

Design and Construction of Multi- Cell Metal Concrete Cube Moulds By B.S Standard Using 2mm Thick Metallic Sheet Material

Mansur Nuri, Ahmed Mohammed Goji

Department of Building Technology, Federal Polytechnic Bali, Taraba State, Nigeria.

*Corresponding author: Email: mansurnuri1@gmail.com, Phone No: 07034764141,

Abstract

Concrete cube moulds are essential tools for preparing standard specimens used in the determination of compressive strength of concrete. The dimensional accuracy, rigidity, and durability of these moulds directly influence the reliability of test results. Conventional single-cell moulds require considerable time and labour during casting, handling, and demoulding. The multi-cell design reduced casting time, minimized material wastage, ensured uniform specimen production, and improved laboratory efficiency. The fabricated mould is suitable for routine concrete quality control laboratories, educational institutions, and construction industries. The mould was designed to accommodate twenty (20) concrete cubes arranged in a 4×5 configuration while maintaining the standard internal cube dimensions of $100 \text{ mm} \times 100 \text{ mm} \times 100 \text{ mm}$ specified in BS EN 12390-1. Computer-aided design principles were employed to produce fabrication drawings, followed by cutting, welding, grinding, machining, drilling, and assembly processes. Performance evaluation showed that the fabricated mould possessed excellent dimensional accuracy, adequate rigidity, ease of demoulding, high resistance to deformation, and significant improvement in productivity compared with conventional single-cell moulds. This study presents the design, fabrication, and performance evaluation of a multi-cell concrete cube mould manufactured from 2 mm thick mild steel sheets in accordance with British Standard requirements.

Keywords: *British Standard, Compressive strength, Concrete cube mould, Concrete testing, Fabrication, Mild steel, Multi-cell mould.*

1. INTRODUCTION

Concrete remains the most widely used construction material worldwide because of its versatility, strength, durability, and cost-effectiveness (Tiza *et.al*, 2024). The quality of concrete produced for structural applications is commonly evaluated through compressive strength testing of standard cube specimens. Consequently, the accuracy of concrete cube moulds is fundamental to obtaining reliable laboratory results. Concrete testing plays an important role in quality assurance during construction. According to BS EN 12390-2, concrete specimens must be cast in rigid, watertight moulds with accurately controlled internal dimensions. Several researchers have reported that steel moulds produce more accurate compressive strength results than plastic moulds because steel undergoes negligible deformation during casting and curing (Koo *et. al.*, 2024).

British Standards require that concrete cube specimens possess precise dimensions, smooth internal surfaces, and rigid mould walls capable of resisting distortion during casting and compaction. Any deformation or dimensional variation may introduce significant errors in compressive strength measurements (Okezue, 2021).

Traditional single-cell steel moulds have been widely used in construction laboratories. However, these moulds require repeated filling, vibration, demoulding, and cleaning, resulting in increased labour requirements and reduced productivity, particularly where numerous specimens are produced daily (Chen *et.al.*, 2026).

According to Mahdi *et.al.*, (2021), the development of multi-cell moulds provides an efficient alternative by allowing several concrete cubes to be cast simultaneously while maintaining dimensional consistency.

Fabricating such moulds from 4 mm thick mild steel provides sufficient structural rigidity, long service life, resistance to repeated mechanical loading, and compliance with British Standard specifications. The adoption of multi-cell mould systems for concrete production significantly improves laboratory productivity by reducing preparation time while maintaining uniformity among test specimens. This study therefore focuses on the design, fabrication, and performance evaluation of a multi-cell metal concrete cube mould fabricated using 4 mm thick mild steel sheets.

2.0 MATERIALS AND METHODS

2.1 Materials

The following materials were used for the fabrication of the multi-cell steel concrete cube mould

2.1.1 2mm Thick Mild Steel Sheet

A 2 mm thick mild steel sheet was used as the primary fabrication material for the base, side walls, and internal partitions of the mould. The material was selected because of its high strength, rigidity, good weldability, and ability to resist deformation during concrete casting and compaction.

2.1.2 Mild Steel Flat Bars

Mild steel flat bars were utilized as stiffeners and support members for the mould assembly. They increased the strength of the fabricated mould and provided additional support to the side plates, thereby improving durability and maintaining the alignment of the mould components.

2.1.3 High Tensile Bolts and Nuts

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High tensile bolts and nuts were employed to securely fasten the detachable side plates of the mould. Their high mechanical strength allowed repeated assembly and dismantling without loosening, ensuring firm connections and easy demoulding of concrete specimens.

2.1.4 Welding Electrodes (E6013)

E6013 welding electrodes were used during the welding of the steel components because they produce smooth, strong, and reliable welds with minimal spatter. The electrodes provided adequate joint strength required to withstand the stresses encountered during casting and handling of the mould.

2.1.5 Anti-Rust Primer

An anti-rust primer was applied to all fabricated steel surfaces before painting to protect the mould against corrosion. The primer enhanced the adhesion of the finishing paint and prolonged the service life of the mould, particularly under humid laboratory conditions.

2.1.6 Industrial Enamel Paint

Industrial enamel paint was applied as the final protective coating after priming. The paint improved the appearance of the mould while providing additional protection against moisture, abrasion, corrosion, and general wear during repeated laboratory use.

2.1.7 Released oil

Release oil was applied to the internal surfaces of the mould before each concrete casting operation to prevent the concrete from adhering to the steel surfaces. This facilitated easy removal of the hardened concrete cubes, reduced the risk of specimen damage, and helped preserve the smooth internal finish of the mould.

2.2 METHODOLOGY

First, a survey and selection of suitable materials required for the fabrication of the concrete cube mould were conducted. The fabrication process commenced with the preparation of detailed design parameters, followed by marking out the dimensions on the selected materials using appropriate measuring and layout tools. A 2 mm thick mild steel sheet was selected as the fabrication material because it is non-absorbent, sufficiently strong to withstand the pressure exerted by fresh concrete, and capable of preventing leakage of cement paste and free water while resisting distortion during use.

The steel sheets were cut to the required dimensions using appropriate cutting equipment, after which the individual components were assembled and permanently joined by welding. The internal faces of each mould compartment were carefully ground and finished to produce smooth, rigid surfaces. The opposite walls were accurately spaced 100 mm apart, forming cubical cells with internal dimensions of 100 mm × 100 mm × 100 mm, in accordance with the relevant standards for concrete compressive strength test specimens. The lower edges of the side plates were designed to fit into corresponding slots of equal thickness (2 mm), ensuring proper alignment and structural stability during assembly.

To enhance rigidity, a vertical anchoring bolt with a threaded end was welded to the base of the mould. This anchoring system securely clamped the longer side plates to the shorter end plates through U-shaped protrusions, thereby preventing movement or separation during concrete casting and compaction. Rectangular grooves were formed along the plates prior to welding to facilitate accurate alignment and achieve a strong welded joint. This fabrication technique ensured that the intersections between

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the thicker outer walls and the internal partition plates formed precise 90° angles, resulting in accurately shaped cube compartments that complied with standard dimensional requirements for concrete cube moulds. The completed mould provided the necessary strength, dimensional accuracy, and durability required for repeated casting of concrete specimens used in compressive strength testing.

The required dimensions of the base plate, as well as the longer and shorter vertical side plates, were accurately measured and marked on the steel sheet using appropriate measuring and marking tools. The marked square and rectangular sections were then cut to the specified sizes using an angle grinder fitted with a cutting disc. Following the cutting operation, the edges of all fabricated components were smoothed and finished using a grinding disc attached to the angle grinder to remove burrs and ensure accurate fitting during assembly.

DESIGN CONSIDERATIONS

The mould was designed according to BS EN 12390-1 with the following considerations:

1. Internal cube dimensions: 100 × 100 × 100 mm
2. Number of cells: 20 cubes
3. Arrangement: 4 × 5 matrix
4. Plate thickness: 2 mm
5. Internal surface: Smooth finish
6. Joint: Bolted detachable side plates
7. Rigidity: Reinforced external frame
8. Water tightness: Precision welded joints

Design Calculations

1. Internal cube size: 100 mm × 100 mm × 100 mm
2. Number of cells: 20
3. Overall internal dimensions

4. Length: $5 \times 100 = 500$ mm
5. Width: $4 \times 100 = 400$ mm
6. Height: 100 mm

Considering steel thickness

1. External Length: $500 + (2 \times 4) = 508$ mm
2. External Width: $400 + (2 \times 4) = 408$ mm
3. External Height: 104 mm

The two longer vertical side plates, each measuring 508 mm in length, were attached to the base plate by welding pairs of 104 mm hinges at positions corresponding to the required mould configuration. The hinges were welded securely to both the base plate and the longer side plates, allowing the side walls to open and close as required during specimen demoulding. Subsequently, the shorter vertical side plates, each measuring 100 mm × 100 mm, were connected at right angles to the opposite ends of the longer side plates using additional 110 mm hinges. These hinges were welded firmly to the adjoining plates to produce a rigid and accurately aligned mould assembly while facilitating easy dismantling after concrete casting.

Subsequently, 5 mm thick and 20 mm wide steel strips were welded perpendicularly to the free edges of the opposing shorter vertical side plates. These extension plates projected outward to align flush with the extended ends of the longer vertical side plates on both ends of the mould, thereby providing additional rigidity and facilitating secure assembly. Two holes were then drilled through the extended ends of both the longer and shorter side plates to accommodate the fastening bolts and nuts used during mould assembly.

The side plates were assembled into a rectangular frame by inserting bolts through the drilled holes and tightening them with nuts using a 16 mm × 17 mm flat spanner, ensuring a firm and rigid connection. To accommodate the internal

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partition plate, 5 mm deep grooves were machined along the midpoint of the base plate and the inner faces of the two longer side plates.

An internal partition plate measuring 355 mm × 555 mm was then inserted into the corresponding grooves in the base and longer side plates, parallel to the shorter side plates, thereby dividing the mould into multiple cubical compartments and forming the multi-cell concrete cube mould.

Upon completion of the fabrication and assembly process, all welded joints and surfaces were finished by filing and grinding to remove sharp edges and weld irregularities. Any surface imperfections were corrected with metal putty before the mould was thoroughly cleaned, primed, and coated with protective paint to improve corrosion resistance, durability, and appearance.

4.0 RESULTS DISCUSSIONS

A multi-cell steel concrete cube moulds was fabricated using 2 mm thick mild steel sheets in accordance with the relevant British Standard (BS) specifications. The completed moulds were installed in the Concrete Laboratory for routine use in the casting of concrete cube specimens. Following fabrication, the moulds were subjected to practical performance evaluation to assess their functionality, structural integrity, and ease of operation.

The performance assessment demonstrated that the fabricated multi-cell moulds possessed adequate strength and dimensional stability for repeated use. No leakage of cement paste or free water was observed during concrete casting, indicating effective sealing of the mould joints. Furthermore, the moulds were found to be easy to assemble, dismantle, and demould, enabling efficient production and removal of concrete cube specimens without causing damage to the cubes.

These results confirm that the fabricated multi-cell steel moulds are suitable for laboratory concrete compressive strength testing and satisfy the functional requirements for durable and reliable concrete specimen preparation.

Figure 1 showing Base flat and mould cells during construction



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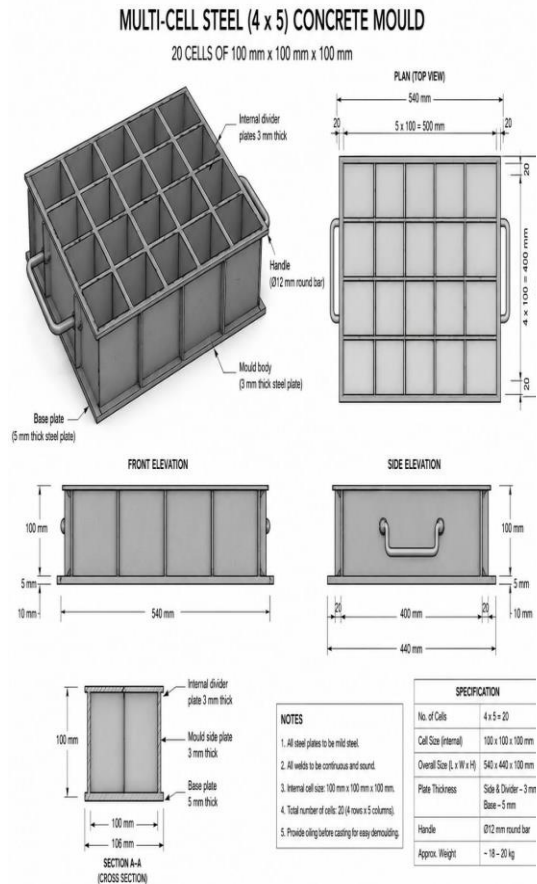


Figure 2 showing a completed multi-cell mould after construction.

4.1 CONCLUSION

This study successfully designed, fabricated, and evaluated a 2 mm thick multi-cell steel concrete cube mould in accordance with the relevant British Standard requirements for concrete cube production. The fabrication process involved the selection of suitable mild steel materials, accurate marking out, cutting, welding, assembly, surface finishing, and painting to produce a durable and dimensionally accurate mould suitable for laboratory applications.

Performance evaluation of the fabricated mould demonstrated that it possessed adequate structural strength, rigidity, and dimensional

stability to withstand the pressures generated during concrete casting and compaction. The mould exhibited excellent sealing characteristics, as no leakage of cement paste or free water was observed during casting. Furthermore, the hinged and bolted assembly facilitated easy coupling, dismantling, and demoulding of concrete cubes without damaging the test specimens.

Overall, the fabricated multi-cell steel mould proved to be efficient, durable, reusable, and capable of producing high-quality concrete cubes that satisfy laboratory testing requirements. Its ability to cast multiple specimens simultaneously also enhances productivity, reduces labour requirements, and minimizes the time required for specimen preparation, making it suitable for routine concrete quality control and research applications.

4.2 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Multi-cell steel concrete cube moulds fabricated from 2 mm thick mild steel sheets should be adopted in concrete laboratories because they provide greater rigidity, dimensional accuracy, durability, and more reliable compressive strength results than other moulds.
2. Laboratories involved in routine concrete quality control should utilize multi-cell moulds to increase specimen production efficiency, reduce casting time, and improve operational productivity.
3. The fabricated mould should be cleaned thoroughly and lightly oiled after each use to prevent corrosion, facilitate easy demoulding, and extend its service life.
4. Future studies should investigate the performance of multi-cell steel moulds

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fabricated using different steel thicknesses (e.g., 3 mm, 5 mm, and 6 mm) to determine the optimum balance between weight, durability, fabrication cost, and structural performance.

5. Further research should evaluate the long-term durability of the fabricated mould under repeated casting cycles and different environmental conditions to establish its service life and maintenance requirements.
6. Comparative studies involving fabricated steel moulds and commercially manufactured moulds should be conducted to assess dimensional accuracy, repeatability, and cost-effectiveness under laboratory and field conditions.
7. Future investigations may also consider integrating detachable or modular partition systems into the mould design to improve flexibility, simplify maintenance, and accommodate different specimen sizes for various concrete testing applications.

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