

Cross-Sectional Area Constraint:  $(w_1 + w_2)(H_1 + H_2 + 1)/2 = 150$  or

$$h_1 = (w_1 + w_2)(H_1 + H_2 + 1)/2 - 150 = 0;$$

Excavated Material Constraint:  $(w_1 + w)(H_1/2) = (2)(w_2 + 2)(H_2 + 1)/2$  or

$$h_2 = (w_1 + w)(H_1/2) - (w_2 + 2)(H_2 + 1) = 0$$

The design variables are not independent; they are related as follows:

$$\tan \theta = \frac{H_1}{(w - w_1)/2} = \frac{H_2 + 1}{(w_2 - 2)/2} = \frac{H_1 + H_2 + 1}{(w_2 - w_1)/2}$$

So we get two more constraints from these relationships, as

$$h_3 = \frac{H_1}{w - w_1} - \frac{H_2 + 1}{w_2 - 2} = 0;$$

$$h_4 = \frac{H_1}{w - w_1} - \frac{H_1 + H_2 + 1}{w_2 - w_1} = 0$$

All the design variables must also be nonnegative:

$$-w \leq 0; \quad -w_1 \leq 0; \quad -w_2 \leq 0; \quad -w_3 \leq 0; \quad -H_1 \leq 0; \quad -H_2 \leq 0$$

### **Formulation 2:**

#### **Step 1: Problem Statement**

Shown above

#### **Step 2: Data and Information Collection**

Shown above

#### **Step 3: Definition of Design Variables**

$w_1$ ,  $H_1$ ,  $H_2$  (m), and  $s$  (unitless) are chosen as design variables which are defined below in relation to Figure E2.22:

$$s = \tan \theta$$

$$w = w_1 + \frac{2H_1}{s}$$

$$w_2 = w_1 + \frac{2(H_1 + H_2 + 1)}{s}$$

$$w_2 = 2 + \frac{2(H_2 + 1)}{s}$$

#### **Step 4: Optimization Criterion**

Optimization criterion is to minimize the volume of excavation, and the cost function is defined as:

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**Jasbir Singh Arora**



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Zong Woo Geem, 2009-05-12 Calculus has been used in solving many scientific and engineering problems For optimization problems however the differential calculus technique sometimes has a drawback when the objective function is step wise discontinuous or multi modal or when decision variables are discrete rather than continuous Thus researchers have recently turned their interests into metaheuristic algorithms that have been inspired by natural phenomena such as evolution animal behavior or metallic annealing This book especially focuses on a music inspired metaheuristic algorithm harmony search Interestingly there exists an analogy between music and optimization each musical instrument corresponds to each decision variable musical note corresponds to variable value and harmony corresponds to solution vector Just like musicians in Jazz improvisation play notes randomly or based on experiences in order to find fantastic harmony variables in the harmony search algorithm have random values or previously memorized good values in order to find optimal solution

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Optimization of Finite Dimensional Structures Makoto Ohsaki, 2016-04-19

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*Mechanical*

*Engineering and Intelligent Systems* J.W. Hu, J. Su, 2012-08-30

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Aided Optimum Design of Structures V Santiago Hernández, S. Hernández, C. A. Brebbia, 1997 Containing the proceedings of the 5th International Conference on Computer Aided Optimum Design of Structures this volume looks at recent advances in

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 American Institute of Aeronautics and Astronautics,2005 **Artificial Intelligence in Optimal Design and  
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 with an emphasis on its combination with numerical optimization and geometric modelling in Computer Aided Design  
*ASM Handbook* S. L. Semiatin,ASM International. Handbook Committee,1990 These volumes cover the properties  
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