

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:

$$\tan \theta = \frac{H_1}{(w - w_1)/2} = \frac{H_2 + 1}{(w_2 - 2)/2} = \frac{H_1 + H_2 + 1}{(w_3 - w_1)/2}$$

So we get two more constraints from these relationships, as

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

$$h_4 = \frac{H_1}{w - w_1} - \frac{H_1 + H_2 + 1}{w_3 - w_1} = 0$$

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:

$$s = \tan \theta$$

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

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

$$w_3 = 2 + \frac{2(H_2 + 1)}{s}$$

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

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

# Introduction To Optimal Design Arora Solution

**Xiang Xie**



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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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