

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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Roman Wölfel



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1. Understanding the eBook Introduction To Optimal Design Arora Solution
 - The Rise of Digital Reading Introduction To Optimal Design Arora Solution
 - Advantages of eBooks Over Traditional Books
2. Identifying Introduction To Optimal Design Arora Solution
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Introduction To Optimal Design Arora Solution
 - User-Friendly Interface
4. Exploring eBook Recommendations from Introduction To Optimal Design Arora Solution
 - Personalized Recommendations
 - Introduction To Optimal Design Arora Solution User Reviews and Ratings
 - Introduction To Optimal Design Arora Solution and Bestseller Lists
5. Accessing Introduction To Optimal Design Arora Solution Free and Paid eBooks
 - Introduction To Optimal Design Arora Solution Public Domain eBooks
 - Introduction To Optimal Design Arora Solution eBook Subscription Services
 - Introduction To Optimal Design Arora Solution Budget-Friendly Options
6. Navigating Introduction To Optimal Design Arora Solution eBook Formats

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 - Introduction To Optimal Design Arora Solution Compatibility with Devices
 - Introduction To Optimal Design Arora Solution Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Introduction To Optimal Design Arora Solution
 - Highlighting and Note-Taking Introduction To Optimal Design Arora Solution
 - Interactive Elements Introduction To Optimal Design Arora Solution
 8. Staying Engaged with Introduction To Optimal Design Arora Solution
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Introduction To Optimal Design Arora Solution
 9. Balancing eBooks and Physical Books Introduction To Optimal Design Arora Solution
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Introduction To Optimal Design Arora Solution
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Introduction To Optimal Design Arora Solution
 - Setting Reading Goals Introduction To Optimal Design Arora Solution
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Introduction To Optimal Design Arora Solution
 - Fact-Checking eBook Content of Introduction To Optimal Design Arora Solution
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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