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ESTIMATION AND COSTING OF WELDED STRUCTURE (SOLAR PANEL SUPPORT)

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ABSTRACT
The estimation and costing of welded structures, particularly in the context of solar panel supports, are crucial aspects in mechanical engineering. This study focuses on analyzing the various factors involved in estimating and costing such structures, including materials, labor, equipment, and overheads. By understanding the complexities of welding processes, material properties, design requirements, and project scope, accurate estimations can be made to ensure cost-effective and efficient fabrication of solar panel support structures. This abstract provides a brief overview of the key considerations and methodologies employed in estimating and costing welded structures for solar panel support applications within the domain of mechanical engineering.

INTRODUCTION

1.1 Definition of Welding:

Welding is a fabrication process in which two metals are joined by using high heat to melt andpressure the parts together and allowing them to cool, causing fusion.

Advantages of welding:

- Strong and tight joining;
- Cost effectiveness;
- Simplicity of welded structures design;
- Welding processes may be mechanized and automated.

Disadvantages of welding:

- Internal stresses, distortions and changes of micro-structure in the weld regionHarmful effects: light, ultraviolet radiation, fumes, high temperature.

Applications of welding:

- Buildings and bridges structures;
- Automotive, ship and aircraft constructions;
- Pipe lines;
- Tanks and vessels;
- Railroads;
- Machinery elements.

1.2 Classification of welding process:

1. Gas welding
a) Oxy -Acetylene
b) Oxy-Hydrogen
c) Air acetylene

2. Resistance welding
a) Butt
b) Spot
c) Seam
d) Projection

3. Arc welding
a) Carbon arc
b) Submerged arc
c) Plasma arc

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1.3 Gas Welding:

1.3.1 OXY-ACETYLENE WELDING:

Oxyacetylene welding, commonly referred to as gas welding, is a process which relies on combustion of oxygen and acetylene. When mixed together in correct proportions within a hand-held torch or blowpipe, a relatively hot flame is produced with a temperature of about 3,200 ˚c as shown in the figure 1.1.

1.3.2 OXY HYDROGEN WELDING:

In this process oxygen and hydrogen are used for fusing and cutting. The oxy-hydrogen flame produced in this process is typically of pale blue color. The temperature of this flame is about 2000 ℃. The work piece is firstly heated and the melt bar fused in to make in the connection or joint. The time interval is not fixed for the completion of this process. It will vary from two minutes to five minutes depending on the size of sheets.

Oxy-hydrogen gas welding, also known as oxy-hydrogen welding or water torch welding, is a welding process that utilizes a mixture of hydrogen gas and oxygen to create a high-temperature flame for melting and joining metals. Unlike oxy-acetylene welding, which uses acetylene gas, oxy-hydrogen welding relies on hydrogen gas as the fuel source. This welding method produces a flame with temperatures reaching up to 2,800°C (5,072°F), making it suitable for welding various metals, including steel, copper, and aluminum. Oxy-hydrogen gas welding offers several advantages, including its clean burning nature, as it produces only water vapor as a byproduct, making it environmentally friendly. Additionally, hydrogen gas is readily available and cost-effective compared to acetylene, contributing to lower operational costs. However, oxy-hydrogen gas welding may require additional safety precautions due to the highly flammable nature of hydrogen gas. Common applications of oxy-hydrogen gas welding include jewelry making, electronic soldering, glass sealing, and small-scale metal fabrication. Overall, oxy-hydrogen gas welding offers a versatile and environmentally friendly alternative to traditional welding methods, providing high-temperature flames for various metalworking applications.

1.3.3: AIR ACETYLENE:

Air-acetylene gas welding, also known as oxy-fuel welding, is a welding process that utilizes a mixture of acetylene gas and oxygen to produce a high-temperature flame for melting and joining metals. The characteristics of this welding method include its versatility, as it can be used for fusion welding, brazing, soldering, and flame cutting. The flame temperature, reaching up to 3,100°C (5,600°F), allows for welding various metals such as carbon steel, stainless steel, aluminum, and copper alloys. One of the notable advantages of air-acetylene welding is its precise heat control, which can be adjusted by regulating the ratio of acetylene to oxygen. This control enables welders to perform delicate operations, making it suitable for applications like jewelry making and repair.

1.9.5 SOLAR PANEL SUPPORT:

Welded structures for solar panel support play a crucial role in the stability and durability of solar installations. Here's a detailed breakdown of various aspects:

1. **Design Considerations:**

Load-Bearing Capacity: The structure must be designed to withstand the weight of the solar panels along with additional loads such as wind, snow, and seismic forces.

Material Selection: Typically, welded structures are made from steel or aluminum due to their strength-to-weight ratio and resistance to corrosion.

Structural Analysis: Engineers perform structural analysis to ensure the design meets safety standards and can withstand anticipated environmental conditions.

2. **Fabrication Process:**

Cutting: Steel or aluminium beams and plates are cut according to the design specifications using saws, lasers, or plasma cutters.

Welding: The cut pieces are then welded together using techniques like MIG (Metal Inert Gas) or TIG (Tungsten Inert Gas) welding. Welds must be of high quality to ensure structural integrity.

Surface Treatment: After welding, the structure may undergo surface treatments such as painting or galvanizing to enhance corrosion resistance.

3. **Types of Welded Structures:**

Ground Mounts: These support structures are installed on the ground and are usually made of steel. They can be fixed tilt or have a tracking system to optimize solar exposure.

Roof Mounts: Designed to be installed on rooftops, these structures are typically lighter and more adjustable to accommodate various roof types and angles. They are often made of aluminum to reduce weight.

Pole Mounts: Suitable for areas with limited ground space, pole mounts are installed on single or multiple poles and can be fixed or adjustable.

4. **Installation Process:**

Site Preparation: Before installation, the site is surveyed to ensure proper alignment and orientation for maximum

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sunlight exposure.

Foundation Installation: Ground mounts may require concrete foundations, while roof mounts are attached directly to the roof structure using specialized mounting hardware.

Assembly: The welded support structures are assembled on-site according to the design specifications, with careful attention to alignment and structural integrity.

Panel Mounting: Solar panels are then mounted onto the support structure using clamps or brackets, securely fastened to withstand environmental forces.

5. Maintenance and Inspection:

Regular Inspections: Periodic inspections are necessary to check for signs of wear, damage, or corrosion that could compromise the structural integrity.

Cleaning: Keeping the solar panels and support structures clean from dirt, debris, and snow buildup helps maintain optimal performance.

Repairs: Any damaged welds or components should be repaired promptly to prevent further deterioration.

6. Regulatory Compliance:

Building Codes: Solar installations must comply with local building codes and regulations regarding structural design, installation, and safety.

Permitting: Obtaining the necessary permits and approvals from local authorities is essential before installing solar support structures.

Overall, welded structures for solar panel support require careful design, fabrication, installation, and maintenance to ensure long-term performance and safety. Collaboration between engineers, fabricators, and installers is crucial to delivering successful solar installations.

EXPERIMENTATION PROCEDURE

1. Design Specifications:

Length = 380mm
Height = 730mm (Front)
Height = 900mm (Back)
Slope of the Structure = 48˚

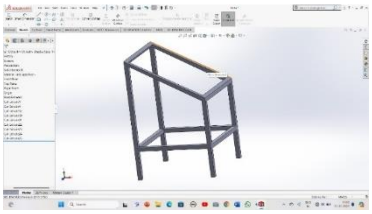

Fig 3.3.1: Design Specifications

Commands used for the above diagram:

- Line
- Extruded Boss / Base
- Extruded Cut

Obtain detailed drawings or specifications for the solar panel support structure. Note down requirements such as dimensions, material types (e.g., steel grades), load-bearing capacities (wind load, snow load, etc.), and any specific regulations or standards that must be followed.

2. Material Selection:

Material used: ASTM A36 Iron

Fig 3.3.2: Material Used

Evaluate various material options based on factors like strength, durability, corrosion resistance, and cost. Consider the environmental conditions where the structure will be installed (e.g., coastal areas may require corrosion-resistant materials). Choose materials such as ASTM A36 structural steel based on their suitability for the project.

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3. Breakdown Structure:

Fig 3.3.3: Breakdown Structure

Analyze the design drawings to identify individual components of the support structure, such Angles and base plates, etc. Divide the structure into manageable sections to facilitate estimation and fabrication.

4. Calculate Material Quantities:

Material's	Parts used	Cost	Total Cost in Rupees
ASTM A36 Iron	3x25x25 mm	68 / Kg	7x68 = 476/-
Welding Electrode	4	15 / 1 Num	4x15 = 60/-
Grinding Wheel	2	90 / 1 Num	2x90 = 180/-

Fig 3.3.4: Calculate Material Quantities

For each component, calculate the required quantities of material (e.g., length of Angles, thickness of plates) based on the design specifications. Account for material wastage and allowances for fabrication processes like cutting, welding, and grinding.

5. Labor Estimation:

Labor	Work Done	Charge Per Hour	Time Taken	Total Cost in Rupees
Fitter	Planning and designing	100	1	100/-
Welder	Welding of component	100	2	200/-

Estimate the labor hours required for fabrication, welding, and assembly of each component. Consider factors such as the complexity of fabrication, welding techniques required, and the skill level of the workforce. Consult with experienced fabricators or welders to validate labor estimates.

6. Equipment and Tooling:

Machines Used	Charges per hour in Rupees	Total Cost in Rupees
Cutting Machine	200	1x200 = 200/-
Welding Machine	500	2x500 = 1000/-
Grinding Machine	150	1x150 = 150/-

Fig 3.3.5.1: Grinding Machine

Fig 3.3.5.2: Welding Machine

Identify the specific equipment and tools needed for fabrication, welding, and assembly. Include costs for renting or purchasing welding machines, cutting tools, grinding equipment.

7. Overhead Costs:

Item's Used	Charge per hour	Total Cost in Rupees
Electricity	65	5x65 = 325/-
Water Bill	40 per 1 Num	3x40 = 120/-
Shop Space	94	94x8 = 752/-

Fig 3.3.6: Shop Space

Estimate indirect costs associated with the fabrication process, such as electricity, shop space rental, insurance, and administrative expenses.

8. Quality Control:

Allocate resources for quality control measures, including inspections, testing and certifications (e.g., welder certifications, material certificates).

9. Markup:

Determine the desired profit margin or markup percentage to be added to the total cost. Consider market conditions, competition, and the client's budget constraints when setting the markup.

10. Final Cost Calculation:

Sum up all estimated costs, including materials, labor, overheads, quality control and markup. Present the total estimated cost in a detailed breakdown, showing individual cost components and their respective percentages of the total.

11. Documentation:

Document the entire estimation process, fabrication process including Raw material procurement, transport, and cutting, welding and grinding with proper images /photographs for representation.

RESULTS AND DISCUSSION

Estimation amount of all the materials and Welded Structure

1. Cutting machine + Cutting Wheel + Cost for the Machine per day = 400 Rupees
2. Welding machine + Holder + Electrode + Helmet + Gloves + Rent =600 Rupees
3. Grinder machine + Cost for the Machine per = 300 Rupees
4. Rent for Equipment's used per day = 1300 Rupees
5. Shop space Cost per day =752 Rupees

Table – 01 Overall Cost for the Solar Panel Support

S. No	Procedure	Quantity and Quality	Cost per kg	Total Cost
1	Design Specifications	Length, width, thickness 3x3x25 mm	68	272
2.	Material Selection	ASTM A36 Iron	68	544
3.	Calculate Material Quantities	Dimensions, Welding Electrode, Grinding	162	650
4.	Labor Estimation	Fitter, Welder	3	300
5.	Tooling	Welding machine, Cutting Wheel and Grinding machine	566	1122
6.	Overhead cost	Shop Space and Electricity bill	199	1197
			Total Cost	**4085/-**

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Solar panel support

Fig 4.1: Solar Panel Support

Total Cost for 1 Solar Panel Support is 4085/-

METHODOLOGY

Design Specifications
Length=380mm, Height=730mm (Front), Back=900mm, Angle=48˚

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Material Selection

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Breakdown Structure

↓

Calculate Material Quantities

↓

Labor Estimation

↓

Equipment and Tooling

↓

Overhead Costs

↓

Quality Control

↓

Markup

↓

Final Cost Calculation

↓

Documentation

CONCLUSION

In conclusion, several key points can be highlighted regarding the estimation and costing of welded structures like solar panel support. In our Project the material we used is ASTM A36 Iron and the cost for iron is 68 Rupees per Kg and it supports the environmental conditions. As per our estimation the cost for 1 Solar Panel Support is **4085**/-. The Solar Panel Support we made was affordable and it is mainly recommended for the middle-class people as the cost is low. We use here 3 machines mainly they are Welding, Grinding and Cutting machine respectively.

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