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Construction and Installation of a Signboard for Mechanical Engineering Complex

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Abstract- This study focuses on the construction and installation of a signboard for the Department of Mechanical Engineering, The Federal Polytechnic, Bida. Recognizing the critical role of signage in effective campus wayfinding, safety, and institutional branding, the study emphasizes the importance of durable, legible, and accessible signage systems that are tailored to environmental and aesthetic considerations. The research examines the historical evolution of signboards, current standards for visibility and readability, and innovative materials suitable for outdoor signage. The signboard, which measures 8 ft × 6 ft, was fabricated from a 3 mm thick mild steel sheet and reinforced with a frame and base made from mild steel square pipes of sizes 2 inches × 2 inches, and 3 inches × 1 inch. The surface of the signboard features the polytechnic logo and the departmental Latin slogan for students, Aut Optimum; Aut Nihil ("The Best or Nothing"). Test results after installation showed that the structure was stable and that the maximum deviation in alignment was 1 mm, which is acceptable for large signboards of this nature. The signboard was also found to be visible and legible to passers-by, enabling them to see, read, and understand the information displayed. Thus, the design problem was successfully addressed.

Keywords: Signboard, Wayfinding, Institutional Branding, Evolution, Polytechnic

I. INTRODUCTION

Wayfinding, the process of navigating from one location to another has been extensively studied within environmental design, architecture, and human factors engineering. Physical elements such as landmarks and signs enhance cognitive mapping, allowing individuals to interpret and navigate complex environments more easily. In modern institutional settings, signboards remain integral components of wayfinding systems and environmental communication. Learning institutions often expand their physical infrastructure to accommodate growing academic programs and student populations. This expansion, while beneficial, frequently results in decentralized and spatially dispersed facilities. Without adequate directional systems, both newcomers and existing campus users may struggle to locate essential buildings. Poorly designed wayfinding environments reduce user efficiency, cause frustration, and create negative institutional impressions. Signage plays a critical role in the communication of essential information within educational institutions, public spaces, industries, and transportation systems. As a visual communication tool, a signboard provides direction, identification, and guidance to users navigating a particular environment. Within the campuses of higher institutions of learning such as the Mechanical Engineering department of The Federal Polytechnic, Bida, signboards are vital elements of the physical information system that ensures students, staff, visitors, and stakeholders can easily locate buildings and services without confusion. According to the International Sign Association (ISA, 2021), signs significantly enhance wayfinding, reduce navigation time, and improve the overall accessibility of facilities.

Without adequate directional signage, users may experience difficulties navigating these spaces. Signboards are not only functional elements but also components of institutional branding. They communicate the identity, values, and standards of the organization they represent (Calori & Vanden-Eynden, 2015).

Currently, visitors and new students spend unnecessary time locating the Mechanical Engineering Department due to inconsistent or absent external signage. The existing signboard is small, and it does not fully represent the department, as it presents majorly the slogan for students of the Mechanical Engineering Department: *Aut Optimum; Aut Nihil,* which means. The Best, or Nothing. Furthermore, the signboard is already corroded by the weather

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conditions, its view is obscured by other signposts and the tree growing beside it. This has led to frequent direction requests, and late arrivals for lectures.

II. HISTORICAL DEVELOPMENT OF SIGNAGE

Signage is a fundamental visual communication tool that has evolved in tandem with human civilization and technological advancement. From prehistoric cave paintings to modern digital interfaces, the development of signboards reflects shifts in materials science, literacy, and urban complexity. Effective signage is now recognized as a critical component of campus wayfinding systems; it reduces spatial anxiety, optimizes travel time, and reinforces institutional identity (University of Michigan, 2017).

2.1 Pre-industrial and ancient signage

The genesis of signage dates to approximately 18,000 BC with cave paintings and petroglyphs in sites such as Chauvet Cave and El Castillo. These basic symbols were the first visual records of the human environment. As civilizations emerged in Egypt, Greece, and Rome, signage changed towards functional utility. The Romans utilized milestones for roadway navigation and terracotta relief signs to identify commercial entities like bakeries and taverns (Larwood & Hotten, 1867).

2.2 Medieval guilds and the renaissance

During the Middle Ages (5^{th}– 15^{th} century), the rise of commerce led to the formalization of guild signs. Symbols like scissors for tailors or horseshoes for blacksmiths allowed a largely illiterate population to navigate trade districts. The Renaissance (14^{th}–17^{th} century) introduced higher aesthetic standards, utilizing vibrant pigments (verdigris, saffron) and the development of enameled metal signs. This period marked the beginning of signage as both a decorative art form and a competitive branding tool.

2.3 The industrial revolution and the 20th century

The 18th and 19th centuries transformed sign making from a craft to a mass-production industry. The introduction of mechanized metal casting and porcelain enamel firing allowed for durable, weather-resistant outdoor advertising (Frutiger, 1989). The subsequent invention of gas and electric lighting in the early 20th century revolutionized urban visibility. By the 1920s, neon lighting, pioneered by Georges Claude became the hallmark of commercial architecture (Levinson, 2016). The mid-century was also characterized by the introduction of plastics and Light Emitting Diodes (LEDs).

Modern signage must transcend decorative appeal to meet rigorous technical and ergonomic standards. Research indicates that visibility, color contrast, and installation height are the primary determinants of sign effectiveness. The American National Standards Institute (ANSI, 2011) provides specific frameworks for legibility relative to traffic flow. The Occupational Safety and Health Administration (OSHA, 2020) mandates visible building identification to facilitate emergency response.

III. MATERIALS

The signboard, measuring 8 ft × 6 ft (approximately 2.44 m × 1.83 m), was constructed using carefully selected materials to ensure structural integrity, durability, and visual effectiveness. 3mm thick mild steel sheet was utilized as the primary sign face due to its strength, weldability, and cost-effectiveness, while mild steel square pipes (2 × 2 inches) were employed to form the main structural frame and internal bracing, providing rigidity and support. Additionally, rectangular mild steel pipes (2 × 3 inches) were used for the base structure to enhance stability during installation. The institutional logo, with a diameter of 30 mm, was cast in aluminum, alongside decorative and symbolic castings such as spanners and gears to reflect the mechanical engineering discipline. The finishing process involved the application of painted lettering and graphical elements, which not only improved the aesthetic appeal of the signboard but also enhanced its functionality in clearly conveying the department's identity, location, and purpose.

3.1 Methods

3.1.1 Design Considerations

The design of the signboard prioritized visibility, legibility, durability, and aesthetic integration with the Mechanical Engineering Complex. Key considerations include:

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i. The signboard is taken to be a freestanding façade sign, with the wind resultant acting at the centroid of the sign (mid-height).
ii. Shear per anchor is assumed to be equal among the four anchors

3.2 Design for stability

The diagram shown in Figure 3.1 is used for the design calculation. iii.

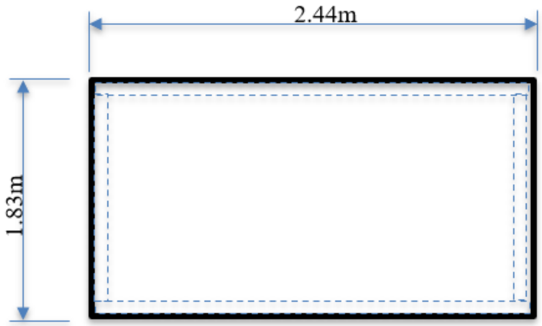

Figure 3.1: Orthographic view of the face of the signboard

i. Maximum wind force to be withstood by the signboard iv.

The maximum wind pressure (P) can be estimated using the formula:

$$P = \frac{1}{2}\rho V^2 C d A, \quad (3.1)$$

This derives from the dynamic pressure expression.

$$q = \frac{1}{2}\rho V^2 \quad (3.2)$$

where:

ρ = is the air density (approx. 1.225kg/m^3) v.

V = the design wind speed (40m/s for high wind areas)

Cd = the drag coefficient (1.2 for flat plates)

A = the area of the signboard ($2.44m \times 1.83m = 4.4652m^2$)

This calculation will inform the required strength of the frame and mounting.

$$q = \frac{1}{2}\rho V^2$$
$$= 0.5 \times 1.225 \times (40)^2$$
$$= 0.5 \times 1.225 \times 1600$$
$$= 980 N/m^2$$

ii. Total wind force on the sign (horizontal drag)

$$F = q \times C_d \times A$$
$$= 980 \times 1.2 \times 4.4652$$
$$= 5{,}251.0752N, \text{ or } 5.251N.$$

So the instantaneous wind force on the sign is 5.251 kN (correct to 3 decimal places)

Applying a factor of safety of 1.5, design force

$$F_{design} = 1.5 \times 5.251kN$$
$$= 7.88kN \text{ or } 8kN$$

So , we use ≈ 8.0 kN as the lateral design force for the sign (horizontal)

Overturning moment and anchor loads

To check frame and mounting, we need the overturning moment about the mounting line. the wind resultant acts at the centroid of the sign (mid-height, h_{cp}).

Design moment about bottom mounting line, M_d:

$$M_d = F_{design} \times h_{cp} \quad (3.3)$$

The vertical height of the sign = 1.832 m, so centroid above the bottom h_{cp} is:

$$\approx \left(\frac{1.83}{2}\right) \quad \text{i.e.} \quad 0.915 \text{ m}$$

This implies that;

$$M_d = 7.88kN \times 0.915 \text{ m}$$
$$\approx 7.2102kN/m$$

Shear per anchor

Assuming equal shear sharing for the four anchors):

$$V_{anchor} = \left(\frac{Fdesign}{4}\right) \quad (3.4)$$

Vertical separation between top and bottom anchor rows ≈ 0.915 m

Therefore, shear per anchor V_{anchor},

$$= \left(\frac{Fdesign}{4}\right) \quad \text{i.e.} \quad \left(\frac{7.88kN}{4}\right)$$
$$= 1.97kN/\text{anchor shear}$$

Tensile/compressive force on extreme anchors due to moment

The moment is resisted by a couple formed by tension in the top anchors and compression in the bottom anchors. For a vertical lever arm Sv = 0.915m:

$$T = \left(\frac{M}{Sv}\right) \quad \text{i.e.} \quad \left(\frac{7.2102kNm}{0.915m}\right)$$
$$= 7.88kN$$

The results show that the frame members have sufficient in-plane stiffness to transfer 8kN to the anchors without excessive deflection. Thus, in selecting anchor/foundation bolt selection, anchors to be chosen should have minimum shear capacity > 1.97 kN and tensile capacity > 8 kN

3.3 Assembly and Fabrication

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The fabrication process involved cutting the steel pipes to the required dimensions and joining them by welding to form the structural framework and support stand of the signboard. The finishing process involved the application of painted lettering and graphical elements, which not only improved the aesthetic appeal of the signboard but also enhanced its functionality in clearly conveying identity, location, and purpose of the department. The departmental slogan, *Aut Optimum, Aut Nihil* ("The Best or Nothing"), was also incorporated into the design. Thereafter, the mild steel sheet was welded onto the fabricated frame. The signboard structure was then erected on its base supports and inspected for levelness and structural stability.

3.4 Installation of the Signboard

The selected installation location, which was the roofed balcony at the entrance of the Mechanical Engineering Complex, was first prepared by cleaning the surface and creating openings for the anchor bolts that would secure the signboard base. The signboard was then transported to the site and moved to the balcony frontage for installation. The fabricated signboard was subsequently positioned, and installed at the entrance location. During the lifting and placement stage, manual handling was adopted in i.
place of a forklift due to the moderate installation ii.
height and the availability of sufficient personnel. With coordinated teamwork and the use of ladders, the iii.
signboard was safely raised and placed onto its marked iv.
position.

IV. TESTS, RESULTS AND DISCUSION OF RESULTS

4.1 Tests

After the fabrication of the signboard, it was tested for stability and alignment to confirm if it met the design requirements. The tests were performed as follows:

4.1.1 Stability test

The object of this test is to ensure the signboard remains stable and does not tip or fall under normal conditions. It was carried out as follows:

i. Visual Inspection: The mountings and supports were checked if they were firmly anchored
ii. Manual Stability Test: The signboard was gently pushed and shaken from different directions to see if it wobbles or shifts.
iii. Weight Check: It was checked if the weight distribution is even by trying to push it back, and watching if it will bend backwards at certain pressure points.

Results of the tests are as presented in Table 4.1

Table 4.1: Stability test results

Parameter	Measurement/Observation	Result/Comments
Support firmness	Secure/Loose	Secure
Movement during shake	No movement / Slight / Significant	No movement
Anchor stability	Firm / Loose	Firm

4.1.2 Alignment test

The objective of this test is to verify the signboard is properly aligned horizontally and vertically. It was carried out as follows:

A spirit level was used to check the horizontal and vertical alignment along the edges.

Measurements were taken at multiple points across the signboard for accuracy, and results recorded in the Table 4.2

Table 4.2: Alignment test results

Point	Horizontal Level (mm deviation)	Vertical Level (mm deviation)	Comments
Top edge	0	0	Properly aligned
Middle	0.5 mm	0.2 mm	Slight deviation, acceptable
Bottom edge	1 mm	0.3 mm	Slight deviation

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4.2 Discussion of Results

From the stability results shown in Table 4.1, it was discovered that when pushed a little and more, the anchor was firm, and the signboard did not move from its position. The signboard remained stable during manual tests without wobbling, showing that the supports are adequate, and that the installation is firm. Results from the alignment test (Table 4.2) show that the top edge was properly aligned, while the middle gave deviations of 0.5mm and 0.2mm. at the horizontal and vertical levels. This deviation is very insignificant, and acceptable. As for the bottom edge, the horizontal deviation is 1mm, with a vertical deviation of 0.3mm. These values are very small, and acceptable. Overall, such small deviations will cause not changes on the visibility of the signboard, straightness of the edges and texts bearing in mind that deviations within ±2 mm are generally acceptable for large signs. So, the job can be said to be well fabricated and installed to be able to stand the test of time.

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This work, which is on the construction and installation of a signboard for the Department of Mechanical Engineering Complex of The Federal Polytechnic, Bida has been completed, and the aim achieved by attainment of the objectives as follows: A working drawing was prepared, which was used in the design and material selection, and also, the results of the design calculations were used in the construction of the signboard, Furthermore, the school logo and other signage were cast, the parts of the signboard were assembled and fabricated, and the write-ups were effectively done. Finally, the signboard was mounted at the balcony, just in front of the complex as proposed. It also withstood the stability test, the signboard was properly aligned for wind resistance and stability, and it was also very visible, and informative to passers-by, thus solving the design problem.

5.2 Recommendations

Based on the outcome of this work, the following are recommended:

i. Aerodynamic features or should be included in future designs to reduce wind impact.
ii. Periodic checks should be carried out especially before the rainy/windy seasons.
iii. Research should be ventured into making the signboard digital/interactive.
iv. Wind load calculations tailored to local wind speeds should be used for safer designs.

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