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OPTIMIZATION OF RISER THROUGH GENETIC ALORITHM

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Abstract - *India is the second largest country in the field of manufacturing a component through casting process. Therefore, the casting foundries are one of the main sector in the manufacturing industry. Quality or the yield of the cast component is directly affected by the casting design which includes gating and riser design. The volume of the gating and riser system plays an important role in improvement of the yield percentage of the casting. The gating and riser system should be designed such that it provides minimum volume thereby warranting the quality of the casting. Gating system varies as per the geometry of the component. When designing the gating system, the riser is always designed first as its parameters are directly obtained from the parameters of the casting. The riser or the feeder supplies the liquid molten metal to the casting for compensating the shrinkage. The riser should be located such that it will provide directional solidification in the casting. The riser should be the last one to be solidified. Generally riser is designed using modulus method or the trial and error basis method which is time consuming and inaccurate. Genetic Algorithm gives the optimized size of the riser. It provides various alternate size which the designer can use as per the constraints of the casting.*

Key Words: Feeder, riser, Genetic Algorithm, module, modulus method, shrinkage

1. INTRODUCTION

Casting is one of the most important manufacturing process for various types of industries. There are various types of casting process, among which sand casting is most widely used for both ferrous and non- ferrous metals. In manufacturing industries, casting is one of the most economical manufacturing production process. The rate of solidification in the casting process, affects the microstructure of the metal to be cast which in turn controls its mechanical properties such as strength, machinability, hardness etc. Filling and solidification are the two consecutive stages in casting process. The filling stage consists of gating system , which is composed of - pouring basin, sprue, sprue well, runner , ingates and riser. This parts are so designed that molten metal enters properly into the mould cavity. The riser is designed such that it compensate the shrinkage that occurs in the cast component during solidification.

The gating and riser system play a very important role for improving the quality of the casting. As the metal cools, it changes its state from liquid to solid, during this a considerable amount of shrinkage takes place in the component. Not all the metals shrink, some of them expand such as grey cast iron, in which low density graphite flakes form as the part of solidification process. Hence, the risers are used to compensate the shrinkage that occurs during solidification in the casting process. According to the component to be cast, the shape and size of the riser is varied. The proper design of riser is important to achieve directional solidification, improperly designed risers results in casting defect with shrinkage in cavity and lower yield. The experimental setups are done for the design and development of mould and for optimum process parameters. But it is costly, time consuming and may be impossible in some cases. Therefore, casting simulation software are used for designing of gating system. Riser is also the part of gating system but its dimensions are to be given manually by using some empirical relations and human experience that provides feasible solution in most of the case but it will never end up with an optimum solution. Genetic algorithm is the method which can be used to design the optimized design of riser by using some empirical relationships as inputs along with some other parameters.

GENETIC ALGORITHM (GA) is the optimization technique which is inspired mechanism of evolution and natural genetics. GA is the method which can solve both constrained and unconstrained problem based on natural selection. These algorithms encode a potential solution to a specific problem on a simple chromosome like data structure and apply recombination operators to these structures as to preserve critical information. Genetic algorithm can be applied to wide range of problems. GA begins with a population of chromosomes which are selected randomly. Then it evaluates these structures and allow them to reproduce in such a way that the chromosomes which represents better solution to the targeted problem are given more chances to reproduce than those chromosomes which give poorer solution. Over successive generations, the population evolves towards an optimal solution. Generally the goodness of a solution is typically defined with respect to the current population. The advantages of GA are it can scan a vast set of solution. Bad population do not affect the end solution as they are eliminated by the algorithm itself. The genetic algorithm is inductive in nature. It does not need to know the rules of the problem, it works by its own rules. GA also have disadvantage, in nature life does not evolve towards the good solution. It evolves away from the bad situations. This can cause the species to evolve towards the dead end. The Genetic Algorithm uses three main types of rule at each step to create the new generation from the current population which are as follows-

1. Selection of the individuals called parents, they reproduce to get the population at the next generation.

2. Combining the two parents to reproduce the children for the next generation.

3. Applying mutation i.e random changes to individual parents or children to form children.

1.1 Problem Statement

Various casting Companies are facing problem of shrinkage defect in differential case casting due to improper design of riser .So we have to find out proper design of riser and try to solve them by using optimization technique – genetic algorithm.

1.2 Objectives

1. To generates intelligent initial design that can go a long way in making intelligent manufacturing of casting component.

2. To generate optimized initial design of riser by using Genetic algorithm

3. To reduce Yield percentage per component

4. To reduce Weight of gating system and riser

5. To reduce shrinkage defect in differential case casting

6. The main objective of the optimization is to find the value of diameter (D) and height (H) of the feeder, with minimizing volume of the feeder and respecting constraint specified on the rules.

2. METHODOLGY

2.1 INTRODUCTION

Genetic Algorithms are a family of computational models inspired by evolution. These algorithms encode a potential solution to a specific problem on a simple chromosome-like data structure and apply recombination operators to these structures as to preserve critical information. Genetic algorithms are often viewed as function optimizer, although the range of problems to which genetic algorithms have been applied are quite broad. An implementation of genetic algorithm begins with a population of (typically random) chromosomes. One then evaluates these structures and allocated reproductive opportunities in such a way that these chromosomes which represent a better solution to the target problem are given more chances to 'reproduce' than those chromosomes which are poorer solutions. The 'goodness' of a solution is typically defined with respect to the current population.

2.2 BASIC PRINCIPLE

The working principle of a canonical GA is illustrated in Fig. 1. The major steps involved are the generation of a population of solutions, finding the objective function and fitness function and the application of genetic operators. These aspects are described briefly below. They are described in detail in the following subsection.

/*Algorithm GA */
formulate initial population,
randomly initialize population,
repeat,
evaluate objective function,
find fitness function apply genetic operators,
reproduction,
crossover mutation,
until stopping criteria,

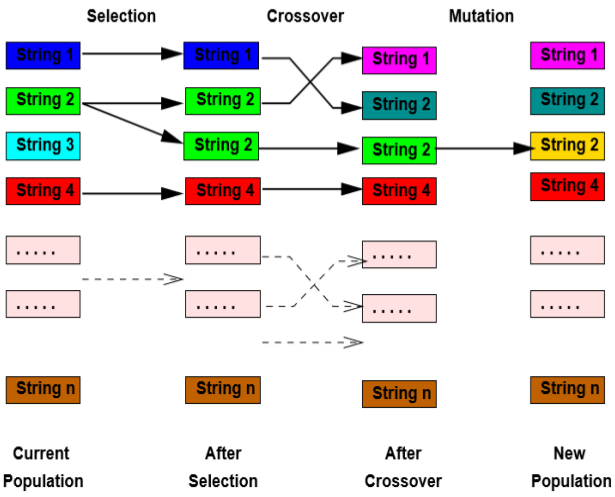

Fig. no. 01 - Working principle of GA

2.3 STEPS IN GENETIC ALGORITHM

1. Reproduction

Reproduction (or selection) is an operator that makes more copies of better strings in a new population. Reproduction is usually the first operator applied on a population. Reproduction selects good strings in a population and forms a mating pool. This is one of the reason for the reproduction operation to be sometimes known as the selection operator. Thus, in reproduction operation the process of natural selection cause those individuals that encode successful structures to produce copies more frequently. To sustain the generation of a new population, the reproduction of the individuals in the current population is necessary. For better individuals, these should be from the fittest individuals of the previous population.

2. Crossover

A crossover operator is used to recombine two strings to get a better string. In crossover operation, recombination process creates different individuals in the successive generations by combining material from two individuals of the previous generation. In reproduction, good strings in a population are probabilistic-ally assigned a larger number of copies and a mating pool is formed. It is important to note that no new strings are formed in the reproduction phase. In the crossover operator, new strings are created by exchanging information among strings of the mating pool.

3. Mutation

Mutation adds new information in a random way to the genetic search process and ultimately helps to avoid getting trapped at local optima. It is an operator that introduces diversity in the population whenever the population tends to become homogeneous due to repeated use of reproduction and crossover operators. Mutation may cause the chromosomes of individuals to be different from those of their parent individuals. Mutation in a way is the process of randomly disturbing genetic information. They operate at the bit level; when the bits are being copied from the current string to the new string, there is probability that each bit may become mutated. This probability is usually a quite small value, called as mutation probability pm. A coin toss mechanism is employed; if random number between zero and one is less than the mutation probability, then the bit is inverted, so that zero becomes one and one becomes zero. This helps in introducing a bit of diversity to the population by scattering the occasional points. This random scattering would result in a better optima, or even modify a part of genetic code that will be beneficial in later operations. On the other hand, it might produce a weak individual that will never be selected for further operations

2.4 Flow chart

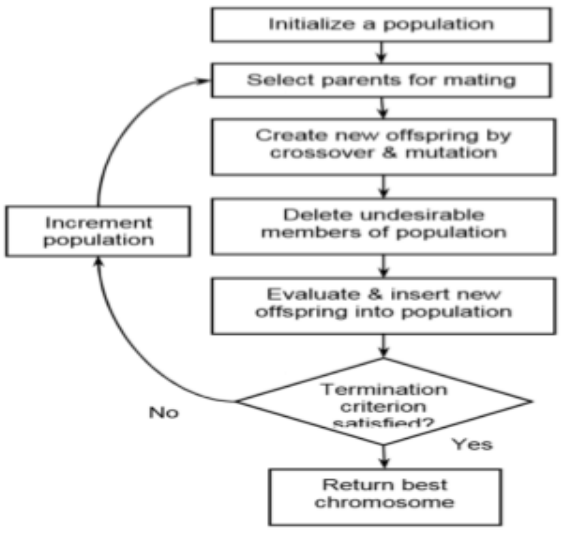

Fig. no.02-Flow chart of GA

2.5 RESULTS

1. SPECIFICATION OF CASTING

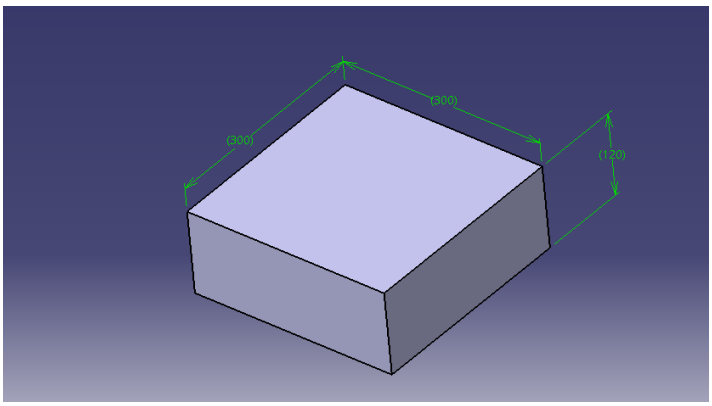

Fig. no. 5 - Square block casting

Specifications of casting square block:

1. Material = Spheroidal Graphite Cast Iron
2. Casting weight = 45 kg
3. Dimensions of casting (square block) = 300 * 300 * 120 mm
4. Volume of casting = 10.8*106 mm3
5. Surface area of casting = 324000 mm2
6. Modulus of casting = volume / casting = 3.24
7. Shrinkage factor of material = 2.5% contraction

2. Results obtain from modulus method

Diameter of the riser - 57mm.
Height of the riser - 85mm.
Volume of the riser - 216899.48mm^3
Modulus of the riser - 3.88

3. Results obtain from GA

The alternate method for optimizing the riser design which we have used that is Genetic algorithm gives alternative and optimized sizes of riser. As shown in the below table riser no.1 gives minimum volume of riser that is 205337 mm^3 and having average diameter of 58 mm and height of 77 mm and of modulus 4 which is sufficient for square block casting. Also one can select riser no.2 of volume 227010 mm^3, with diameter 57 mm and height 89 mm. But to increase the yield percentage of the casting, riser no.1 will be the best for square block casting. Riser no. 4 also all three technical conditions of riser but it provides lesser yield percentage as compared to the riser no.1. As per the demand or constraints of the mould cavity the designer can choose any of the combination of riser diameter and height. Following are the obtained results from the program of genetic algorithm.

Table no. 1. Results obtain from GA

Sr. No.	Average Diameter (mm)	Height (mm)	Volume (mm)	Modulus
1	58	77	205337	4
2	57	89	227010	4
3	75	60	200589	3
4	64	84	199874	3
5	75	62	192547	2.75
6	80	57	185652	2.5

4. Comparison of results

Generally, the method used for designing the riser is modulus method. The modulus of square block is 3.24, so the riser modulus will be 1.2 times of the modulus of casting. Therefore the modulus riser should be equal to or greater than 3.88. In the modulus method, the diameter and height obtained by the calculation done are 57mm and 85mm. Volume of the riser obtained by the calculation is 216899.48 mm^3.

Table no.2 Comparison of results

Sr. No.	Method	Average Diameter	Height	Volume	Modulus
1	Modulus	57	85	216899.48	3.88
2	GA	58	77	205337	4

3. CONCLUSION

For every type of casting, the program generated by genetic algorithm can be used to obtain optimized size and shape of the riser. This method can be applied to any standard shape of the riser as the geometrical parameters can be calculated by the formulae. Genetic algorithm can make intelligent design can last longer. It is very essential and time saving technique in casting industry. As it GA is fast and easy many riser dimensions can be obtained for different components as per demand. The optimization tool, Genetic Algorithm can be used in future in casting industries which will minimize the volume and hence thereby increasing the yield percentage.

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REFERENCES

[1] http://faculty.ksu.edu.sa/melrayes/Course%2OME355%20Processing%20of%20Engineering%20Materials1/prediction%20of%20solidification%20time.pdf (Cited on 4-10-2012, time-03:15 pm).

[2] E. Jacob, R. Sasikumar, B. Praveen, and V. Gopalkrishna, "Intelligent Design of Feeders for Castings by Augmenting CAD with Gentic Algorithm", Journal of Intelligent Manufacturing, pp. 299-305,2004.

[3] Jean Kor, Xiang Chen, Zhizhong Sun, and Henry Hu, "Casting Design Through Multi-Objective Optimization", Preprints of the 18th IFAC World Congress Milano (Italy),pp. 11642-11647,Sup. 2004.

[4] S. Rajasekaran, and G. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm", Prentice-Hall of India, Eastern Economy Edition, 2008.

[5] H. Htofuji, M. Tamura, and H. Ito, "Production of the 7-ton Nonmagnetic Ductile Iron Casting for Largest Class Power Generator", Material Transactions, vol. 51, pp. 103-109,2010. 8. Zhou, "Analysis of Reasons Causing Riser Feeding Failure in Nodular Iron Casting.

[6] C. M. Choudhari, Nikhil S. Dalal, Akshay P. Ghude1, Pratik P. Sankhe, Ashutosh M.Dhotre, "DESIGN AND ANALYSIS OF RISER FOR SAND CASTING"

[7] S.N.Sivanandam·S.N.Deepa, "Introduction to Genetic Algorithms"

[8] R. Tavakoli·P. Davami, "Optimal riser design in sand casting process with evolutionary topology optimization"

[9] Mohadmed M. Marzouk, Osama A. Omar, " An optimization algorithm simulation based planning of low income housing projects.

[10] Uday A. Dabade* and Rahul C. Bhedasgaonkar, "Casting Defect Analysis using Design of Experiments (DoE) and Computer Aided Casting Simulation Technique"

[11] Nedeljko Dučić1, Žarko Ćojbašić2, Radomir Radiša3, Radomir Slavković1, Ivan Milićević1, "CAD/CAM DESIGN AND THE GENETIC OPTIMIZATION OF FEEDERS FOR SAND CASTING PROCESS"

[12] F. Havlicek, T. Elbel*, "Geometrical modulus of a casting and its influence on solidification process"