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INTERFACIAL TENSILE BOND STRENGTH BETWEEN PRECAST RIB AND CAST-IN-SITU CONCRETE FOR BEAM AND BLOCK SLAB SYSTEMS

TECHNICAL ARTICLE[1]

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HIGHLIGHTS

- Temporary propping can be removed from the beam and block slab when the cast-in-situ concrete compressive strength exceeds 17 MPa.
- Interfacial tensile bond strength was tested on precast roughened concrete ribs and cast-in-situ concrete using pull-out tests.
- For a 3 mm surface roughness and a cast-in-situ compressive strength of 17 MPa, the interfacial tensile bond strength is 0.15 MPa.
- For a 3 mm surface roughness and a cast-in-situ compressive strength of 25 MPa, the interfacial tensile bond strength is 0.21 MPa.

ABSTRACT

The beam and block slab system, also referred to as rib and block slab, is widely used in South Africa as a preferred suspended flooring system owing to its structural efficacy and economic viability. According to SANS 1879 (2021) guidelines for precast concrete suspended slabs, the removal of temporary propping for beams and block slabs is recommended once

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the cast-in-situ concrete's compressive strength surpasses 17 MPa. Notwithstanding, the limited availability of literature on the matter means that certain manufacturers and structural engineers have raised apprehensions regarding the structural soundness of the interfacial tensile bond strength that exists between precast rib and cast-in-situ concrete, particularly when the compressive strength of concrete is 17 MPa. In order to measure the structural soundness of interfacial tensile bond strength, pull-out tests were conducted on precast roughened concrete ribs and cast-in-situ concrete. The study determined that, when the surface roughness is 3 mm, the delamination experiments exhibit a tensile stress of 0.15 MPa, which equates to a compressive strength of 17 MPa for cast-in-situ concrete. Furthermore, the study revealed that the tensile strength attains a value of 0.21 MPa upon attainment of a compressive strength of 25 MPa for concrete, given a surface roughness of 3 mm. The study revealed the interfacial tensile bond stress between precast rib and cast-in-situ concrete, which manufacturers and structural engineers can use in conjunction with Annex B (B1) of SANS 1879 (2021). This allows temporary props to be removed once the concrete reaches 17 MPa. The test results show sufficient interfacial tensile bond strength between precast ribs and cast in-situ concrete if the interfacial surface is adequately prepared and the rib supports its own weight.

ABSTRAK

Die balk- en blokbladstelsels, ook bekend as rib- en blokblad, word wyd in Suid-Afrika gebruik as 'n voorkeur-hangvloerstelsel vanweë hul strukturele doeltreffendheid en ekonomiese lewensvatbaarheid. Volgens SANS 1879 (2021)-riglyne vir voorafvervaardigde beton-hangblaaie, word die verwydering van tydelike stutte vir balke en blokblaaie aanbeveel sodra die in-situ beton se druksterkte 17 MPa oorskry. Sekere vervaardigers en strukturele ingenieurs het bekommernisse met betrekking tot die strukturele egtheid van die grensvlak trekbindingsterkte wat bestaan tussen voorafvervaardigde rib en in-situ beton, veral wanneer die druksterkte van beton 17 MPa is. Ten einde die strukturele egtheid van grensvlak trekbindingsterkte te meet, is uittrektoetse uitgevoer op voorafvervaardigde, geruwde betonribbe en in-situ-beton. Die studie het vasgestel dat, wanneer die oppervlakruwheid 3 mm is, die delamineringseksperimente 'n trekspanning van 0.15 MPa toon, wat gelykstaande is aan 'n druksterkte van 17 MPa vir in-situ beton. Verder het die studie aan die lig gebring dat die treksterkte 'n waarde van 0.21 MPa bereik by die bereiking van 'n druksterkte van 25 MPa vir beton, gegewe 'n oppervlakruwheid van 3 mm. Die studie het die grensvlak trekbindingspanning tussen voorafvervaardigde rib en in-situ beton geopenbaar, wat vervaardigers en strukturele ingenieurs kan gebruik in samewerking met Bylae B (B1) van SANS 1879 (2021). Dit laat toe dat tydelike stutte verwyder word sodra die beton 17 MPa bereik. Die toetsresultate toon voldoende grensvlak trekbindingsterkte tussen voorafvervaardigde ribbes en gegote in-situ beton indien die grensvlak-oppervlak voldoende voorberei is en die rib sy eie gewig dra.

1. INTRODUCTION

The beam and block slab system, also known as rib and block or lintel and block, is an efficient slab system that provides optimal structural performance. According to García (2016), these floor slabs have gained popularity since the 1970s. The voids in the slabs are designed based on the unit soffit block, resulting in a significant reduction in the slab's self-weight. They can be considered a rigid diaphragm comprising a slab (Tena-Colunga, Chinchilla-Portillo & Juárez-Luna, 2015) and account for a sizeable portion of the South African domestic and light industrial floor slab market (Gohnert, 2003). These floors are comprised of prestressed beams, infill blocks, and cast-in-situ topping (Caballero-Garatachea, Juárez-Luna & Ruiz Sandoval-Hernández, 2021). The achievement of a monolithic structural performance can be ensured by adhering to a strict quality-assurance programme during the manufacturing of ribs as well as during their transportation, assembly, and detailing (Camposinhos & Serra Neves, 2006).

According to Khuzwayo (2014), the infill blocks can be made from a variety of materials, including concrete, burnt clay, fired briquettes, shale, clay, or expanded polystyrene. The most prevalent type of infill blocks in South Africa is concrete masonry which employs the same components as cement or concrete blocks conforming to South African National Standards (2016), also widely used in the South African masonry construction industry. Ribas and Cladera (2013) noted the presence of two distinct concrete types in beam and block slabs. The cross-sectional area comprises two distinct components, namely a precast prestressed concrete element and a cast-in-situ lightly reinforced concrete element. The T-shaped cross-section exhibits depth-dependent width variability. The classification of current beam-and-clay block floor systems can be delineated into two primary classifications: those that incorporate a slender structural overlay and those that do not possess such an overlay (Marini *et al.*, 2022).

Two opposing sides hold up a slab in a single direction. Primary reinforcement is provided in only one direction. Normal distribution is provided in the transverse direction. This type of slab combines pretensioned concrete elements with a conventional cast-in-situ concrete topping devoid of shear reinforcement (Oliveira *et al.*, 2021). Flooring systems with spans of up to 7.5m have been demonstrated to be a structurally efficient, versatile, and cost-effective substitute for conventional reinforced concrete slabs. Typically, these systems are designed to accommodate standard slab depths of 150 or 170mm, 200mm, and 255mm. According to De Klerk (2013), the prevalent rib spacings are 560mm, 600mm, and 650mm. A diverse range of heights is available for rebated filler blocks that range between 60 and 350mm.

The beam and block slab systems are characterised by quick installation (García, 2016). The use of hollow blocks can facilitate the accommodation of conduits. The utilisation of minimal formwork and shoring results in a solution that is lightweight, uncomplicated, and economically efficient (Camposinhos & Santos, 2004). The precast prestressed beams and hollow blocks are capable of self-support and necessitate less formwork in comparison to cast-in-situ concrete. However, skeletal props are still required to support the floor during the application of the concrete topping and construction loads. The reinforcement in a precast floor is less than in cast-in-situ concrete, where reinforcement is required for beams and the slab. Thus, the cost of a precast floor slab may be less than that of a cast-in-situ floor slab (Asamoah *et al*., 2016).

The beam and block slab systems have limitations such as their incompatibility with non-uniform plan configurations, which necessitates a large number of custom-shaped components because standardisation is essential for achieving economic efficiency. The creation of a monolithic structure can present challenges, due to the complexities involved in establishing an effective and inflexible connection between the floor and the supporting beams or walls. In addition, they not only exhibit a more fragile behaviour as a result of the addition of an opening within the diaphragm, but also experience a decrease in their strength and resistance when subjected to lateral loads (Aminitabar, Kanaani & Eskenati, 2021). Furthermore, according to Hopkins (2012), the spaces between the bricks in rib and hollow brick slabs are prone to weak spots. This can result in internal sound reverberation and the amplification of sound waves at specific frequency bands. Resonance in the cavities of the blocks has an impact on the T-beam/hollow-block slab's acoustic performance, according to Oliveira *et al*. (2021). However, the addition of a subfloor can offset the acoustic fragility compared to the concrete slab. This is due to the resulting increase in the mass of the system. The estimation of acoustic insulation is a complex process, due to the presence of nonhomogeneous floor slab systems. Despite its lower cost and structural load compared to solid concrete systems, this type of system remains prevalent in several countries (Souza *et al*., 2020). In conclusion, excessive vibrations caused by particular component combinations or the joint connection of the structural slab may have a negative impact on the performance and serviceability of the structural system. The act of individuals traversing a slab surface induces vibrations within the slab system, due to the dynamic forces they produce, as noted by Chik, Kamil & Yusoff (2018).

According to Gohnert, Bulovic and Bradley (2018), the beam and block construction method necessitates the use of temporary supports at intervals of approximately 1.5m. In addition, load transfer transverse ribs are required after every eight to ninth filler block, or at a maximum distance of 1.5 to 1.8m, throughout the span of the ribs in the transverse direction. The removal of props should only occur once the concrete has achieved a certain level of strength. At this point, the composite interaction between the roughened top surface of the rib and the thickened T-portion of the cast-in-situ concrete can be established, resulting in the formation of a composite T-section beam. In the South African context, as per Annex B (informative) of SANS 1879 (2021), the removal of props is subject to the approval of the design engineer, contingent upon the attainment of a minimum strength of

17 MPa. However, although it is permissible to remove temporary props once the cast-in-situ concrete achieves a compressive strength of 17 MPa, according to Khuzwayo (2015), some manufacturers and structural engineers have raised concerns about the strength of the bond between precast ribs and cast-in-situ concrete when the compressive strength of concrete is 17 MPa. The concerns arise, due to the limited information available in SANS 1879 (2021) about the magnitude of interfacial tensile bond stresses between the two concrete surfaces; hence, this study.

2. LITERATURE REVIEW

2.1 Precast rib integrity

Beam and block floors are a widely used flooring system in various countries across the globe, as reported by Ribas and Cladera (2013). They are configured as a sequence of T-section beams, also known as joists, which are combined with soffit blocks to form a one-way slab system. Typically, there are three primary components, namely the soffit unit block, the joist, and the topping (Marcos & Carrazedo, 2014). According to a study by Gohnert (2000), it is crucial for manufacturers of beam and block slab systems to ensure consistent and high-quality products such as precast ribs, in order to ensure reliable results. In the Gohnert (2000) study, during testing, premature failure of certain precast ribs was observed at the shear interface. It was hypothesised that this was attributed to inconsistencies in the manufacturing process. The SABS 0100-1:1992 standard, now updated to SABS 0100-1:2000, conforms to global standards regarding the capacity of ribs to withstand shear stress in the absence of shear links, as noted by Gohnert (1999). Shear links are infrequent in South Africa, due to the prevalent usage of beam and block slab systems in structures with low loads, leading to reduced shear. In order to initiate the composite action involving the cast-in-situ concrete topping, it is a customary procedure to deliberately create a rough texture on the upper surface of the precast ribs. Increased surface roughness improved the bonding property of new-old concrete composite structures, according to Diab, Abd Elmoaty & Tag Eldin (2017). According to a study by Ju, Shen and Wang (2020), surface roughness is the main factor influencing bonding shear strength and splitting tensile strength.

The findings from the Ju *et al*. (2020) study indicated a noteworthy reduction in the horizontal shear strengths for ribs exhibiting an undulation Rz measuring less than 1mm. Superior outcomes were observed in precast ribs exhibiting an undulation Rz exceeding 3mm. According to Gohnert (2003), the horizontal shear capacity is significantly influenced by the surface roughness, which serves as a more reliable indicator of strength compared to compressive strength. Gohnert's (2003) study revealed an ascending pattern in shear strength as the compressive strength of cast-in-situ concrete increased. However, the absence of a correlation between horizontal shear strength and compressive strength impeded the findings. The absence of a minimum roughness amplitude Rz specification in Code (SABS 0100-1) was identified as the reason for its attribution of blame. This horizontal shear strength is contingent upon the deliberately created undulations, as measured by the Rz parameter. Wang, Xu and Liu (2016) reported that a surface roughness increase of 4-5 mm can enhance bonding strength, while excessive roughness can weaken the interface layer. According to Courard *et al*. (2014), it is important to avoid excessive surface roughness as it may lead to a decrease in bonding strength. Not all standard ribs incorporate shear lugs, studs, or links for the purpose of offering horizontal shear resistance. Hooks are commonly employed for the purpose of handling and do not affect the horizontal shear strength. According to Loov and Patnaik's (1994) study, links of this nature are considered ineffective and unstressed until the horizontal shear stresses surpass the range of 1.5 to 2 MPa. This underscores the significance of preserving the integrity of roughening.

2.2 Surface texture standardisation code

According to SANS 1879 (2021) on Precast Concrete Suspended Slabs, it is mandatory for all beam and block slab systems used in South Africa to possess a deliberately formed undulation or roughness Rz on the top interface that measures at least 3mm, along a spacing of no more than 40mm (as stipulated in clause 4.3.4) when evaluated in accordance with clause 5.5. A digital calliper is employed to obtain no less than ten sets of measurements pertaining to the mean disparity between the ridge and the neighbouring valley, relative to a horizontally situated reference line that is arbitrarily selected for convenience. However, the code fails to account for additional variables that may impact on the efficacy of a roughened surface, including but not limited to the distance between segments, the permissible range of roughness frequency within a 40mm segment, and the consistency of the roughened surface.

In the South African context, designers of beam and block slab systems use South African Bureau of Standards (2000) to determine the minimum ultimate horizontal shear stresses for the interface design of precast units without shear links. The ultimate horizontal shear stresses at the interface of in-situ concrete with a grade of 25 MPa are contingent upon the type of surface. Specifically, the values are as follows: (1) 0.4 MPa for surfaces that are either as-cast or as-extruded; (2) 0.6 MPa for surfaces that have been brushed, screeded, or rough-tamped, and (3) 0.7 MPa for surfaces that have been washed to remove laitance or treated with a retarder and subsequently cleaned. The term “as-cast” refers to concrete that has been placed and vibrated, leaving a rough finish. The surface is not as rough as it would be if tamping, brushing, or other artificial roughening techniques had been used. The term “as-extruded” refers to situations in which an open-textured surface is produced directly from an extruder. The terms “brushed”, “screeded”, or “rough-tamped” refer to surfaces that have been intentionally roughened but not to the extent that the aggregate is exposed.

The guide on Shear at the Interface of Precast and In-Situ Concrete (Prefabrication, 1982) addressed significant matters such as surface treatment and workmanship requirements. Increasing surface roughness and using adhesive improved the new-to-old concrete bonding strength (He *et al.*, 2017). Hussein and Amleh (2015) observed an enhancement in the bonding strength of new-to-old concrete through mechanical properties. The bonding strength was found to be impacted by several factors, one of which is the surface treatment, as reported by Bass *et al.* (1989). The horizontal shear strength of cast-in-situ concrete is subject to the effects of surface cleanliness and wetting prior to concreting, as well as appropriate compaction and curing measures. SANS 10100-2 (2014) proposes several recommendations, including dampening the concrete surface before placing new wet concrete (clause 10.4), protecting and curing newly placed concrete (clause 10.8), and cleaning the concrete surface before placing new wet concrete (clause 10.9). The quality of the precast interface influences all of the aforementioned factors. The dominant factor that governs the strength of the horizontal shear interface, as stipulated in various codes such as SANS 1879 (2021), is acknowledged to be the surface roughness. The quality of the work is a factor that affects the shear strength. According to the guide published by the Prefabrication (1982), it is acknowledged that the practical limitations of surface finishes may not always align with the requirements outlined in design codes and standard specifications.

The specification for achieving the desired horizontal shear strength through surface finish undulation is outlined in SANS 0100-1, as per the South African Bureau of Standards (2000). SANS 1879 (2021) specifies a minimum surface roughness Rz of 3mm, and guidelines for its measurement are provided. The South African codes that were referenced did not offer any guidance, procedural instructions, or particulars on the means to attain the intended surface texture. Attaining uniform surface roughness can be a challenging task, due to the variability in roughness that can be generated by a brush or rake, which is contingent upon factors such as the rigidity of the tool, the degree of force exerted, and the thickness or maturity of the mixture (Gohnert, 2003). In certain instances, the delamination of the composite section in these slabs can be attributed to low interfacial tensile bond strength.

3. METHODOLOGY

3.1 Preparation

The objective of this study was to determine the interfacial tensile bond strength between precast rib and cast-in-situ concrete for beam and block slab system. The study involved determining the surface roughness Rz of all sixty precast ribs donated by a KwaZulu-Natal manufacturer of beam and block slab systems. The evaluation was conducted in accordance with SANS 1879 (2021), clauses 4.3.4 and 5.5. A stiff brush was used to roughen the precast ribs during their manufacture at the precast plant. The precast ribs demonstrated a compressive strength of 50 MPa after 28 days. The only surface on which Rz was measured was the intended surface for cast-in-situ concrete. For the cast-in-situ concrete topping over the precast ribs, the laboratory used the 30 MPa concrete mixture specified in Table 1.

Table 1: Concrete ingredients

Description	*Quantity per m³*
Tap water	205
CEM II/B-M (S-V) 42.5 N	350
19.0 mm Natal Group Sandstone	1 020
Umngeni River Sand	770

These constituents are commonly used in cast-in-situ concrete mixes for structural topping applications. Figure 1 shows timber box formworks that are equipped with anchor hooks.

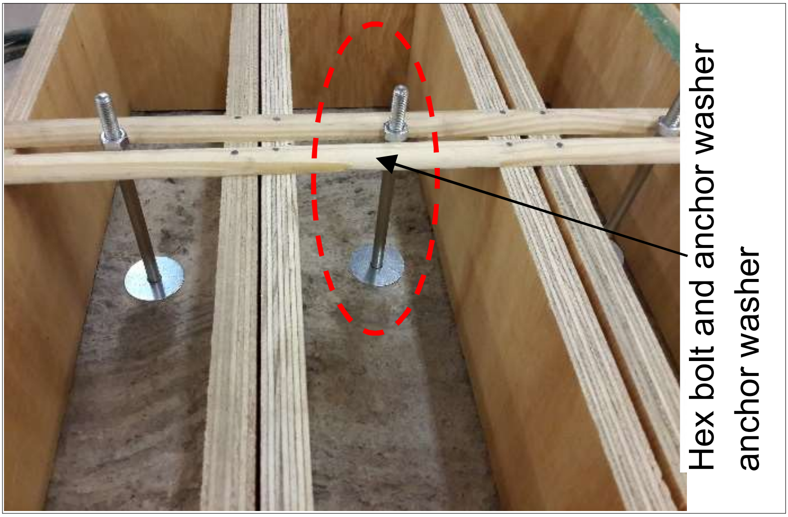

Figure 1: Timber box formwork

The precast ribs underwent a rigorous cleaning procedure with a high-pressure hose to eliminate any impurities, including loose laitance, dust, and sand, one day prior to testing. Before applying the concrete topping, the specimens, specifically the top surface of precast ribs, were adequately moistened with water on the day of testing. The newly laid concrete complied with SANS 10100-2 (2014), clauses 10.2, 10.3, and 10.8, with respect to placement, protection, and curing.

3.2 Tests

Test 1

A total of 60 tests were performed to evaluate the interfacial tensile bond strength of precast ribs. These tests were conducted ten days after casting in-situ concrete. The assessment of the concrete compressive strength of the cubes was used as a basis for selecting the testing time points, which included three, four, five, ten, 14, and 28 days. The determination of interfacial tensile bond strength involved measuring the contact surface area and the force necessary to cause the delamination of the bonded concrete surfaces (see Figures 2 and 5). The interfacial tension bond strength (stress) is found by dividing the force that caused the cast-in-situ concrete to separate from the precast rib by the area where the precast rib and cast-in-situ concrete touched. This proposed testing method involved applying a direct tensile force (*P*) to the two concrete surfaces in order to cause delamination:

$$\sigma = \frac{P}{A}$$

Where:

σ – Interfacial tensile bond stress (N/mm²)

P – Force reached to cause delamination between precast rib and cast-in-situ concrete (N)

A – Contact area between precast rib and cast-in-situ concrete (mm²)

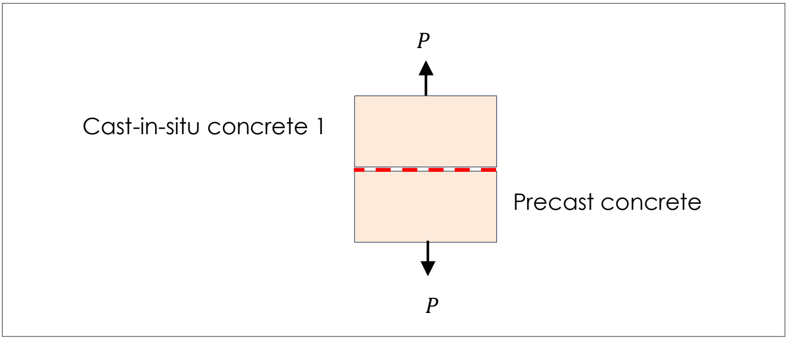

Figure 2: Cross section of interfacial tensile bond specimen

Source: Author

Test 2

Following the completion of the first round of tests, the precast ribs were again cleaned and prepared for the second round of tests, which included casting in-situ concrete topping in timber box formwork. There was no visible damage to the surface of the precast ribs, due to the difference in concrete strengths between precast ribs and cast-in-situ concrete. On the fourth day after casting, the exact same precast ribs were subjected to a second round of interfacial tensile bond strength tests. Only 58 ribs were used this time, as beams A7 and A60 were damaged in Test 1. The compressive strength of concrete was measured at three, four, five, ten, 14, and 28 days. The cast-in-situ concrete in Test 2 was positioned centrally in relation to its initial placement (see Figures 3 and 4). Various alternatives were evaluated, in order to determine the optimal testing methodology. Limited financial resources, specifically the acquisition of innovative testing equipment, necessitated the use of a beam press machine with multiple modifications, as depicted in Figures 3 to 5.

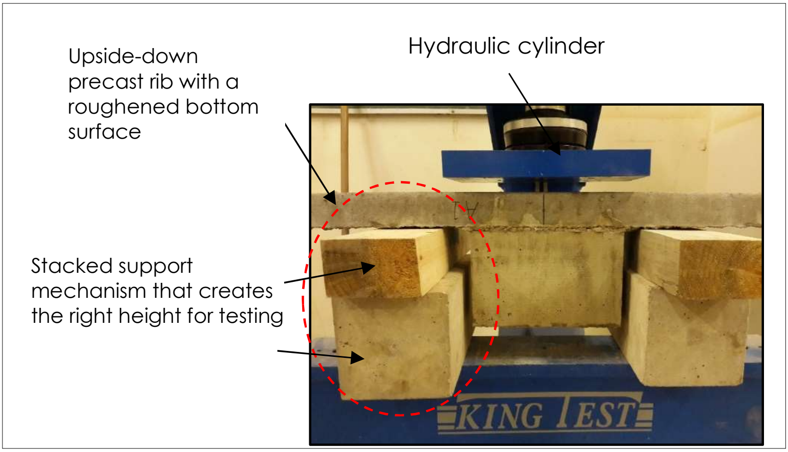

Figure 3: Placement of the specimen into the beam press apparatus

Source: Author

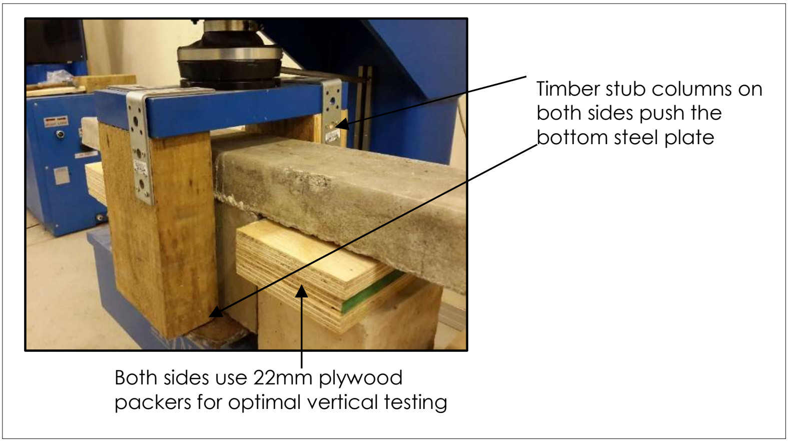

Figure 4: Specimen testing

Source: Author

4. FINDINGS AND DISCUSSION

Tests 1 and 2 were undertaken to assess the interfacial tensile bond strength of intentionally roughened concrete ribs and cast-in-situ concrete topping. The weight of a cast-in-situ concrete topping or beam was considered.

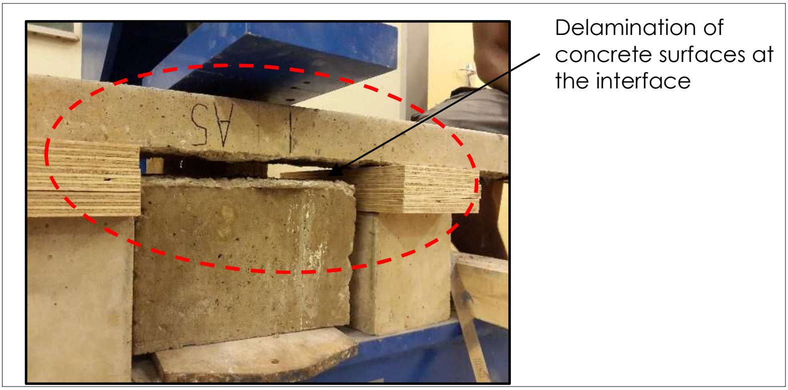

Figure 5: Precast and cast-in-situ concrete delaminates

Source: Author

Test 1: 10-day results

Figure 6 depicts the relationship between interfacial tensile bond stresses and surface roughness Rz ten days after in-situ concrete casting. At that time, the characteristic compressive strength of the cast-in-situ concrete topping, determined by crushing the concrete cube specimen, was around 25 MPa. It can be seen that a surface roughness (Rz) of -3mm for precast ribs, as recommended by SANS 1879 (2021), results in an interfacial tensile bond strength of 0.21 MPa between the precast rib and cast-in-situ concrete. The interfacial tensile bond strength of 0.21 MPa is sufficient to allow the precast rib to support its own weight while hanging underneath the cast-in-situ concrete. However, the beam and block slab system manufacturer or structural engineer should carefully evaluate the interfacial connection between the precast rib and cast-in-situ concrete using a rational design approach, as 0.21 MPa may not be sufficient if the precast rib experiences forces beyond its self-weight that could lead to delamination. The best-fit curve ($y = 0.0067 x^2 + 0.0209 x + 0.2113$) shows a weak relationship, indicating that an increase in surface roughness is associated with an increase in tensile bond strength. The broad distribution of the data implies that additional factors contribute to the expansion of the trend. This representation does not account for the impact of the degree of uniformity, the variability in roughening frequency, or the influence of laitance concrete. It should be noted that the data presentation contains some overlaps regarding surface roughness and bond strength.

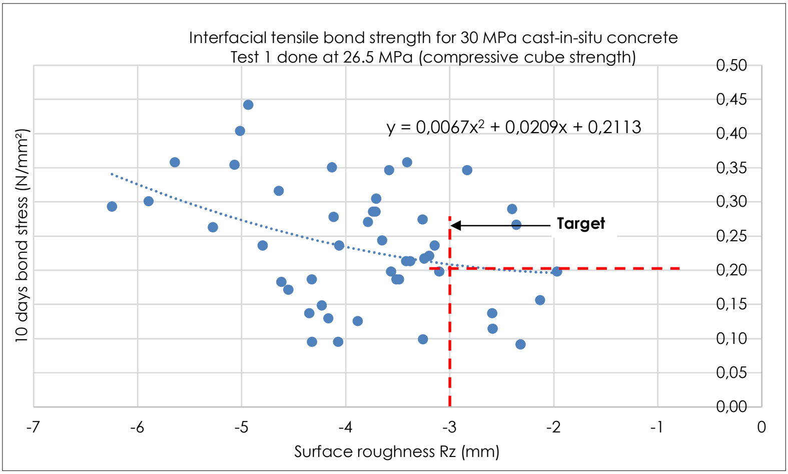

Figure 6: Interfacial tensile bond strength at ten days for 30 MPa concrete

Test 2: 4-day results

Figure 7 depicts the weak relationship between interfacial tensile bond strength and surface roughness Rz after a period of four days. At that time, the characteristic compressive strength of the cast-in-situ concrete topping, determined by crushing the concrete cube specimen, was around 17 MPa, corresponding to the time SANS 1879 (2021) recommends that temporary props be removed. It can be seen that a surface roughness (Rz) of -3mm, recommended by SANS 1879 (2021), results in an interfacial tensile bond strength of 0.15 MPa between the precast rib and cast-in-situ. The interfacial tensile bond strength of 0.15 MPa is sufficient to allow the precast rib to sustain its own weight while suspended beneath the cast-in-situ concrete. As stated earlier, it is even more critical for the beam and block slab system manufacturer or structural engineer to evaluate the interfacial connection between the precast rib and cast-in-situ concrete using a rational design approach, as 0.15 MPa may not be sufficient if the precast rib is subjected to forces greater than its self-weight, which could result in delamination. Delamination tests exhibit a discernible pattern, suggesting that an increase in surface roughness is associated with a corresponding increase in tensile bond strength. However, in this instance, the low surface roughness (below 3mm) does not suggest higher tensile bond stresses. Conversely, the elevated surface roughness implies a broader spectrum of tensile bond stresses that can be attained. This provides evidence in favour of the hypothesis that additional variables are contributing to the expansion of this upward trend. The aforementioned depiction fails to account for the impact of the degree of consistency in laitance concrete, alongside fluctuations in the frequency and intensity of roughening. It should be noted that the presentation of data regarding surface roughness and bond strength contains overlapping information.

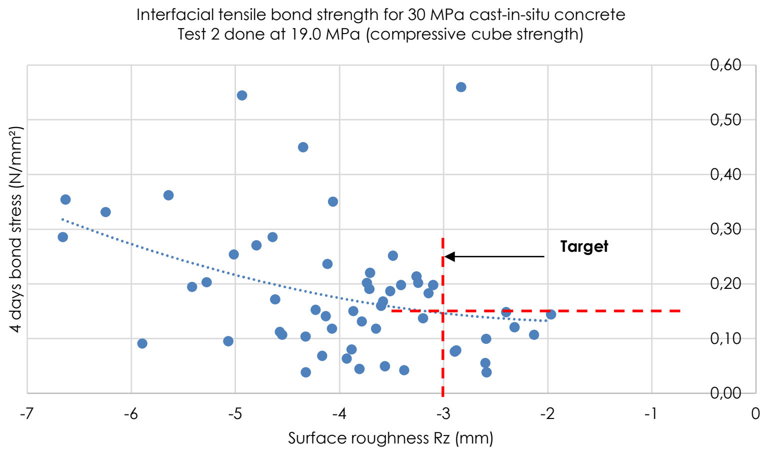

Figure 7: Interfacial tensile bond strength at four days for 30 MPa concrete

Within four days, low interfacial tensile bond stresses were observed between the precast surface and the cast-in-situ concrete. Based on the compressive strength of the concrete cubes, the compressive strength of the concrete was determined to be 19.0 MPa at the time of evaluation. Despite the fact that the compressive strength of cast-in-situ concrete topping was 19 MPa and not 17 MPa at the time of testing, this difference of 2 MPa is relatively small and still reflects how low the interfacial tensile bond stresses will be at the time when temporary props can be removed by the date specified in Annex B (informative) of SANS 1879 (2021). Typically, the delamination of a 150mm wide by 60mm deep precast rib suspended beneath the structural topping is not caused by its own weight. Inadequate surface preparation and surface contamination may also play a role in the occurrence of delamination. Surfaces with minimal roughness can attain a higher tensile bond strength if surface treatment procedures are carried out properly.

5. CONCLUSION AND RECOMMENDATION

Beam and block slab systems, alternatively known as rib and block slab, are extensively implemented as the preferred suspended flooring system in South Africa, due to their cost-effectiveness and structural integrity. As per the guidelines outlined in SANS 1879:2021 for precast concrete suspended slabs, it is advisable to eliminate temporary propping for beams and block slabs once the compressive strength of the cast-in-situ concrete exceeds 17 MPa. Some manufacturers and structural engineers have expressed concerns, due to complete lack of information about the bond strength between precast rib and cast-in-situ concrete when the temporary props can be removed; hence, the study. Pull-out tests were conducted on precast roughened concrete ribs and cast-in-situ concrete to measure the structural soundness of interfacial tensile bond strength. The study found that, with a surface roughness of 3mm, the tensile stresses average at 0.15 MPa for a compressive strength of approximately 17 MPa for cast-in-situ concrete. In addition, the study found that the interfacial tensile bond strength reaches an average tensile strength of 0.21 MPa when cast in-situ concrete reaches a compressive strength of approximately 25 MPa for the same roughness of 3mm.

This study provided insight into the magnitude of interfacial tensile bond stress between precast rib and cast-in-situ concrete that manufacturers and structural engineers can use as a guide in combination with Annex B (B1) of SANS 1879 (2021), when temporary props may be removed once the cast-in-situ concrete reaches a compressive strength of 17 MPa. Providing the interfacial surface of precast ribs is adequately prepared and the precast rib is supporting its own weight, the test results show sufficient interfacial tensile bond strength between the precast rib and cast in-situ concrete. Consequently, the results of this study should alleviate the concerns arising from the complete absence of data regarding the structural integrity of the interfacial tensile bond strength between precast ribs and cast in-situ concrete at a compressive strength of 17 MPa. It is advisable for the manufacturer of beam and block slab systems or the structural engineer to engage in a rational design process for the slab in question, should the precast ribs be exposed to any forces beyond their own weight that could potentially contribute to the delamination forces. When the precast ribs are subjected to forces beyond their self-weight that could lead to delamination, it is important for the beam and block slab system manufacturer or structural engineer to carefully evaluate the interfacial connection between the precast rib and cast-in-situ concrete using a rational design approach.

6. LIMITATIONS AND FURTURE RESEARCH

Inaccurate concentric placement of precast rib and cast-in-situ topping may result in uneven stresses at the interface and slight bending along the vertical axis, thereby causing premature interfacial tensile bond stresses between precast rib and cast-in-situ concrete. In addition, other variables such as the lack of uniformity in surface roughness, the variation in roughening frequency, and the influence of laitance concrete may have had an effect on the results and require further study.

Future studies are required to provide more data for different sizes of precast ribs with different types of strength of cast in-situ concrete toppings under different loading conditions.

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