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DEVELOPMENT AND EVALUATION OF ADJUSTABLE FORMWORK YOKE

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Abstract: The yoke plays a crucial role in the construction industry, as it provides essential support and alignment in formwork systems, ensuring structural accuracy and safety during concrete works. The study aimed to develop and fabricate an adjustable formwork yoke, determine its acceptability in terms of design, efficiency, functionality, and features, and test its strength in terms of tensile, shearing, and bending. The study used the developmental-descriptive method of research. A researcher-made instrument was formulated and administered to twenty-five (25) DTI-accredited builders and contractors to evaluate the technology acceptability of the developed adjustable formwork yoke across the identified criteria. The results of the study revealed that the adjustable formwork yoke achieved very high ratings in all areas. The item with the highest mean score was design, followed by features, functionality, and lastly, efficiency. Furthermore, laboratory tests showed that the yoke's material is highly suitable for various construction activities, as it demonstrated superior strength in tensile, shearing, and bending tests. It is recommended that the area of efficiency be further examined, since it received the lowest mean score among the criteria, by adding mechanisms to make the device more secure and sturdy. Additionally, exploring other locking mechanisms to further increase the holding power of the formwork yoke and incorporating attachments such as shoring and bracing should be undertaken to improve the device further.

Keywords: *Adjustable Formwork Yoke, Construction Support, Technology Acceptability, Structural Strength Testing, Formwork Efficiency*.

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Introduction

The yoke plays a crucial role in the construction industry, as it provides essential support and alignment in formwork systems, helping ensure structural accuracy and safety during concrete works. By securing and stabilizing formwork panels, the yoke contributes to the uniformity of concrete surfaces and minimizes the risk of deformation or collapse. Its function is especially important in large-scale projects where precision and durability are critical to meeting engineering standards and delivering quality structures.

However, despite these advancements, traditional formwork yokes still present persistent limitations that hinder efficiency and increase costs. According to Blythe (2018), conventional yokes are often made from timber, lumber, or bamboo—materials that, while readily available, have poor tensile strength, are heavy to handle, and deteriorate quickly when exposed to harsh elements. As Nemati (2007) observed, formwork can account for up to 60 percent of the total cost of concrete work in a project, making formwork failures or inefficiencies a major economic concern. Common installation methods such as nailing, clamping, pegging, and tying each have drawbacks, including damage to materials, limited adjustability, and reduced holding power over time. These limitations highlight the need for improved solutions that can withstand repeated use, adapt to various sizes of structural members, and ensure reliable performance while minimizing labor and material waste.

In response to these challenges, this research was undertaken to explore the development of an adjustable formwork yoke constructed from aluminum, incorporating a locking mechanism designed to fit different column and beam sizes. The study aimed to examine whether such a device could offer a balance of strength, light weight, reusability, and ease of installation. While the project set out to assess the acceptability and strength of the proposed design, it remains to be determined how effectively this innovation can meet the evolving requirements of the construction industry and contribute to more efficient, cost-effective, and sustainable building practices.

Objectives of the Study

The main objective of the study is to develop an adjustable formwork yoke.

Specifically, the study aims to:

1. design and fabricate an adjustable formwork yoke

2. determine the acceptability of the adjustable formwork yoke in the aspects of:

    a. design

    b. efficiency

    c. functionality, and

    d. features

3. test the strength of adjustable formwork in terms of:

    a. tensile

    b. shearing

    c. bending

4. formulate a user's manual.

Framework of the Study

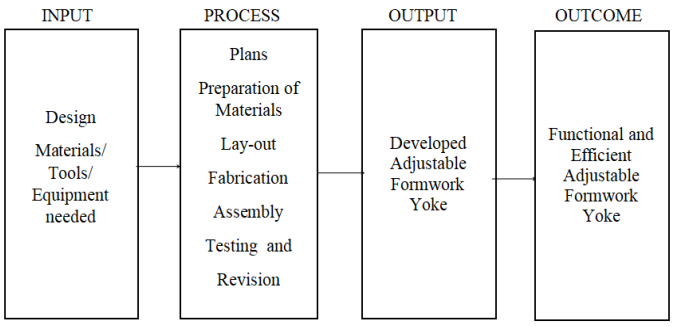
The creation of an adjustable formwork yoke begins with a carefully planned design, followed by the identification of appropriate materials, tools, equipment, processes, and assembly procedures. Finally, the prototype is subjected to rigorous testing and evaluation. The development of such devices takes into account the gaps and limitations of previous designs to enhance and upgrade the current product for improved performance and broader application.

Like many other construction innovations, formwork yokes are continually evolving, with modifications in their design and functionality implemented to meet the changing demands of the industry and comply with modern standards.

The conceptual framework of the study is illustrated in the schematic diagram presented in Figure 1.

Figure 1.

Schematic Diagram Illustrating the Conceptual Framework of the Study



As shown in Figure 1 is the schematic diagram of the illustrating the conceptual framework of the study. The inputs of the study included the conceptual design and specifications of the adjustable formwork yoke, the careful selection of materials such as aluminum to address the limitations of traditional timber or bamboo yokes, and the identification of appropriate tools and equipment required for fabrication. The process involved preparing detailed plans, procuring the necessary materials, and carrying out the layout, fabrication, and assembly of the prototype. This phase also included subjecting the materials to laboratory testing to evaluate their tensile, shearing, and bending strength, as well as assessing the finished device in terms of design, efficiency, functionality, and features. The outputs consisted of a fabricated prototype adjustable formwork yoke, comprehensive test results demonstrating its strength and reliability, and evaluation data gathered from builders and contractors regarding the technology's acceptability in real-world applications. Finally, the outcomes aimed to produce a formwork yoke that is lightweight, durable, reusable, and easy to install, with the potential to reduce construction cycle times and indirect costs. The improved design also sought to enhance structural safety and operational efficiency, providing a foundation for continued refinement and innovation to meet the evolving standards and demands of the construction industry.

Methodology

This study employed a developmental-descriptive research design. The developmental aspect focused on the design, fabrication, and refinement of an adjustable formwork yoke intended for use in small to mid-rise construction projects. The process included conceptualization, material selection, fabrication, and testing of the device to address limitations in traditional formwork systems, particularly in terms of adjustability, durability, ease of use, and efficiency.

The descriptive component of the research aimed to assess the technology acceptability of the developed device. This was achieved through the collection and analysis of quantitative feedback from selected industry professionals. The evaluation covered four main criteria: design, features, functionality, and efficiency. To gather relevant data, the study used purposive sampling, selecting twenty-five (25) respondents who were DTI-accredited builders and contractors. These individuals were considered suitable due to their expertise and experience in formwork systems and construction practices.

A researcher-made instrument, which underwent content validation and reliability testing, was used as the primary data collection tool. The instrument included statements rated on a Likert scale to evaluate the respondents' perceptions of the adjustable formwork yoke across the four identified areas.

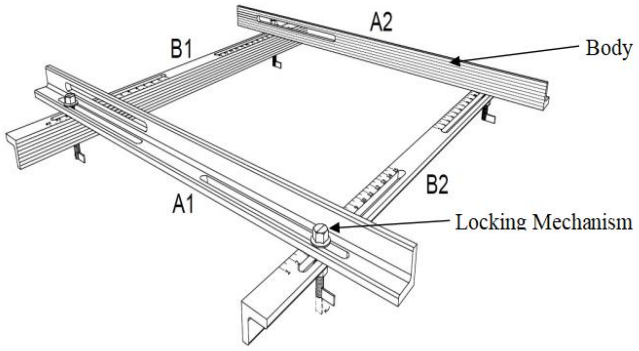
For data analysis, mean and standard deviation were the primary statistical tools used. The mean determined the level of acceptability in each criterion, while the standard deviation helped assess the consistency of the responses among participants. This methodological approach ensured that both the technical development and practical evaluation of the formwork yoke were grounded in a rigorous and structured research framework, providing credible results that reflect the perspective of professionals in the construction industry

Design and Fabrication of Adjustable Formwork Yoke

The project is consists of two major parts, the body and locking mechanism as shown in Figure 2.

Figure 2.

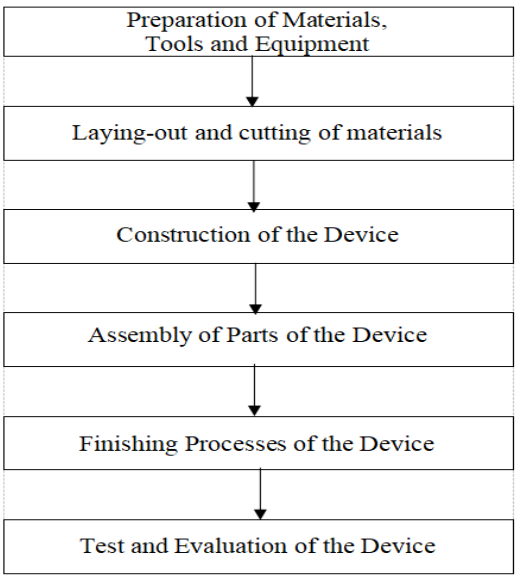
Design and Dimension of Adjustable Formwork Yoke



As shown in Table 2 is the design and dimension of adjustable formwork yoke. The adjustable formwork yoke consists of two main parts: the body and the locking mechanisms. The body is made of thick aluminium, chosen for its excellent strength-to-weight ratio, corrosion resistance, and durability. This sturdy frame is designed to secure the formwork panels firmly in place so they can reliably hold the load of freshly poured concrete without shifting or deforming. The thickness of the aluminium helps the yoke withstand significant compressive forces, ensuring that the formwork remains stable throughout the curing process. The locking mechanisms enable the yoke to adjust to different sizes of columns and beams. These mechanisms may include sliding brackets, threaded bolts, clamps, or quick-release levers, allowing workers to expand or contract the yoke to fit the formwork dimensions precisely. Once adjusted, the locking system secures the position tightly, preventing any movement during concrete placement. Together, the thick aluminium body and the reliable locking mechanisms make the adjustable formwork yoke strong, adaptable, and efficient, addressing common problems such as limited size options and low holding power found in traditional formwork supports.

Figure 3

Workflow in the Development of the Adjustable Formwork Yoke



As shown in Figure 3 is the workflow for developing the adjustable formwork yoke follows a systematic process to ensure quality, precision, and functionality. It begins with the preparation of materials, tools, and equipment. In this stage, thick aluminium sheets and other necessary components are gathered and inspected to confirm that they meet the required specifications for strength and durability. Tools such as cutting machines, welding equipment, clamps, and measuring devices are prepared to support the fabrication process.

Next is the laying-out and cutting of materials, where the aluminium sheets and other parts are measured and marked according to the design dimensions. Accurate layout is critical to ensure that all components fit together correctly. The materials are then cut precisely to the specified sizes and shapes. Following this, the construction of the device takes place. This involves forming and shaping the aluminium body and preparing the components that will make up the locking mechanisms. Holes are drilled, slots are created, and other necessary modifications are made to accommodate adjustments and assembly. After the main components are constructed, the assembly of parts of the device is carried out. The body and locking mechanisms are fitted together, ensuring that all moving parts align properly and function smoothly. Bolts, brackets, and fasteners are secured to hold the structure firmly. The workflow then moves to the finishing processes of the device, where surfaces are cleaned, deburred, and treated to improve appearance and resistance to corrosion. Any protective coatings or labels are applied as needed to enhance durability and usability. Finally, the test and evaluation of the device are conducted. This includes strength testing for tensile, shearing, and bending loads to verify that the yoke can safely support the weight of concrete during formwork. Functional tests are also performed to assess the ease of adjustment, locking, and overall performance of the device. Each step in this workflow is essential to ensure that the adjustable formwork yoke meets the demands of modern construction practices, offering reliability, safety, and efficiency on-site.

Results and Discussions

Design and Fabrication of the Adjustable Formwork Yoke

The first objective of the study was to design and fabricate an adjustable formwork yoke for low to mid-rise construction with rectilinear columns and beams. The design addressed limitations of existing formworks by ensuring the device would be easy to adjust, lightweight, fast to install, reusable, and convenient to carry and store. The fabrication process I involved several steps. Materials and tools were prepared, and components were measured and marked based on the project plan. The aluminium angle bar was cut at medium speed, then shaped and milled using an aluminium shaper machine to create slots and faces. Grooves were added to the contact side of the stem for improved grip, and a cold gun was used to reduce friction and aid cooling during milling. Edges were smoothed and chamfered, and sandpaper was used for deburring. Finally, the stem and locking mechanism were assembled, and the drop lock pin was securely welded below the hex nut shaft.

Acceptability Evaluation

The second objective of the study was to determine the level of acceptability of the adjustable formwork yoke in terms of design, features, efficiency and functionality as shown in Table 1.

Table 1: *Summary of mean scores on technology acceptability of the adjustable formwork yoke*

Item	Mean	SD	Interpretation
Design	4.48	0.590	Very Highly Acceptable
Features	4.46	0.570	Very Highly Acceptable
Efficiency	4.43	0.66	Very Highly Acceptable
Functionality	4.45	0.63	Very Highly Acceptable
Total	4.45		

As presented in Table 1, the summary of the mean scores on the acceptability of the adjustable formwork yoke shows an overall mean of 4.45, which is interpreted as very highly acceptable. Among the evaluated areas, design was considered the most superior aspect, with a mean score of 4.48, followed by features with 4.46, functionality with 4.45, and efficiency with 4.43, all interpreted as very highly acceptable. The table suggests that design stood out as the strongest aspect of the device due to its unique characteristics, which simplify the conventional process of setting up a formwork yoke. Conversely, efficiency emerged as the area that should be further examined and improved. Overall, the device received a very highly acceptable assessment from the panel of experts composed of DTI-accredited builders and contractors.

Testing of Adjustable Formwork Yoke

The third objective of the study was to test the strength of adjustable formwork in terms of tensile, shearing and bending. Since the tool will be used for reinforced concrete members of 200mmx 300 mm minimum and 500 mm x 500mm maximum columns, and 200 mm x 300 mm and 200 x 500 mm beams respectively, it is imperative that it would be tested in testing centres for assessment of its actual capacity. The researcher sought the assistance of two esteemed testing laboratories, namely West Negros –STI and Mega Testing Center.

Table 2: *Tensile strength of material based on laboratory test*

Strength Test	Laboratory Test Result (Yield Point)
Tensile	192kN

As shown in Table 2, the laboratory test result of adjustable formwork yoke is 192 kN before the material will start to elongate. In a formwork preparation to a column with 500mmx500mm lateral dimension at 3m height, the expected maximum pressure coming from wet concrete at bottom section will be 10.84kN. The table implies that there is a big difference of 181.16kN which can be an advantage if security of its usage is being consider. This further implies that the device can be subjected to extreme force or temperature and very much commendable to other applications.

Table 3: *Shearing strength of material based on laboratory test*

Strength Test	Laboratory Test Result (Yield Point)
Shearing	238kN

As shown in Table 3 the shearing strength of materials based on laboratory result is 238kN before a hard or pointed object will punch the material. Shearing the material used in adjustable formwork yoke is very slim due to its very high shearing strength of the material.

This implies that the material used in adjustable formwork yoke is very suitable due to its superior quality of maintaining its structural integrity in holding the wet concrete in both column and beam construction.

Table 4

Bending strength of material based on laboratory test

Strength Test	Laboratory Test Result (Yield Point)
Bending	13.850kN

As shown in Table 4 the bending strength of adjustable formwork yoke is 13.850kN before the material will start to lose its shape or bend. In a formwork preparation to a column with 500mmx500mm lateral dimension at 3m height, the expected maximum pressure coming from wet concrete at bottom section will be 10.84kN. This implies that the adjustable formwork yoke can support or hold the column from breaking until it sets due to its difference of 3.01kN. This further ensures that the user will have the confidence to use even to varying demands of forming the column and beams. The number of yokes to be placed in a typical unit per pouring requires at least 4 to 6 pieces, thus for added security, increasing the number of yokes as required will do the job.

The User Manual

The fourth objective of the study was to develop a user manual for the Adjustable Formwork Yoke. This was developed to guide the user on the project specifications, proper use and ensure safety.

Findings of the Study

The following are the summary of the findings of the study:

1. The design and fabrication of adjustable formwork yoke has main features of adjustability, lightweight, reusable and easy to carry and store.

2. Overall the adjustable formwork yoke has a very high acceptability in all its areas being evaluated by the respondents. The area that garnered the highest acceptability is on design, followed by features, then on the area on functionality and lastly is on the area of efficiency.

3. The laboratory testing of aluminium as the primary material used in making the adjustable formwork yoke when subjected to various strength tests reveal that its tensile, shear and bending properties are very superior to perform its intended function, to hold forms securely for wet concrete placement in small to mid-rise structures.

4. The user-manual was provided to guide the user on the proper use of adjustable formwork yoke.

Conclusions

With the foregoing findings, the following conclusions are drawn:

1. The formwork yoke features of are adjustability, lightweight, reusable and easy to carry and store is an innovation in the construction industry that will greatly help both builders and contractors.

2. The acceptance of the adjustable formwork yoke revealed a very high rating from accredited builders and contractors, implying that the product in terms of design, features, efficiency and functionality can be used in the their line of work which is cost efficient. Moreover safety is ensured, proper forming is attained that traditional formwork yoke fails to deliver.

3. Aluminium as the primary material used in making the adjustable formwork yoke is a good choice as this material is light, corrosion resistant and strong. This is further reinforced by laboratory tests as aluminium was subjected to tensile, shearing and bending tests as results showed the superiority of the material in withstanding the wear-and-tear, load and pressures of construction requirements

4. A user manual for the use of the adjustable formwork yoke was developed to maximize the use of the device.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were formulated:

1. The adjustable formwork yoke is recommended to be used by builders and contractors in the construction industries. Considering its useful features of adjustability, lightweight, reusable and easy to carry and store, it will dramatically lighten and improve the productivity of its target users. It will hasten the process and project turnover. Therefore, it is recommended for adaption and production.

2. Technology acceptability of adjustable formwork yoke along efficiency should be looked into since this area has the lowest mean score. Efficiency which covers the device's adjustability, easy to assemble and disassemble has to be revisited by adding another mechanism to make the process faster and secure. Similarly, functionality of the device should be reviewed in terms of the locking mechanisms and slot design to improve its sturdiness in continuous and repetitive work.

3. The adjustable formwork yoke is highly accepted by both builders and contractors thus these industries should reconsider adding the device in accomplishing their construction jobs.

4. For future researchers to further conduct studies along adjustable formwork yoke,

Particularly in exploring other potential add-ons or attachment like bracing and shoring system to further improve the project.

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