Optimum Cost DESIGN of RCC RETAINING WALL with GA

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Abstract

During last decades, economical criteria are the most important factor in civil engineering projects. Cantilever retaining walls, as reinforced concrete retaining structures, are required to resist against a combination of lateral earth pressure and hydrostatic stress. "Genetic Algorithms" (GAs) method is a general search and optimization algorithms inspired by "Darwin's Evolution Theory". In the recent years, GA is rapidly extended in many fields such as criminal suspect recognition, music composition, earthquake epicenter detection and many other fields. The application of algorithm genetic (GA) for nonlinear constraint optimum cost design of reinforced concrete cantilever (RCC) retaining wall is argued in the present research. A genetic algorithm is applied to achieve the optimized design of the RCC retaining wall. The main feature of GA is the ability to change nonlinear constrains problems to linear with no constraint problems. It is well established that genetic algorithm can be successfully applied to the optimum cost design of RCC walls. The results of optimization process of 6 RCC retaining walls show 30% to 5% reduction in total cost with respect to the same walls with initial design. The difference in percents of reduction respect to height of wall is proportion to the rate of steel to concrete and their prices. In high walls the rate of steel to concrete is more since their reduction of cost is less. During the optimization all stabilities controls respond to overturning, sliding, bearing capacity, the location of resultant, minimum and maximum steel rate in sections are satisfied.

Keywords: Retaining wall, Algorithm Genetic, optimization.

1. INTRODUCTION

A retaining wall is defined as a structure whose primary purpose is to provide lateral support for soil or rock. Retaining walls have traditionally been constructed with plain or reinforced concrete, with the purpose of sustaining the soil pressure arising from the backfill. This study is concerned with reinforced concrete cantilever (RCC) retaining walls. A schematic view of RCC is shown in Figure 1.

Earth retaining structures constitute an integral part of the infrastructure and reinforced concrete retaining walls as earth structures are frequently constructed for a variety of applications, most commonly for bridge abutments, road, transportation systems, lifelines and other constructed facilities. In order to economize the cost of the reinforced concrete retaining walls under design constraints, the designer needs to vary the dimensions of the wall several times, making design process rather tedious and monotonous. Since it is extremely difficult to obtain a design satisfying all the safety requirements, it is beneficial to cast the problem as an optimization problem. Some studies have been made in this direction by Dembicki & Chi [1], Keskar & Adidam [2], Saribas & Erbatur [3], Rhomberg & Street [4], Basudhar & Lakshman [5], Sivakumar & Munwar [6], and Yepes [7]. Although some mathematical programming based methods have been developed for optimum design problems, however, their applications are limited due to the fact that they require gradient information and usually seek to improve the solution in the neighborhood of a starting point. In recent years, structural optimization has witnessed the emergence of some novel and innovative design techniques. These stochastic search techniques make use of the ideas adopted from the nature, and do not suffer the discrepancies of mathematical programming based optimum design methods. The basic idea behind these techniques is to simulate the natural phenomena such as survival of the fittest, immune system, swarm intelligence and the cooling process of molten metal into a numerical algorithm. In this study, the genetic algorithms are used to determine the optimum design of reinforced concrete retaining walls. The objective function considered is taken as the cost of the retaining wall, and design is based on ACI 318-08. This function is minimized subjected to design constraints. A numerical example together with sensitivity analysis is presented to illustrate the performance of the provided algorithms.