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Understanding the Challenges of Building Standards for Structural Masonry: A South African Case Study

Bonga Khuzwayo[1], Walied Elsaigh[2], Roderick Rankine[3], Mark Walker[4]
[1]Department of Civil & Environmental Engineering and Building Science
Preller St, Muckleneuk, Pretoria, 0002, South Africa
43570208@mylife.unisa.ac.za
[2]Department of Civil & Environmental Engineering and Building Science
Preller St, Muckleneuk, Pretoria, 0002, South Africa
hussiwam@unisa.ac.za
[3]Rod Rankine Engineering Solutions cc, South Africa
PO Box 506 Ferndale 2160, South Africa
rod.rankine@telkomsa.net
[4]Department of Mechanical Engineering, Durban University of Technology
121 Steve Biko Rd, Musgrave, Berea, 4001, South Africa
walker@dut.ac.za

Abstract **-** Socioeconomic status influences in some way how people construct their houses, which, in the majority of nations, are made of structural masonry. Most countries have Building Regulations, Building Standards and Codes of Practice that define acceptable structural masonry performance. This South African case study explores structural masonry challenges that persist despite established frameworks. The study used scoping reviews and purposive sampling interviews to try to understand the challenges. The goal is to provide policymakers and authorities with insights into the challenges of existing frameworks and thus prompt rethinking of framework access mechanisms. The ongoing study also finds discrepancies in the implementation of outdated and ineffective frameworks that may not be understandable to regular builders, as well as a need for more accessible, relevant, user-friendly, frequently updated and strategically implemented frameworks.

Keywords**:** Building Regulations; Building Standards; Codes of Practice; South Africa; South African National Standards; Structural Masonry

1. Background and introduction

The way our houses are constructed is somehow influenced by socioeconomic status, which is evident in many countries where masonry is commonly used. Structural masonry is a multidisciplinary undertaking that necessitates the use of frameworks to comply with minimum standards. According to Watermeyer [1], general structures, including structural masonry, require the meticulous engagement of skilled personnel to ensure their ability to safely withstand a variety of loads. Using South Africa as an example, the Building Regulations, Building Standards and Codes of Practice, to a certain extent, provide a framework for the design and construction of structural masonry, including the manufacturing of construction materials. Holistically, this framework establishes guidelines for how buildings should be constructed in order to prioritise safety, facilitate trade and commerce, promote quality and consistency and protect the environment [2].

Watermeyer and Milford [3] report the apparent ineffectiveness of frameworks, particularly in the context of low-cost housing and recommend the promotion of Building Regulations, in conjunction with other interventions, to counteract their apparent ineffectiveness. However, no effective strategies have emerged to improve the situation. The South African structural masonry industry is currently facing numerous challenges, leading to the provision of substandard masonry infrastructure, which in turn threatens various sustainable development goals (SDGs) established by the United Nations in 2023, ranging from good health and wellbeing (goal 3), industry, innovation and infrastructure (goal 9); sustainable cities

and communities (goal 11) and responsible consumption and production (goal 12) [4]. The issues encompass: (1) failure to adhere to the National Building Regulations, Codes of Practice and Building Standards; (2) use of low-quality materials; (3) implementation of below-standard building practices; (4) employment of below-standard design practices; and (5) poor supervision in the structural masonry construction process [5].

The authors of this paper anticipate that in the near future, a large portion of masonry buildings or walls, currently considered non-structural or non-engineered, will require the expertise of a structural engineer for a variety of reasons, one obvious reason being the extremes in structural loading and dilapidation caused by exposure conditions resulting from climate change (or climate breakdown). This would be required in the event that repurposing could potentially endanger human health and safety, be it as a result of straightforward additions and alterations to the current building design, environmental influences, or developments in Building Standards. There is evidence to support this claim, as Novelli, et al. [6] put forward a Seismic Mitigation Framework. This framework was tested on informal houses in Malawi, which are situated in the East African Rift zone. The aim was to enhance the safety of non-engineered masonry buildings in developing countries. During seismic events, these buildings often suffer from weak connections between walls and floors due to the use of poor-quality construction materials. Non-engineered masonry buildings can be found in different regions of South Africa and other African countries and around the world.

South Africa is not well-known for experiencing frequent earthquakes. However, it's important to note that the country is not immune to earthquakes and Seismologists in South Africa emphasise that these can be just as devastating as earthquakes in Los Angeles [7]. Large earthquakes have been relatively uncommon in South Africa due to its stable tectonic setting. Many of the most devastating earthquakes are caused by tectonic activity and typically happen at the edges of the earth's major plates. However, South Africa experiences low-intensity tremors on a daily basis, largely as a result of the mining history. South Africa is located in an area where the Nubian and Somalian plates are rotating, influencing its geological features [8].

This paper is part of a larger research project that aims to gain a deeper understanding of the challenges associated with Building Standards for Structural Masonry, using South Africa as a case study. So far this study utilises findings from five experts, four of whom are semi-retired and one who is less than a decade away from retirement. Experts have dedicated years to projects that utilise Structural Masonry as a primary construction material in both South African and international projects. This paper aims to address pressing challenges that demand immediate attention. Identifying the ambiguities of certain structural masonry standards has proven to be a significant challenge. The research concluded that masonry designers must spend a considerable amount of money to gain access to the Buildings Standards that are critical for producing high-quality Structural Masonry.

2. Literature review

According to Mewomo, et al. [9], developing nations are still facing ongoing design and project execution challenges. The construction sector suffers from a lack of oversight and surveillance, which has negative consequences on building quality, client satisfaction and investor confidence [10]. Client involvement is essential for project success, as highlighted by Al-Tayeh [11]. In their study, Babatunde, et al. [12] found that clients frequently hire architects to handle the design, contractor selection and construction supervision. Structural engineers are responsible for ensuring the stability and structural integrity of a building. Furthermore, this requires efficient teamwork with the architect to guarantee adherence to building standards, safety standards, sustainability and cost-efficiency. Watermeyer [1] states that in South Africa, the National Building Regulations and Building Standards Act, No 103 of 1977, mandates that a skilled individual must produce designs and/or rational assessments to demonstrate structural design compliance when the deemed-to-satisfy-rule framework in South Africa as per SANS 10400 is not utilised. The existing civil engineering legislation adequately safeguards public safety as long as those in charge of compliance appoint capable, knowledgeable and experienced individuals. Contractors or builders are responsible for overseeing on-site construction and managing

the entire construction process from start to finish. They work to ensure that the vision of the client is brought to life in the final product. Builders must possess a high level of skill, strategic thinking and organisational abilities in order to transform architectural plans into functional and visually appealing structures. Manufacturers in the construction industry produce a wide range of products that are essential for building structural masonry. Suppliers play a crucial role in helping manufacturers and construction projects, effectively handle intricate logistics, coordinate deliveries and maintain a consistent supply of materials. Quality should be the top priority for manufacturing, suppliers and producers, as emphasised by Hossain, et al. [13]. For effective and valuable contributions, it is essential for all stakeholders involved in the South African masonry building industry to have access to and understanding of building frameworks.

According to Laubscher [14], there is a lack of consistent implementation of Act 103 of 1977 and the National Building Regulations (NBR) in South Africa, even though they are considered National Standards. According to Boshoff and Mey [15], it is important to regularly update laws, rules and regulations. This study also highlights the risk faced by an increasing number of 'Level 1: Sub-Standard housing [16] due to the lack of easily accessible, user-friendly, regularly updated, strategically implemented and enforced Building Standards. The study also discovered that certain NBR content can be quite intricate, posing challenges for builders who are not familiar with technical terminology to comprehend and apply. Twum-Darko and Mazibuko [17] argue that the inconsistent understanding, interpretation and implementation of NBR and their core regulatory processes pose obstacles to the creation of buildings that are safe, healthy and environmentally friendly and that meet high quality standards for human occupancy. Homebuilders may find NBR documents less useful due to accessibility issues and high costs. In a recent study, Mazibuko, et al. [18] discovered that implementing clear-language policies can lead to better compliance with NBR regulations within the construction industry. This is important because numerous construction contractors may not possess the necessary knowledge and expertise to fully comprehend the regulatory frameworks.

3. Knowledge gap

There appears to be a 'practical knowledge gap' in the prior research in terms of understanding the challenges of building standards for structural masonry. There is a widely held belief that standards that are effective in one country can be effective in any other country. There is evidence to suggest that certain countries, including South Africa and others facing similar challenges, struggle with significant non-compliance, despite having established building standards. Certain factors can contribute to noncompliance with building standards for structural masonry. Therefore, it may not always be a matter of just implementing building standards. Without understanding the complexities of these specific situations, these countries cannot move forward on the right path. Researchers have recently recognized this 'practical knowledge gap' [19], which is often overlooked. Some of these unexplored 'dos and don'ts' appear to be lacking in the practice of structural masonry. An investigation into the challenges of building standards for structural masonry and how to improve the quality of structural masonry in developing countries is a ripe opportunity in the field of structural masonry. Many of the previous studies focused on the theoretical aspects of structural masonry. However, there is a notable gap in studies seeking to understand the challenges of building standards for structural masonry. This is important and worthy of investigation in the context of developing countries that are still behind on sustainable development goals (SDGs). One obvious further reason for non-compliance is a complete lack of enforcement in South Africa. It is crucial to address the actions required to successfully accomplish the SDGs.

4. Expert interviews

So far, this ongoing study has conducted five expert, semi-structured interviews. Experts were able to freely express their perspectives, due to the open-ended and flexible nature of the interview questions. This provided an opportunity to gather in-depth data and ask insightful questions about the challenges of Building Standards for Structural Masonry. The interview guide consisted of a combination of well-sequenced questions and opportunities for in-depth exploration. Prior studies have only provided a limited understanding of the difficulties encountered in structural masonry. Through expert interviews, we have gained valuable insights into the challenges of accessing the building frameworks. Experts provided

insights into the challenges faced where dealing with Building Standards for Structural Masonry. All five experts have extensive experience in both South Africa projects and international projects. They have the chance to compare and both local and international contexts, which is beneficial. The team consisted of four seasoned experts who have into semi-retirement, with one member still actively working full-time. Throughout their extensive careers, they have consistently been involved in projects that utilise structural masonry. The first author manually transcribed the from the expert interviews verbatim. In addition, to ensure the accuracy of the data, the investigation utilised NVivo® tool for analysing qualitative data, to effectively organise unstructured mixed text data. NVivo® facilitated the classification and organisation of data, simplifying the process of identifying themes and patterns. The data obtained from NVivo® was classified and organised into different thematic categories, which were subsequently validated against manually coded themes and patterns.

5. Expert views on masonry building standards in South Africa

Experts in the built environment shared insights into the challenges of building standards in South Africa, as summarised below:

5.1. Expert 1

The interviewee stated that *"there are many problems with our national standards*." The standards must be revised or reviewed over time. However, sometimes the changes made to the standards are simply "*cosmetic changes,*" where *"they change a word here or there, or they take a table out, and you feel compelled to buy a whole new standard, which is very expensive*." There is also a need for simplified or unified standards that are easy to comprehend by even a client, even if they cannot read or are non-technically minded. The expert further highlighted the need for standards that resemble picture books, enabling individuals with poor literacy to learn by simply examining the schematic details that demonstrate correct procedures, as well as the visual representations of incorrect actions.

Furthermore, there is a large population that requires these standards but cannot afford to purchase them. Some people have never seen them. This includes most building inspectors. One major challenge arises when building inspectors lack access to the standards or lack knowledge about them - this raises concerns about their ability to effectively enforce the standards. The cost associated with accessing standards can sometimes lead to designers specifying outdated materials, such as *"Specify the old cement standard that went out of date 20 years ago."* Furthermore, some institutions with large staff will have just "*one computer terminal with access to SABS standards*." The difficulty in accessing the standard leads to problems where most people end up saying, "*No, we'll just buy standards for cash as and when we need them."* Lastly, there is a "*many of our national standards contain contradictions"*.

5.2. Expert 2

The interviewee stated that some statutory bodies will allow access to certain critical standards for members in good standing, for example, "*40 standards where you can download free of charge*." One additional challenge arises from the fact that team members, including clients and nontechnical personnel, may struggle to fully grasp the expectations placed upon them by these Building Standards. Typically, these standards frequently need additional clarification from a specialist such as an engineer or an architect. Building standards have room for improvement but the true issue lies in the lack of attention and skill within the design industry.

5.3. Expert 3

The interviewee stated that South Africa also lacks working societies that can look after the relevance of these standards. This is different from other countries, such as in the United States of America. For example, "*US they always have working societies, people to look after*, "their Building Standards. Additionally, there seems to be a lack of awareness and understanding regarding building standards, which often leads to noncompliance.

5.4. Expert 4

The interviewee highlighted a challenge in the effectiveness of standard enforcement mechanisms, posing the question, question, "*How do you enforce these standards*?" In addition, standards seem to be a bit complicated and difficult to use by by some stockholders. For instance, "*the bricklayers don't understand these standards and regulations.*" Further, the experts experts believe that South Africa needs intervention mechanisms. The expert stated, "*Maybe there should be a standardised standardised checklist for building inspectors for structural masonry*."

5.5. Expert 5

The interviewee emphasised the difficulty of accessing critical standards and also suggested that this may be contributing to a lack of compliance. Furthermore, the revisions to the standards, which are occasionally minor, frequently require the purchase of the entire standard concerned. Some of these minor changes can be resolved by sending a replacement page or sticker to individuals who have already purchased the standard/s in order to update their standard/s. Another challenge to these standards is the absence of support from the individuals who are responsible for writing the standards. "*It is challenging to obtain assistance when one requires clarification, such as in the case of an ambiguity in the standard*". The final obstacle is the intricacy of these standards. They are not written in a manner that is easily comprehensible to the average engineer, and they frequently necessitate reference to other standards. In the majority of cases, this could be prevented by creating unified standards that are written in a format that is easily comprehensible.

6. Conflicts and Ambiguities in South African Building Standards

Among many other observations, the sample of an observation obtained by Content Analysis of the Building Standards used in structural masonry is mentioned below:

- According to SANS 10400-K: Walls [20], which pertains to the implementation of the National Building Regulations, specifically Part K focusing on walls, it is mandated that masonry walls in single-storey structures or the upper level of double-storey structures must possess an average compressive strength of at least 3.0 MPa for hollow masonry units and 4.0 MPa for solid masonry units.
- According to the SANS 1215 [21], standard, concrete masonry units are mandated to possess an average compressive strength of 4.0 MPa (with a nominal compressive strength of 3.5 MPa). However, the standard does not differentiate between hollow units and solid units in terms of this requirement. This determination is based on the examination of five samples.

The problem this has created for the masonry industry is that while certain stakeholders reject concrete blocks with a minimum compressive strength of 3 MPa, others reject them at a minimum of 3.5 MPa. Especially when the minimum compressive strength was not determined and agreed upon at the outset of the project, this frequently leads to disputes among stakeholders.

7. The cost of Codes of Practice, National Building Regulations and Building Standards

To explore the burden that stakeholders face when procuring standards, the study obtained the cost from the South African Bureau of Standards webstore in March 2024: https://store.sabs.co.za/ [22]). The standards were classified into distinct categories that are readily identifiable in civil engineering. The costs related to this can be located within different categories, encompassing admixtures, aggregates, cementitious materials, concrete and mortar testing, concrete and related products, design and construction, laboratory practice and equipment, masonry, other standards, reinforcement, structural steel, structural timber and water. The total cost is approximately R127, 000 (Figure 1 shows the breakdown).

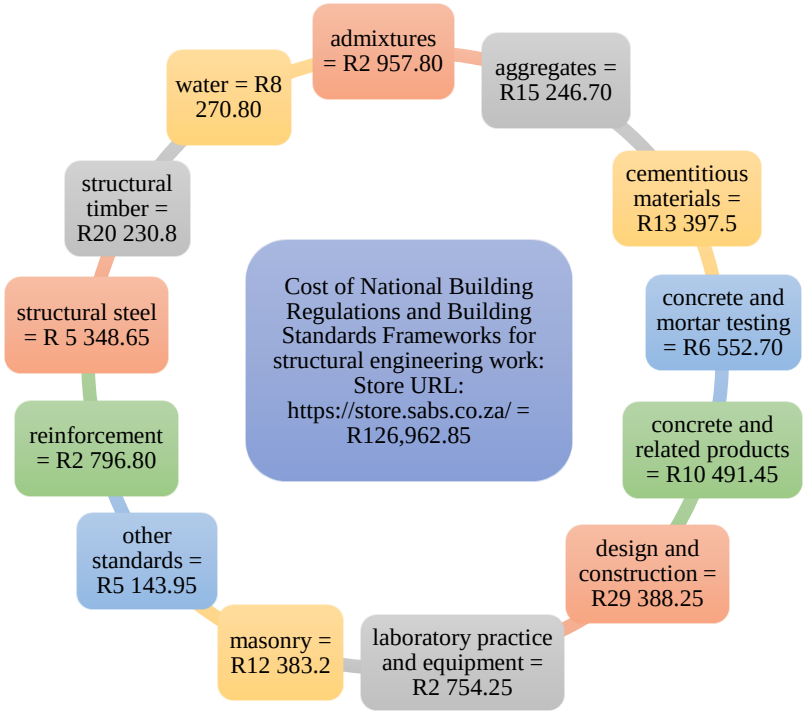

Fig. 1: Costs of National Building Regulations and Masonry-Related Standards in March 2024

The choice of which standard to acquire depends on the specific requirements of the masonry structure. The findings suggest that people in the civil engineering industry and other relevant stakeholders face significant financial challenges when trying to obtain the necessary data needed to comply with regulations. This raises an important question: how can we make sure that valuable information about structural masonry is readily available for affordable housing projects in South Africa, developing countries and other regions dealing with similar difficulties?. According to Watermeyer [23], standards should be reviewed every five years to ensure their continued relevance in the market. Users recognise this as a potential additional challenge, as it imposes an even greater financial burden on stakeholders who are seeking access to updated or revised standards.

8. Conclusion and recommendation

The conclusions and recommendations of this study are as follows:

Building standards are essential for quality masonry structures. It is crucial for developing countries, for example South Africa, to strike a balance between accessible building standards and the associated costs. Construction environment specialists imparted their knowledge regarding the complexities of building standards in South Africa. Over time, the standards must be revised or reviewed. But occasionally, the modifications implemented to the standards are merely superficial, involving minor wording adjustments or the elimination of a table. In such cases, involved parties may feel obligated to purchase an entirely new standard/s.

Additionally, simplified or unified standards that are accessible to clients, including those who lack reading proficiency or technical expertise, are imperative.

Moreover, a considerable segment of the populace is in need of these standards but lacks the financial means to acquire them. Others have never been exposed to these standards. One evident obstacle is that building inspectors will

be unable to enforce the standards if they lack access to them or have no knowledge of them. Frequently, and all too often, the expense linked to obtaining standards may result in designers specifying materials that have become obsolete. Certain standards contain inconsistencies.

Additionally, South Africa should have volunteers that can ensure that these standards remain relevant. An additional concern pertains to the inefficacy of conventional enforcement mechanisms.

Moreover, some stockholders perceive standards to be somewhat complicated and challenging to implement. According to the interviewed specialists, South Africa requires intervention mechanisms which invites future research.

9. Practical implications

This investigation has practical implications for South Africa and other African countries that use South African National Standards. As a result, the study will have a wider impact than just on South Africa. Furthermore, as a developing country, South Africa, like most others, faces significant socioeconomic issues. As a result, this study is also useful for them.

10. Limitation of the study

Despite the fact that the study interviewed experts in the field of civil engineering, specifically structural masonry, opinions about building frameworks may differ due to differences in individual experiences, such as the engineering consultants they have worked for, their educational background, their level of experience, and the projects they have been involved in.

Conflict of interest

The researchers assert that they have no conflicts of interest.

Ethical Statement

The research was carried out with ethical approval. Ref #: 2183.

AI-assisted technologies

AI-assisted technology was only used to improve the readability of this manuscript.

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