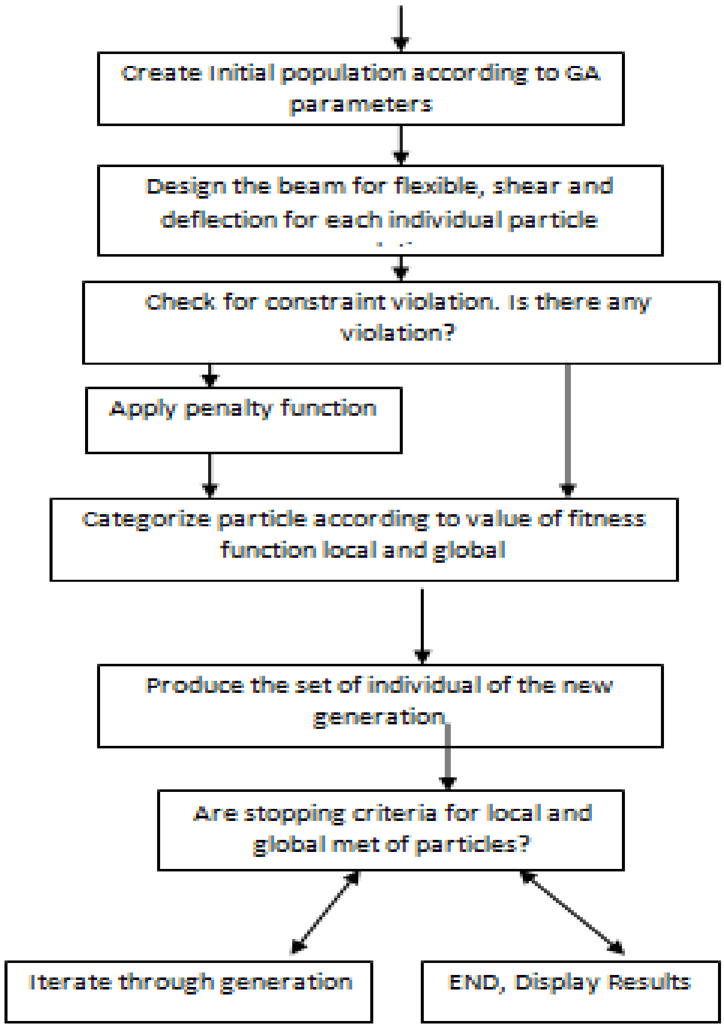


Figure 1.1 Particle Swarm Optimization (PSO) Model

3.1. Particle Swam Optimization Method

1. Initialise the swam with random position value, and random initial velocities
2. Regulate the velocity vector for each particle in the swarm using the information of the best position complete by each particle and the swarm as a whole and also the earlier position of each element in the swarm.
3. Modify the current position at each particle using the velocity vector and the former position of each.
4. Repeat from Step 2 until the stop criterion achieved.
5. The velocity vector

$$V_k^i = \omega v_{k-1}^i + c_1 r_1 (P_i - x_{k-1}^i) + c_2 r_2 (P^g_{k-1} - x_{k-1}^i)$$

Where the superscript i denoted the particle and subscript k denotes the iteration, C_1 and C_2 denotes acceleration and the P^g_{k-1} denotes the global position.

The Position after it is calculated

$$X_k^i = X_{k-1}^i + V_k^i$$

Parameter Selection: Parameters are selected in the following steps :-

1. Number of Particles :

It depends on the beam pattern, it is 4-40 in range

2. Maximum velocity V_{max}= 4 or V_{max}= 8

3. Inertia Parameter :

It depends on previous history. It is suggested to range ω in a decreasing way from 1.4 to 0 and ω = 0.75.

4. The acceleration is defined as follows :

$$C_1 = 1$$

$$C_2 = 1$$

5. Stop criterion : The stop criterion can be of two types

a. Convergence

b. Iteration

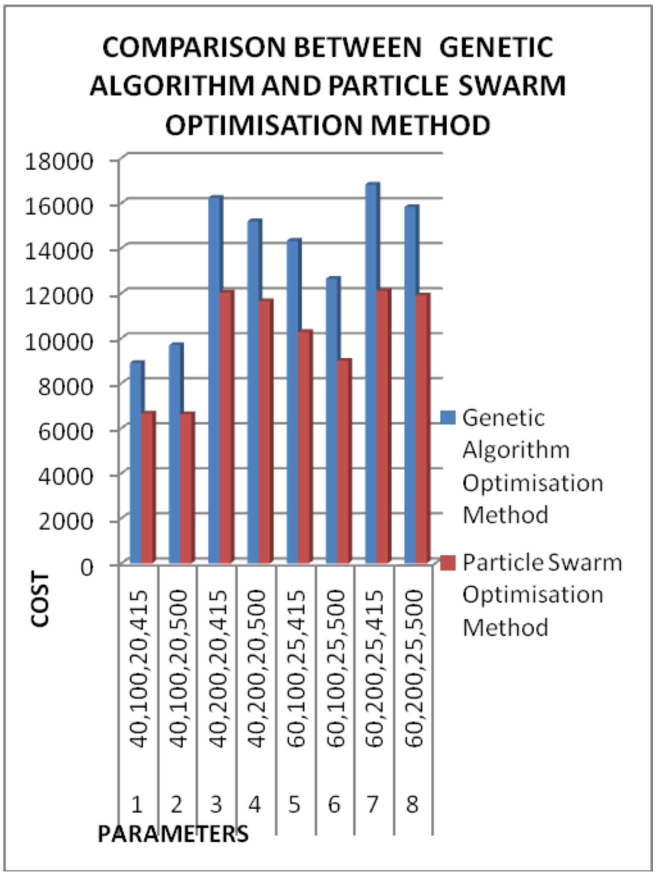
In this case iteration is not applicable only convergence is the stop criterion that will be used here.

IV. RESULTS

1. Comparison for optimum cost of 8m span

Sno.	Parameter - Load, depth of flange, fck, fy,	Genetic Algorithm Optimisation Method	Particle Swarm Optimisation Method
1	40,100,20,415	8899	6648
2	40,100,20,500	9687	6618
3	40,200,20,415	16236	12022
4	40,200,20,500	15190	11639
5	60,100,25,415	14322	10278
6	60,100,25,500	12637	8996
7	60,200,25,415	16823	12098
8	60,200,25,500	15825	11893

TABLE 1: Comparison for optimum cost of 8m span



GRAPH 1.1: Comparison for optimum cost of 8m span

V CONCLUSION

In the comparitive study of optimization of a simply supported T-Beam by genetic algorithm optimisation technique and Particle swarm optimisation technique, the following conclusions can be made :-

a. For a simply supported Reinforced concrete T-beam of span 4m, on an average Particle swarm optimisation showed a **10.2%** decreased cost or it can be said **10.6%** better optimisation then genetic algorithm method.

b. For a simply supported Reinforced concrete T-beam of span 8m, on an average Particle swarm optimisation showed a **15.6%** decreased cost or it can be said **15.6%** better optimisation then genetic algorithm method.

c. Particle swarm optimisation method proved better in this study owing to its nature of optimising parameters both locally and globally.

d. It is not always true that a better grade of concrete or steel would result in lesser cost for a structural member.

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