

CHAPTER TWO: LITERATURE REVIEW

2.1 Historical Development of Metal Doors

Historically, **metal doors** date back to the use of **bronze and wrought iron** in ancient fortifications and castles. These materials offered **defensive advantages** and durability. With the advent of the **Industrial Revolution**, steel manufacturing and welding advancements allowed mass production of doors for urban buildings. Doors are movable barriers used to block off or allow access through an entrance. According to Oyekunle (2022), metal doors now account for 40% of newly installed doors in urban areas due to security and fire protection needs. Historical Development of Metal Doors. The use of metal in door construction dates back to ancient civilizations where bronze and wrought iron were used for gates and fortress entries. In modern architecture, steel and aluminum have largely replaced wood in commercial and industrial door applications due to their superior strength, fire resistance, and longevity (Ekong, 2023). The development of welding techniques in the 20th century allowed for the fabrication of complex metal structures, making steel doors common in urban residential buildings. In modern times, **mild steel, stainless steel, and aluminum** dominate the market due to:

- Corrosion resistance
- Fireproof properties
- Ease of forming and welding

Ekong (2023) notes that steel doors became prevalent in African urban housing developments after the 1980s due to their superior resilience and low maintenance.

2.2 Types of Metal Doors

Metal doors are classified by design, structure, and application:

- **Flush Metal Doors** – Feature flat, plain surfaces often used in internal spaces.
- **Panel Metal Doors** – Include decorative or structural panels for aesthetic or functional purposes.
- **Reinforced Security Doors** – Heavy-duty, multi-layer doors with additional locking mechanisms.
- **Twin Panel Metal Doors** – Consist of two steel sheets forming an inner and outer panel, joined by a central or perimeter frame. Often includes internal reinforcements or insulation.

Yusuf & Musa (2024) highlight that twin panel doors combine elegance and strength, ideal for homes and institutional buildings exposed to weather and vandalism.

2.3 Materials Used in Door Fabrication

1. Mild Steel

- Most commonly used due to **availability, low cost, and ease of welding**.
- Requires proper coating to prevent corrosion.

2. Stainless Steel

- Used in sanitary or luxury environments.
- Offers excellent **corrosion resistance** but is costlier.

3. Galvanized Iron (GI)

- Mild steel coated with **zinc for rust resistance**.
- Ideal for external doors in humid environments.

Adebayo & Okoro (2022) found mild steel to provide an optimal balance of **cost and mechanical performance** for residential doors in West Africa.

2.4 Welding and Fabrication Techniques

Welding is a cornerstone of metal door fabrication. Common techniques include:

- **SMAW (Shielded Metal Arc Welding)**: Economical, simple, and suitable for small workshops.
- **MIG (Metal Inert Gas Welding)**: Clean, fast, and ideal for large-scale production.
- **TIG (Tungsten Inert Gas Welding)**: High-quality welds for thinner sheets or stainless steel.

Fabrication stages:

- **Measuring and cutting** using angle grinders or guillotine shears.
- **Joining panels and frame** using fillet welds.
- **Grinding and finishing** to smoothen welds and prepare for painting.

Reference: ASME (2021) Welding Standards recommend SMAW for general-purpose structural welding where access to inert gas is limited.

2.5 Design Considerations for Twin Panel Doors

Key factors influencing performance:

- **Panel Thickness:** Typically 1.2–1.5 mm for residential security doors.
- **Frame Strength:** 25–40 mm angle or square bar used for rigidity.
- **Hinge and Lock Placement:** Proper reinforcement prevents sagging and improves security.
- **Reinforcement Bars:** Internally placed to prevent buckling or forced entry.
- **Finishing:** Priming and painting to prevent corrosion and improve aesthetics.

Oyekan & Adetunji (2021) suggest that good design reduces lifecycle costs by minimizing repair frequency and improving user safety.

2.6 Safety and Durability Requirements

For doors to be considered **safe and durable**, they must:

- **Resist physical force** and intrusion.
- **Last under harsh environmental conditions.**
- **Resist corrosion** using paints or galvanization.
- Meet minimum standards for **fire resistance** in public or commercial settings.

British Standards Institution (2020) in BS EN 16034 specifies performance standards for metal doors in terms of fire resistance, mechanical durability, and weather performance.

2.7 Metal Doors vs Wooden Doors

Metal doors offer higher fire resistance, less warping, and longer life cycles than wooden doors (Umar et al., 2023). They are also more tamper-resistant and better suited for outdoor conditions.

2.8 Material Selection for Metal Doors

Mild steel is commonly chosen due to its strength, ductility, and affordability (Fatoki & Akande, 2021). Galvanized steel is used in corrosive environments.

2.9 Welding and Fabrication Techniques

Metal Inert Gas (MIG) and Shielded Metal Arc Welding (SMAW) are popular in door fabrication due to their strength and ease of control (Ibrahim et al., 2023). Proper edge preparation and joint design are crucial for durability.

2.9.1 Safety and Security Considerations

Modern security doors feature reinforced frames, concealed hinges, and multiple locking points to deter break-ins. Fire-rated metal doors are now regulated in public buildings (BS EN 16034:2014).