Proceedings of the Joint CIB W099 & TG59 International Web-Conference 2020: Good Health, Wellbeing & Decent Work

Knowledge of Scaffolding Requirements in Construction: An Assessment

Marius Eppenberger[1] and John Smallwood[2]

[1]Eppen-Burger & Associates, South Africa

[2]Nelson Mandela University, South Africa

Correspondence: john.smallwood@mandela.ac.za

Abstract

Scaffolding features regularly in terms of construction-related accidents reported in the media. Furthermore, it contributes a fair percentage in terms of the agencies linked to construction accidents.

A range of health and safety (H&S) legislation, and South African National Standard (SANS) 10085 informs with respect to the requirements relative to scaffolding.

The study reported on, investigated the knowledge of delegates attending four scaffold safety information sessions with respect to various aspects related to scaffolding. A self-administered questionnaire was circulated and completed prior to commencement of the information sessions.

Findings include: the highest level of response was relative to the length of a timber sole board when under a single scaffold standard / base jack; the lowest level of response was relative to 'name the five occasions where scaffolds may need to be inspected by the appointed scaffold inspector as per the SANS Scaffold Code' - 'before dismantling'; the highest level of response within 10% of the range was relative to the 'acceptable height for a scaffold platform guard rail above the platform', and the lowest level of response within 10% of the range was relative to the 'what is the approximate weight of a pallet of bricks'.

Conclusions include: the attendance of the scaffold information sessions indicates that there is a need for knowledge relative to scaffolding; there is a need to assess practitioners' knowledge, and there is a lack of knowledge in terms of the specifics with respect to scaffolding.

Recommendations include: practitioners must familiarise themselves with the specifics of SANS 10085; employer associations, professional associations, and statutory councils should evolve and or promote scaffolding-related continuing professional development (CPD); the industry should evolve a consolidated guide to scaffolding, and more scaffolding-related knowledge sessions should be staged.

Keywords: construction, health and safety, knowledge, scaffolding.

Introduction

The International Labour Office (ILO) (1999) defines scaffolding as "A temporary structure supporting one or more platforms, and which is used either as a workplace or for the storage of materials in the course of any type of construction work, including both maintenance and demolition work."

The Health and Safety Authority (HAS) (1999) contends scaffolding performs several important functions during the construction process. It enables work to be performed at a height, it is used to protect persons working at height from falling, and to protect persons working below from falling objects. According to Davis (2002), scaffolding can provide an efficient and safe means to perform work, however, unsafe scaffolding practices can lead to accidents, serious injuries, and fatalities.

Scaffolding and staging accounted for 15.0% of fatal falls to a lower level in construction in the United States of America for the years 2011-2015 (Dong, Wang, Katz, West, & Bunting, 2017). Within the context of South Africa, according to the Federated Employers Mutual Assurance Company (FEMA) (2020), scaffolding, which is one of 188 (0.53%) agencies in terms of accidents, contributed as follows to accidents in terms of agencies during 2019: 2.5% of total accidents; 3.2% of total fatalities; 4.9% of total lost days; 4.4% of permanent disablements, and a cost of R62 428 per accident versus an overall mean of R31 803.

Scaffolding has featured periodically in terms of construction-related accidents reported in the South African media. The notable 'Investec' scaffolding collapse in Sandton, Johannesburg on 26 August 1997 resulted in three fatalities and sixteen seriously injured, and a plethora of articles in the media. It is alleged that too many marble tiles were stacked on the scaffolding, the weight of which brought it down (Cresswell, 1997). A 27-year-old worker, who was believed to be working on scaffolding on a project in Sandton, Johannesburg, fell four floors to his death when he accidentally fell from a temporary platform in February 2011 (news24, 2011). Five workers were injured when they fell between 10 to 15 metres when the scaffolding they were working on, collapsed at a construction site in Pretoria in June 2015 (Masinga, 2015).

The Construction Industry Development Board (cidb) (2009) report 'Construction Health & Safety Status & Recommendations' highlighted the considerable number of accidents, fatalities, and other injuries that occur in the South African construction industry. The report cited the high-level of non-compliance with H&S legislative requirements, which is indicative of a deficiency of effective management and supervision of H&S on construction sites as well as planning from the inception / conception of projects within the context of project management. The report also cited a lack of sufficiently skilled, experienced, and knowledgeable persons to manage H&S on construction sites.

Limited research has been conducted relative to scaffolding, including scaffolding H&S, in South Africa. Furthermore, invariably research has investigated practices and causes of accidents and / or failures, however, not the scaffolding-related knowledge of participants in the construction process. Anecdotal evidence underscored by the status of scaffolding alludes to inadequate scaffolding-related knowledge of such participants.

Given the abovementioned, a study 'scaffolding knowledge' was conducted to determine industry participants' scaffolding knowledge, which effectively constitutes the research gap.

Review of the Literature

Legislation

A range of legislation and regulations impact on scaffolding, including knowledge relative thereto.

The Occupational Health and Safety Act (OH&SA) (Republic of South Africa, 1993) schedules generic requirements. Employers are required to provide such information, instructions, training, and supervision as may be necessary to ensure, as far as is reasonably practicable, the H&S at work of their employees.

The General Safety Regulations (Republic of South Africa, 1986) address a range of scaffolding related aspects. In terms of scaffold framework: categories in terms of loads; foundations; spacing of standards; bracing; provision of ladders; securing to structure; factor of safety; supervision of erection and dismantling; frequency of inspections, and supervision. In terms of scaffold platforms: width of platforms; distance of platforms from structures; dimensions of planks; guardrails; toe boards, and housekeeping.

The Construction Regulations (Republic of South Africa, 2014) require that contractors ensure that scaffold erectors, team leaders, supervisors, and inspectors are competent.

Standards

'SANS 10085-1:2004 The design, erection, use and inspection of access scaffolding Part 1: Steel access scaffolding' is the South African National Standard applicable to scaffolding.

The standard addresses: scaffolding materials; components; chains, ropes and fasteners; foundations for scaffolding; design requirements for access scaffolding; erection of scaffolding; safety precautions; inspection; maintenance and storage; control of scaffolding operations; responsibilities of the scaffold user, and training requirements for scaffolding personnel.

Problem aspects

The Construction Safety Association Ontario (CSAO) (2001) cites the following as problem areas: erecting and dismantling; climbing up and down; planks sliding off or breaking; improper loading or overloading; platforms not fully decked; platforms without guardrails; failure to install all required components; electrical contact with overhead wires, and moving rolling scaffolds with workers on the platform.

Erecting and dismantling results in between 15 to 20% of scaffolding-related injuries, the most common problem being the failure to provide an adequate working platform for workers when installing the next lift of scaffolding. The next most important consideration are tie-ins, which should be installed as the scaffolding is erected. Doing so prevents sway or movement, which could result in falls, the situation being exacerbated during erection and dismantling as platform boards and guardrails may have been removed. Climbing up and down results in approximately 15% of scaffolding-related injuries due to workers using frames and braces, as opposed to ladders. Planks sliding off or breaking cause many scaffolding-related injuries. Planks must be cleated or otherwise secured. Furthermore, planks must be of the correct grade of timber, maintained, and overloading must be averted. Improper loading or overloading results in deflection, and leads to deterioration and breaking, which is often related to the masonry trade. Platforms not fully decked during use, but also

during erection and dismantling, are related to injuries. Platforms without guardrails are a serious issue in construction and are important for both high and low platforms. Guardrails should consist of a top rail, a middle rail, and a toe board. Failure to install all the required components is a further serious safety issue. Electrical contact with overhead wires does not occur often, however, when it does, it invariably involves a fatality. Failure to maintain safe distances from overhead powerlines while moving scaffolds is a major problem. There are recommended minimum distances depending on the voltage rating of the powerline. Lastly, moving mobile scaffolding with workers on the platform can be dangerous.

Causes of scaffolding-related accidents

A scaffolding study conducted in South Africa investigated a range of aspects (Smallwood, 2006). In terms of the contribution of various aspects to scaffolding-related accidents, the following aspects can be deemed to make between a contribution and a near major / near major contribution to scaffolding-related accidents: overloading (materials) (joint 1st); inadequate guardrails (3rd); inadequate access (joint 4th); inadequate framework (joint 6th); inadequate platform (6th); overloading (plant and equipment) (joint 8th); non-compliance to legislation (joint 8th); inadequately educated / trained Scaffold Supervisors (joint 11th); inadequate base (16th); inadequately educated / trained Scaffold Erectors (joint 17th); overloading people (joint 17th); lack of written safe work procedures (SWPs) (joint 19th); inadequate ground / founding conditions (joint 19th); inadequate tying to structure (joint 23rd) ; inadequate screening (or lack of) (joint 23rd), and lack of scientific design (26th).

According to Davis (2002), the causes of scaffolding accidents include failures at attachment points, parts failure, inadequate fall protection, improper construction or work rules, and changing environmental conditions such as high winds, temperature extremes, or the presence of toxic gases. Furthermore, overloading of scaffolding is a frequent cause of major scaffolding failures.

A study conducted by Enshassi & Shakalaih (2015) in the Gaza strip, Palestine determined the top ten factors influencing the occurrence of falls from scaffolds as: absence of personal protective equipment (PPE); missing ladders; wind loads; disguised the design code; lack of proper assembly or inspection; overhead tools and materials; climbing and neglect using ladders; lack of guardrails; missing bracing, and working during fatigue.

Importance of interventions

The scaffolding study conducted in South Africa also investigated the degree of importance of various aspects / actions / interventions relative to scaffolding aspects (Smallwood, 2006). The following can be deemed to be between more than important to very important / very important: scaffold supervisor training (joint 1st); scaffold erector training (joint 1st), and written safe work procedures (SWPs) (joint 6th).

Research

Research method and sample stratum

Four Association of Construction Health and Safety Management (ACHASM) scaffolding information sessions were conducted by the lead co-author, which were attended by a total of 123 delegates as follows:

- 24 March 2017: 13 No.
- 17 October 2017: 53 No.
- 20 June 2018: 41 No.
- Date not recorded - 16 No.

The delegates were primarily construction health and safety agents, managers, and officers, and not necessarily scaffold erectors or inspectors.

An 18-question self-administered questionnaire was circulated, completed, and recovered prior to the information sessions commencing. The questionnaire was based upon sixteen aspects addressed in SANS 10085 and is in fact similar to the test paper used during scaffold inspector training courses. Therefore, the questionnaire was not pilot tested, and there was no need to verify the questions. The questions are presented below:

1. What are the dimensions of a timber sole board when under a single scaffold standard / base jack (length x breadth x thickness)?
2. What is the maximum load per square meter (in kg) for a typical kwikstage scaffold platform with supports (ledgers or similar) every 2.5m?
3. What is the minimum width (or number of platform boards) of a general-purpose bricklayer's scaffold platform?
4. What is the minimum width, in mm (or number of platforms boards) of a scaffold platform specifically used by painters?
5. The maximum height of a scaffold is based on its minimum base width. For a mobile scaffold tower being used outside a building with a minimum base width of 2.5m, what would the maximum permissible height (in meters) be?
6. As per the above question, what is the maximum permissible height of a static scaffold tower (not on wheels) inside a building where the minimum base width is 3m?
7. Scaffolds need to be tied in so as to prevent them from displacing and falling over. Based on the scaffold face area, what is the ratio of movable fixed ties to square meters of scaffold face – in other words one tie is required for how many square meters?
8. Similarly, if a scaffold is shade clothed, what is the ratio of movable fixed ties to square meters of scaffold face?
9. What is the maximum height that a scaffold ladder may extend before a rest platform or stagger is required?
10. What is an acceptable height for a scaffold platform guard rail above the platform?
11. When do scaffold platforms need to be fitted with toe boards?

12. What is the approximate weight of a typical clay brick?
13. What is the approximate weight of a pallet of bricks?
14. What is the weight of a 2.5m steel scaffold board?
15. Name the five occasions where scaffolds may need to be inspected by the appointed scaffold inspector as per the SANS Scaffold Code.
16. Can you name the three types of scaffold bracing?
17. What scaffold code regulates scaffolding in South Africa – number and year?
18. What is deemed to be hazardous weather (wind in km/h and rainfall in mm/h) in terms of the Scaffold Code?

Research Findings

Table 1 presents the extent of the respondents' scaffold knowledge relative to sixteen aspects.

The five highest percentage responses were relative to the 'length of a timber sole board when under a single scaffold standard / base jack' (86.2%), followed by 'maximum height that a scaffold ladder may extend before a rest platform or stagger is required' (83.7%), 'acceptable height for a scaffold platform guard rail above the platform' (83.7%), 'approximate weight of a pallet of bricks' (83.7%), and 'when do scaffold platforms need to be fitted with toe boards' (82.9%).

The five lowest percentage responses were relative to 'minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform' (mm) (35.8%), preceded by 'minimum width (or number of boards) of a scaffold platform specifically used by painters' (mm) (39.8%), 'minimum width (or number of boards) of a scaffold platform specifically used by painters' (No.) (41.5%), 'minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform' (No.) (43.9%), and 'if a scaffold is shade clothed what is the ratio of movable fixed ties to square meters of scaffold face' (56.9%).

The highest 'overstated' percentage difference was 403.7% relative to 'length of a timber sole board when under a single scaffold standard / base jack' - mean response (2 518.4 mm) versus actual (500 mm). This was followed by 299.6% relative to 'approximate weight of a typical clay brick' – mean response 10.39 kg versus actual (2.6 kg), 237.6% relative to 'acceptable height for a scaffold platform guard rail above the platform' - mean response (3.38 m) versus actual (1.0 m), 206.3% relative to thickness of a timber sole board when under a single scaffold standard / base jack – mean response (116.39 mm) versus actual (38 mm).

The highest 'understated' percentage difference was -51.0% relative to 'approximate weight of a pallet of bricks' – mean response (1 273.6 kg) versus actual (2 600 kg), preceded by -50.5% relative to 'if a scaffold is shade clothed what is the ratio of movable fixed ties to square meters of scaffold face' – mean response (12.9 m^2) versus actual (26.0 m^2), and -30.7% relative to 'one tie is required for how many square meters of scaffold face' - mean response (20.2 m^2) versus actual (32.0 m^2).

The highest response within 5% range of the actual is relative to 'minimum width (or number of boards) of a scaffold platform specifically used by painters' (No.) (43.1%), followed by 'minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform' (No.) (40.7%), and 'mobile

scaffold tower being used outside a building with a minimum base width of 2.5m, what would the maximum permissible height be' (38.8%).

The lowest response within 5% range of the actual is relative to 'minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform' (mm) (0.0%), preceded by 'ratio of movable fixed ties to square meters of scaffold face of a shade clothed scaffold' (1.4%), 'approximate weight of a pallet of bricks' (1.9%), 'approximate weight of a typical clay brick ' (4.0%), and 'length of a timber sole board when under a single scaffold standard / base jack' (6.6%).

The highest response within 10% range of the actual is relative to 'acceptable height for a scaffold platform guard rail above the platform' (62.1%), 'maximum permissible height of a mobile scaffold tower being used outside a building with a minimum base width of 2.5m' (44.9%), 'minimum width (or number of boards) of a scaffold platform specifically used by painters' (No.) (43.1%), 'maximum load (kg) per square meter for a typical kwik-stage scaffold platform with supports every 2.5m' (29.5%), and 'minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform' (mm) (29.5%).

The lowest response within 10% range of the actual is relative to 'approximate weight of a pallet of bricks' (1.9%), preceded by 'ratio of movable fixed ties to square meters of scaffold face of a shade clothed scaffold' (2.9%), 'approximate weight of a typical clay brick' (5.0%), 'minimum width (or number of boards) of a scaffold platform specifically used by painters' (mm) (8.2%), and 'thickness of a timber sole board when under a single scaffold standard / base jack (9.5%).

Table 1: Extent of respondents' scaffold knowledge

Aspect	Response (%)	Mean	Actual	Difference (%)	Response within 5% range (%)	Response within 10%
Dimensions of a timber sole board when under a single scaffold standard / base jack:						
• Length (mm)	86.2	2518.42	500	403.7	6.6	21.7
• Breadth (mm)	77.2	293.12	225	30.3	16.8	17.9
• Thickness (mm)	68.3	116.39	38	206.3	7.1	9.5
Maximum load (kg) per square meter for a typical kwikstage scaffold platform with supports every 2.5m?	71.5	401.01	260	54.2	6.8	29.5
Minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform? (mm)	35.8	1702.11	1125	51.3	0.0	29.5
Minimum width (or number of boards) of a general-purpose bricklayer's scaffold platform? (No.)	43.9	4.00	5	(20.0)	40.7	40.7
Minimum width (or number of boards) of a scaffold platform specifically used by painters? (mm)	39.8	1094.74	675	62.2	8.2	8.2
Minimum width (or number of boards) of a scaffold platform specifically used by painters? (No.)	41.5	3.61	3	20.3	43.1	43.1
Mobile scaffold tower being used outside a building with a minimum base width of 2.5m, what would the maximum permissible height be? (m)	79.7	9.73	7.5	29.7	38.8	44.9

What is the maximum permissible height of a static scaffold tower (not on wheels) inside a building where the minimum base width is 3m? (m)	78.0	8.44	12	(29.7)	10.4	10.4
One tie is required for how many square meters of scaffold face?	68.3	20.16	32	(37.0)	15.5	22.6
If a scaffold is shade clothed what is the ratio of movable fixed ties to square meters of scaffold face?	56.9			(50.5)	1.4	2.9
Maximum height that a scaffold ladder may extend before a rest platform or stagger is required?	83.7	8.86	8	(10.8)	14.6	14.6
Acceptable height for a scaffold platform guard rail above the platform?	83.7	3.38	1	237.6	34.0	62.1
When do scaffold platforms need to be fitted with toe boards?	82.9					
What is the approximate weight of a typical clay brick?	81.3	10.39	2.6	299.6	4.0	5.0
What is the approximate weight of a pallet of bricks?	83.7	1273.59	2600	(51.0)	1.9	1.9

Table 2 presents the percentage respondents that identified the five occasions where scaffolds may need to be inspected by the appointed scaffold inspector as per the SANS Scaffold Code, and the three types of scaffold bracing. Respondents were required to record the occasions i.e. options were not presented.

In terms of the five occasions when scaffolds may need to be inspected by the appointed scaffold inspector as per the SANS Scaffold Code, after erection (26.8%) was identified the most frequently, followed by after alteration (25.2%), weekly (15.4%), after incidents (15.4%), and lastly, before dismantling (2.4%).

In terms of the three types of scaffold bracing, face / long (34.1%) was identified the most frequently, followed by plan (33.3%), and ledger / transom (26.8%).

Table 2: Respondents' knowledge scaffold inspections and the types of scaffold bracing

Question	Yes (%)
Name the five occasions when scaffolds may need to be inspected by the appointed scaffold inspector as per the SANS Scaffold Code:	
• After erection	26.8
• Weekly	15.4
• After incidents	15.4
• Before dismantling	2.4
• After alteration	25.2
Name the three types of scaffold bracing:	
• Face / Long	34.1
• Ledger / Transom	26.8
• Plan	33.3

Conclusions

There is a lack of knowledge on the part of the delegates assessed in terms of the specifics with respect to scaffolding. Furthermore, given this shortcoming, it is likely that the delegates' employers identified a need for their employees to be 'developed' in terms of scaffolding knowledge. This leads to the further conclusion that most were not competent should they have been involved with the scaffolding process or overseeing sites or sections thereof.

There is an inability to apply logic in the case of many aspects e.g. surely scaffolding should be inspected after it is erected, and after incidents, yet only 26.8% and 15.4% identified the occasions, respectively.

There is a lack of knowledge with respect to the dimensions of standard materials / equipment i.e. scaffold boards. This lack of knowledge extends to a basic and common construction material in South Africa, in the form of a brick, and a pallet of bricks, the point being that scaffold platforms are frequently stacked with bricks.

Lastly, given that delegates were not able to access reference material, print or electronic, while completing the questionnaire, the findings can be deemed a reliable reflection of their knowledge.

Recommendations

Contract and site managers, supervisors, and H&S practitioners must familiarise themselves with the specifics of SANS 10085, and employers should address SANS 10085 and the specifics of scaffolding during scaffolding toolbox talks. Upon the commencement of scaffolding on a project scaffolding should be designated the 'H&S theme of the month', or for another period such as a week.

There is a need for scaffolding-related continuing professional development (CPD), which should be promoted and facilitated by industry employer and professional associations. Furthermore, organisations can conduct in-house scaffolding-related training and knowledge interventions.

ACHASM as the professional association for construction H&S management, should conduct more such scaffolding knowledge sessions.

Graphic visual guides or aids that indicate the salient issues relative to the components of scaffolding should be evolved and made available on site for all participants for easy reference during the construction process.

References

Davis, B.R., 2002. A Guide to Safe Scaffolding. Raleigh, United States of America: Division of Occupational Safety and Health, North Carolina Department of Labor.

Construction Industry Development Board (cidb), 2009. Construction Health & Safety in South Africa Status & Recommendations. Pretoria: cidb.

Construction Safety Association of Ontario (CSAO), 2001. Scaffolds in Construction. Etobicoke, Ontario: CSAO.

Cresswell, R., 1997. The men who walk the planks. Sunday Tribune, 31 August, 12.

Enshassi, A. and Shakalaih, S., 2015. Construction Workers Fall Accidents from Scaffolding in Gaza Strip. In: 6th International Conference on Construction Engineering and Project Management

(ICCEPM 2015), 11 – 14 October 2015, Busan, South Korea, 65-69.

FEM., 2020. Statistics by Injuries FEM Regions All Regions Agency 2019 as at 2020-June, [online]. Johannesburg: FEM. Available at: https://roe.fem.co.za/Stats#/Accident-Stats [Accessed 23 July 2020].

Health and Safety Association (HAS)., 2008. Code of Practice for Access and Working Scaffolds. Dublin: HAS.

International Labour Office (ILO)., 1999. Safety, health and welfare on construction sites A training manual. 2nd Impression. Geneva: ILO.

Masinga, L., 2015. 5 injured in Pretoria scaffolding accident. [online]. Johannesburg: IOL. Available at: https://www.iol.co.za/news/south-africa/gauteng/5-injured-in-pretoria-scaffolding-accident-1867617 [Accessed 26 July 2020].

news24., 2011. Man plunges to his death. [online]. Johannesburg, news24. Available at: https://www.news24.com/News24/Man-plunges-to-his-death-20110217 [Accessed 26 July 2020].

Republic of South Africa (RSA)., 1986. Government Notice. R: 1031 General Safety Regulations. Pretoria: RSA.

Republic of South Africa (RSA),. 1993. Government Gazette No. 14918. Occupational Health & Safety Act: No. 85 of 1993. Pretoria: RSA.

Republic of South Africa (RSA)., 2014. No. R. 84 Occupational Health and Safety Act, 1993 Construction Regulations 2014. Government Gazette No. 37305. Pretoria: RSA.

Standards South Africa., 2004. South African National Standard SANS 10085-1:2004 The design, erection, use and inspection of access scaffolding Part 1: Steel access scaffolding. Edition 1.1. Pretoria: Standards South Africa.

Dong, X.S., Wang, X., Katz, R., West, G. and Bunting, J., 2017. Fall Injuries and Prevention in the Construction Industry. Quarterly Data Report, First Quarter. Silver Spring: The Center for Construction Research and Training.