THE INFLUENCE OF ARCHITECTURAL DESIGNERS ON CONSTRUCTION ERGONOMICS

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Relative to other industries in South Africa and construction industries world wide, the construction process generates a disproportionate number of fatalities, injuries and disease, the direct and indirect cost of which contributes to the cost of construction. Designers influence construction ergonomics directly and indirectly. The direct influence is as a result of design, details, and method of fixing, and depending upon the type of procurement system, supervisory and administrative interventions. The indirect influence is as a result of the type of procurement system used, pre-qualification, project time, partnering and the facilitating of pre-planning.The paper presents the findings of a study conducted among architectural practices in South Africa to determine their perceptions and practices relative to construction ergonomics. The following constitute the salient findings. Ergonomics during the use phase is more important to architectural practices than the other phases. A range of design related aspects impact on construction ergonomics. To a degree, construction ergonomics is considered / referred to on most design, procurement and construction occasions by architectural practices. Experience predominates in terms of the means by which ergonomics knowledge was acquired. A range of aspects / interventions have the potential to contribute to an improvement in construction ergonomics. The paper concludes that architectural designers contribute to construction ergonomics, but there is potential and a need for enhanced contributions. Recommendations include the inclusion of construction ergonomics in architectural designer tertiary education and continuing professional development (CPD).

Keywords: architectural designers, ergonomics, health and safety.

INTRODUCTION

According to La Dou (1994) ergonomics “is an applied science concerned with people’s characteristics that need to be considered in designing and arranging things that they use in order that people and things will interact most effectively and safely.” The South African Construction Regulations state that ergonomics “means the application of scientific information concerning humans to the design of objects, systems and the environment” for human use in order to optimize human well-being and overall system performance (Republic of South Africa, 2003).

Schneider and Susi (1994) maintain construction, by its very nature, is a problem in ergonomics as it requires work above shoulder level and below knee height. Materials may also be heavy and /or inconveniently sized and shaped, thus presenting manual materials-handing problems. Gibbons and Hecker (1999) in turn emphasize that numerous construction tasks pose significant ergonomic risks to workers.

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Traditionally, project success has been assessed relative to cost, quality and time. However, the need for a paradigm shift and focus on H&S is amplified by the complementary role of H&S in overall project performance – H&S enhances productivity, quality, time and ultimately, cost (Hinze, 1997). Furthermore, accidents contribute to variability of resource, which increases project risk. Such risk can manifest itself in damage to the environment, reduced productivity, non-conformance to quality standards and time overruns, and ultimately in an increase in the cost of construction (Smallwood, 1996).

Behm (2006) defines 'designing for safety' as "The consideration of construction site safety in the preparation of plans and specifications for construction projects." Hecker, Gambatese, and Weinstein (2006) contend that H&S through design is a fundamental principle of ergonomics. They further contend that architects and engineers regularly address ergonomics in their designs, but with a significant limitation, namely that the concerns apply almost exclusively to the end-user of a facility, rather than the workers who construct it. They also cite Behm (2005) who states that such an approach is problematical in that there is growing evidence that the design of permanent structures has a significant impact on risks to those who construct them.

Hecker and Gambatese (2003) maintain 'H&S through design' is a familiar concept to occupational hygienists in that they invoke the primacy of 'engineering controls' in the hierarchy of controls that is fundamental to the process of hazard reduction. The paper reports on a study conducted among member practices of the South African Institute of Architects (SAIA), the objectives being to determine the:

- Importance of ergonomics during the various project phases to architectural practices;
- Frequency at which architectural practices consider / refer to construction ergonomics on various occasions and relative to various design related aspects;
- Extent to which various design related aspects impact on construction ergonomics;
- Source of ergonomics knowledge;
- Potential of various aspects / interventions to contribute to an improvement in construction ergonomics, and
- Degree of awareness relative to certain provisions of the Occupational Health and Safety Act and the Construction Regulations.

REVIEW OF THE LITERATURE

Legislation and recommendations pertaining to architects

The Occupational Health and Safety Act (OH&S Act) (Republic of South Africa, 1993) schedules comprehensive requirements for all employers. Design practices are employers and therefore need to address H&S within the confines of their practices. Furthermore, designers invariably visit projects, and given possible exposure to hazards and risk, the incentive to address H&S exists from an employer and an individual perspective. However, prior to the promulgation of the Construction Regulations all designers were required to address H&S, as in terms of Section 10 of the OH&S Act designers are allocated the responsibility to ensure that any 'article' is safe and without risks to health.

The Construction Regulations (Republic of South Africa, 2003) lay down important requirements with respect to clients and designers. Clients are required to, inter alia: prepare H&S specifications for the construction work; ensure that principal contractors (PCs) have made provision for H&S costs in their tenders; provide PCs with any information that might affect H&S; appoint PCs for projects; ensure that PCs implement their H&S plans; stop work that is not in accordance with the H&S plans, and ensure that sufficient H&S information and resources are available to the PC where changes to the design or construction are. Although the aforementioned requirements pertain to clients, many require the input of designers e.g. given that designers may specify materials that are hazardous due to the non-availability of alternative non-hazardous substance containing materials, or require hazardous processes, for which there are no alternatives, designer input may be required as H&S specifications must schedule the H&S requirements for a project and PCs must be provided with any information that might affect H&S. Designers are required to, inter alia: make available all relevant information about the design such as the soil investigation report; design loadings of the structure, and methods and sequence of construction; inform PCs of any known or anticipated dangers or hazards or special measures required for the safe execution of the works, and modify the design or make use of substitute materials where the design necessitates the use of dangerous structural or other procedures or materials hazardous to H&S. Designers are also required to ensure that during commissioning, cognisance is taken of ergonomic design principles in order to minimize ergonomic related hazards in all phases of the life cycle of a structure.

Impact of designers on construction ergonomics

Behm (2006) analysed 450 reports of construction workers' deaths and disabling injuries in the USA to determine whether addressing H&S in the project designs could have prevented the incidents. He determined that in 151 cases (33.6%), the hazard that contributed to the incident could have been eliminated or reduced if design-for-H&S measures had been implemented.

A range of South African built environment practitioners surveyed during a construction ergonomics seminar indicated the extent to which aspects negatively affect construction ergonomics. The extent in terms of a mean score ranging between 1.00 and 5.00 is: degree of mechanization (4.03); format of materials (3.94); amount of work relative to project duration (3.91); details (3.65); specification (3.61); general design (3.56), and type of procurement system (3.25) (Smallwood, 2006).

Hecker *et al.* (2006) reviewed a design-for-safety intervention undertaken during the programming and design phases for the construction of DID, a US$ 1.5B semi-conductor research and production factory built for Intel corporation on its campus Portland, Oregon. In essence, Intel developed a design-for-safety process 'Life cycle safety' (LCS), one of nine major goals for the project. According to Hecker, Gibbons, and Barsotti (2001) in Hecker *et al.* (2006), there was also a significant ergonomic component that led Intel to design for safety. Hecker, Gambatese, and Weinstein (2005) in Hecker *et al.* (2006) state that a total of 58 LCS reviews took place relative to the 22 work packages. These reviews produced 789 individual comments that were subsequently reviewed and adjudicated by the design team. A sample of 235 (41%) of the comments were analysed, which analysis determined that almost half were related to the construction phase, 75% were related to in some way to H&S, and 40% were directly related to H&S i.e. the primary reason for the comment was a perceived health or safety hazard. In terms of outcomes the LCS appears to have influenced some early and major programming decisions that ultimately improved access, reduced congestion, and thus reduced risk of both musculoskeletal and struck against injuries. Furthermore, fall protection received more attention in detailed design than it likely would have without LCS. Off-site prefabrication of certain assemblies such as trusses was another category highlighted through LCS that probably contributed to reduced risk.

Obstacles to designing for construction ergonomics

Hecker *et al.* (2006) cite the following as obstacles to designing for ergonomics: the narrow specialization of design and construction practice; limited pre-construction collaboration between the designer and constructor due to the traditional construction procurement system (TCPS); the limited availability of ergonomics-in-design tools, guidelines, and procedures, and the limited education architects and engineers receive regarding construction ergonomics.

Potential of designers to contribute to construction ergonomics

The South African built environment practitioners surveyed during a construction ergonomics seminar also indicated the extent to which aspects could contribute to an improvement in construction ergonomics. The extent in terms of a mean score ranging between 1.00 and 5.00 is: constructability (general) (4.53); awareness (4.52); mechanization (4.45); prefabrication (4.31); general design (4.22); reengineering (4.19); specification (4.09), and details (4.03).

Spielholz and Chavez (2006) report on a project which investigated construction specifications and the opportunity to mitigate problems upstream. Draft language was developed for both a general H&S section and for insertion in the appropriate work sections. The resultant specifications include industry better practices, which in most cases result in improved quality and productivity, and reduce the risk of injury to construction and maintenance workers. Insertions include the use of: a powered-screed for screeding concrete; a mechanical trowel where the unbroken slab area is greater than 800 square-feet, powered wire pullers for long runs of electrical conduiting where feasible, and powered-stretchers for carpet stretching relative to carpet laying.

RESEARCH

Methodology and sample stratum

The sample stratum consisted of 1 334 member practices of the South African Institute of Architects (SAIA). Thirty-four questionnaires were not delivered to addressees, and were returned to the sender, one recipient responded that he had retired, one responded that his practice was too small, one responded that the survey was not applicable to his practice, and one responded he was no longer practicing in South Africa. 72 Questionnaires returned in response to the postal survey were included in the analysis of the data, which constitutes a net response rate of 5.6% [72 / (1 334 – 38)].

Analysis

The analysis of the data consisted of the calculation of descriptive statistics to depict the frequency distribution and central tendency of responses to fixed response questions.

Definition of terms

Before introducing and discussing the findings it is necessary to define:

- Construction ergonomics: refers to ergonomics during the phases of construction, commissioning, maintenance, and deconstruction, and
- End-user ergonomics: refers to ergonomics during the use of the building / structure.

Findings

Respondents were required to indicate the importance of ergonomics to their architectural practices during the various project phases in terms of a scale of 1 (not important) to 5 (very important). The resultant importance in terms of a MS ranging between 1.00 and 5.00 is as follows. Use is the only phase that falls within the range > 4.20 ≤ 5.00 – between more than important to very important / very important. Maintenance and commissioning in turn fall within the range > 3.40 ≤ 4.20 – between important to more than important / more than important. Construction and deconstruction in turn fall within the range > 2.60 ≤ 3.40 – between less than important to important / important. It is notable the 4.39 MS of use is effectively 43.0% higher than that of construction and 19.8% higher that that of maintenance, which is the most common category of recycling.

Table 1 presents the frequencies at which architectural practices consider or refer to construction ergonomics on fourteen occasions in terms of the frequency range, never to always, and a MS ranging between 1.00 and 5.00. The project phase within which the occasion falls is referenced between parentheses in terms of stream: upstream; midstream, and downstream. It is notable that nine of the fourteen MSs are above the midpoint value of 3.00, which indicates the consideration of or reference to construction ergonomics on these occasions can be deemed to be prevalent.

Table 1: Frequency at which Architectural practices consider / refer to construction ergonomics on various occasions.

Occasion (Stream)	Response (%)						Mean Score	Rank
	Un-sure	Never	Rarely	Some-times	Often	Always		
Detailed design (Up)	0.0	4.2	9.7	12.5	45.8	27.8	3.83	1
Working drawings (Up)	0.0	5.6	7.0	23.9	43.7	19.7	3.65	2
Concept design (Up)	0.0	4.2	11.3	23.9	40.8	19.7	3.61	3
Preparing project documentation (Mid)	1.4	8.5	8.5	29.6	28.2	23.9	3.51	4
Site inspections / discussions (Down)	1.4	9.7	8.3	29.2	33.3	18.1	3.42	5
Site meetings (Down)	1.4	8.5	11.3	28.2	33.8	16.9	3.39	6
Design coordination meetings (Up)	0.0	6.9	15.3	27.8	38.9	11.1	3.32	7
Constructability reviews (Up)	7.0	7.0	16.9	21.1	38.0	9.9	3.27	8
Client meetings (Up)	1.4	9.7	26.4	25.0	27.8	9.7	3.01	9
Site handover (Mid)	4.2	19.7	18.3	21.1	22.5	14.1	2.93	10
Deliberating project duration (Up)	2.8	13.9	23.6	26.4	30.6	2.8	2.85	11
Pre-tender meeting (Mid)	2.9	25.7	24.3	20.0	12.9	14.3	2.66	12
Pre-qualifying contractors (Mid)	4.2	22.5	25.4	25.4	11.3	11.3	2.63	13

Evaluating tenders (Mid)	2.8	26.4	25.0	19.4	16.7	9.7	2.58	14

It is notable that no occasions fall within the range > 4.20 ≤ 5.00 – between often to always / always, and that only the top five ranked occasions fall within the range > 3.40 ≤ 4.20 – between sometimes to often / often. However, it is also notable that the top three occasions are all 'upstream' occasions, and that concept design, the occasion when construction ergonomics should be first considered, is ranked third. The occasions ranked sixth to thirteenth fall within the range > 2.60 ≤ 3.40 – between rarely to sometimes / sometimes, and last ranked evaluating tenders, a mid-stream occasion, falls within the range > 1.80 ≤ 2.60 – between never to rarely / rarely.

Table 2 presents the frequencies at which practices consider / refer to construction ergonomics relative to sixteen design related aspects, in terms of the frequency range, never to always, and a MS ranging between 1.00 and 5.00. It is notable that fourteen of the sixteen MSs are above the midpoint value of 3.00, which indicates consideration of / reference to H&S relative to these design related aspects can be deemed to be prevalent.

It is notable that no occasions fall within the range > 4.20 ≤ 5.00 – between often to always / always, and that the top eight ranked occasions (50%) fall within the range > 3.40 ≤ 4.20 – between sometimes to often / often. The remaining eight occasions fall within the range > 2.60 ≤ 3.40 – between rarely to sometimes / sometimes.

Plan layout, details, and design (general) predominate, the first five aspects being within a range of followed by a group of seven aspects within a range of 0.18 of the MS. It is notable that type of structural frame is ranked twelfth as it is the stage that impacts most on construction ergonomics (Smallwood, 2002). Along with design (general) it provides the framework for a project in terms of construction ergonomics. Given that certain materials contain hazardous chemical substances it is notable that content of material achieved a ranking of fifth. Furthermore, given that materials handling, and more specifically the mass of materials contribute to manual materials handling, it is also notable that mass of materials has a MS below the midpoint of 3.00 and was ranked last.

Table 2: Frequency at which Architectural practices consider / refer to construction ergonomics relative to various design related aspects.

Aspect	**Response (%)**						**Mean Score**	**Rank**
	Unsure	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**		
Plan layout	4.2	1.4	8.3	18.1	31.9	36.1	3.93	1
Details	4.2	2.8	4.2	20.8	36.1	31.9	3.90	2
Design (general)	4.2	0.0	9.7	16.7	41.7	27.8	3.88	3
Specification	4.2	1.4	5.6	26.4	41.7	20.8	3.75	4
Method of fixing	2.8	0.0	9.7	26.4	37.5	23.6	3.75	5
Position of components	9.7	1.4	11.1	20.8	33.3	23.6	3.67	6
Finishes	4.2	5.6	4.2	27.8	38.9	19.4	3.63	7
Edge of materials	8.3	5.6	12.5	19.4	36.1	18.1	3.49	8
Texture of materials	5.6	6.9	16.7	20.8	31.9	18.1	3.38	9
Elevations	5.6	8.3	12.5	26.4	30.6	16.7	3.35	10
Schedule	8.5	5.6	14.1	33.8	21.1	16.9	3.30	11
Type of structural frame	4.2	9.7	13.9	25.0	31.9	15.3	3.29	12
Content of material	6.9	6.9	16.7	30.6	25.0	13.9	3.22	13
Site location	7.0	9.9	15.5	31.0	21.1	15.5	3.17	14
Surface area of materials	6.9	11.1	22.2	23.6	27.8	8.3	3.00	15
Mass of materials	11.1	11.1	22.2	29.2	20.8	5.6	2.88	16

Similarly, given that the surface area of many materials required for certain elements such as gypsym boards for ceilings and partitions, and glazing for shop fronts is large, the MS of 3.00 is notable. However, it should be noted that finishes and schedule, which encapsulate materials and processes, achieved rankings of seventh and eleventh respectively.

Table 3 indicates the perceived impact of sixteen design related aspects on construction ergonomics, in terms of percentage responses to 'does not' and a scale of 1 (minor) to 5 (major), and a MS ranging between 0.00 and 5.00. Given that a 'does not' option was provided the scale effectively consists of six points, and hence the MS range. It is notable that all sixteen MSs are above the midpoint value of 2.50, which indicates the respondents perceive the design related aspects to impact on construction ergonomics. The level of 'unsure' response is also notable, particularly the aspects for which it is ≥ 10%, namely content of materials, mass of materials, position of components, and schedule.

It is notable that no MSs fall within the range of > 4.17 ≤ 5.00 - between a near major to major impact / major impact. Eleven of the sixteen aspects fall within the range > 3.34 ≤ 4.17, which indicates that they have between an impact and a near major impact / near major impact on construction ergonomics.

Those aspects ranked from twelfth to sixteenth have MSs > 2.51 ≤ 3.34, which indicates that they have between a near minor impact to impact / impact on H&S. Notable aspects that fall within this range are mass of materials, type of structural frame, elevations, and surface area of materials, which literature indicates to all have an effect.

Table 3: Extent to which various design related aspects impact on construction ergonomics.

Aspect	**Response (%)**							**Mean Score**	**Rank**
	Unsure	**Doesnot**	**Minor……………………………Major**						
			1	**2**	**3**	**4**	**5**		
Design (general)	4.3	1.4	2.9	7.2	18.8	33.3	31.9	3.97	1
Details	5.8	2.9	0.0	10.1	20.3	34.8	26.1	3.91	2
Position of components	11.4	2.9	2.9	12.9	21.4	25.7	22.9	3.89	3
Method of fixing	7.2	1.4	4.3	11.6	17.4	37.7	20.3	3.81	4
Plan layout	5.8	2.9	5.8	8.7	18.8	33.3	24.6	3.75	5
Specification	7.2	2.9	0.0	13.0	30.4	27.5	18.8	3.70	6
Finishes	5.7	4.3	2.9	14.3	18.6	31.4	22.9	3.65	7
Edge of materials	8.8	5.9	7.4	8.8	23.5	26.5	19.1	3.55	8
Schedule	13.0	7.2	1.4	14.5	33.3	20.3	10.1	3.47	9
Site location	5.8	8.7	8.7	8.7	17.4	27.5	23.2	3.42	10
Content of material	10.0	2.9	2.9	22.9	30.0	18.6	12.9	3.41	11
Mass of materials	10.1	2.9	10.1	17.4	23.2	29.0	7.2	3.31	12
Texture of materials	5.8	5.8	5.8	15.9	26.1	26.1	14.5	3.29	13
Type of structural frame	4.3	5.8	8.7	13.0	23.2	27.5	17.4	3.29	14
Elevations	5.8	4.3	10.1	18.8	20.3	23.2	17.4	3.25	15
Surface area of materials	8.8	8.8	11.8	11.8	32.4	16.2	10.3	3.02	16

Respondents were required to indicate their knowledge of ergonomics and 'designing for ergonomics' skills relative to a scale of 1 (limited) to 5 (extensive). Based upon the percentage responses, the resultant MS of 3.17 falls within the range > 2.60 ≤ 3.40 – between less than average to average / average.

Experience (83.3%) predominates in terms of respondents' source of ergonomics knowledge, followed by magazine articles (50%) and tertiary education (47.2%). The other sources include journal papers (29.2%), practice notes (22.2%), CPD seminars (15.3%), workshops (15.3%), conference papers (12.5%), and postgraduate qualification (6.9%). Tertiary education, practice notes, and CPD seminars are notable as they directly relate to the discipline, profession, and practice of architecture.

Table 4 indicates the potential of various aspects / interventions to contribute to an improvement in construction ergonomics during the various project phases in terms of percentage responses to a scale of 1 (minor) to 5 (major), and a MS ranging between 1.00 and 5.00. The letters inserted within parentheses denote whether the aspect / intervention is construction (C), design (D), procurement (P), or multi-phase related. It is notable that all the MSs are above the midpoint score of 3.00, which indicates that in general the respondents can be deemed to perceive the various aspects / interventions to have the potential to contribute to an improvement in construction ergonomics during the various project phases.

Reengineering predominates and its MS is effectively 12.8% higher than that of awareness, both of which fall within the range > 4.20 ≤ 5.00 – between near major potential to major potential / major potential to contribute. The remaining aspects fall within the range > 3.40 ≤ 4.20 – between potential to near major potential / near major potential to contribute. It is notable that the top two ranked aspects / interventions, reengineering and awareness, are multi-phase related, and that the fourth and fifth aspects / interventions, details and general design, are design related.

Table 4: Potential of various aspects / interventions to contribute to an improvement in construction ergonomics during the various project phases.

Aspect / Intervention (C / D / P)	**Response (%)**						**Mean Score**	**Rank**
	Unsure	**Minor**				**Major**		
		1	**2**	**3**	**4**	**5**		
Reengineering (C, D, & P)	31.3	1.6	6.3	29.7	23.4	7.8	4.80	1
Awareness (C & D)	3.1	0.0	4.6	12.3	32.3	47.7	4.37	2
Design of tools (C)	14.1	0.0	10.9	23.4	32.8	18.8	4.18	3
Details (D)	4.6	3.1	4.6	13.8	40.0	33.8	4.16	4
General design (D)	4.7	1.6	6.3	21.9	26.6	39.1	4.15	5
Safe working procedures (C)	6.3	0.0	4.7	25.0	39.1	25.0	4.10	6
Constructability (general) (D)	6.3	0.0	4.7	23.4	43.8	21.9	4.08	7
Design of construction equipment (C)	9.4	0.0	3.1	32.8	37.5	17.2	4.07	8
Mechanization (C & D)	10.9	3.1	7.8	26.6	32.8	18.8	4.00	9
Specification (D)	9.4	3.1	4.7	23.4	46.9	12.5	3.98	10
Prefabrication (D)	14.1	3.1	12.5	25.0	32.8	12.5	3.95	11
Contractor planning (C)	7.8	1.6	10.9	23.4	37.5	18.8	3.92	12
Workshops on site(C)	9.4	4.7	14.1	28.1	31.3	12.5	3.67	13

Only 42.9% of respondents were aware of the provisions of Section 10 of the OH&S Act of 1993, 35.7% were not, and 21.4% were unsure. However, only 13.3% of those that were aware could communicate a synopsis of the content thereof.

Less than a quarter of respondents (22.2%), were aware of the ergonomics related provisions of the Construction Regulations, 43.1% were not, and 34.7% were unsure. However, only 6.3% of those that were aware could communicate a synopsis of the content thereof.

CONCLUSIONS

The conclusions are presented relative to the objectives.

Importance of project parameters to architectural practices and contractors

The traditional project parameters of quality, cost, and time are more important than project H&S and construction ergonomics, and in the case of quality, substantially so. Therefore it can be concluded that architectural practices do not understand and appreciate the synergy between project H&S and ergonomics, and the other parameters.

Importance of ergonomics during the various project phases to architectural practices

Although, construction ergonomics is important, it is less important than ergonomics during the maintenance and commissioning phases and substantially less important than ergonomics during the use phase, and therefore the focus is likely to be more on the latter phases than the former phase. Therefore, it can be concluded that construction ergonomics is important to a degree.

Frequency at which architectural practices consider / refer to construction ergonomics on various occasions and relative to various design related aspects

Architectural practices do consider / refer to construction ergonomics on various occasions, more so during upstream phases than mid-stream phases, concept design included. Therefore it can be concluded that the cited importance thereof does manifest itself. However, the frequency is more so relative to between rarely to sometimes / sometimes, and to a lesser extent, between sometimes to often / often.

Architectural practices consider / refer to construction ergonomics on various design related occasions. However, the frequency is equally split - between sometimes to often / often, and between rarely to sometimes / sometimes.

The frequency relative to mass of materials is notable and is possibly attributable to a lack of knowledge of the mass of materials.

Extent to which various design related aspects impact on construction ergonomics

Architectural practices do appreciate the extent to which various design related aspects impact on construction ergonomics.

Source of ergonomics knowledge

It can be concluded that architectural practices' source of knowledge is more informal than formal – experience vis-à-vis tertiary education. It can also be concluded that tertiary architectural education and the architectural profession is not addressing ergonomics to the extent that they should. These conclusions are reinforced by the architectural practices' 'average' self-rating of their knowledge of ergonomics and designing for ergonomics skills.

Potential of various aspects / interventions to contribute to an improvement in construction ergonomics

Architectural practices do appreciate the potential of various design, procurement, and construction practices to contribute to an improvement in construction ergonomics.

Degree of awareness relative to certain provisions of the Occupational Health and Safety Act and the Construction Regulations

There is a low level of awareness relative to certain provisions of the Occupational Health and Safety Act and the Construction Regulations. Therefore, it can be concluded that tertiary architectural education and the architectural profession is not addressing ergonomics to the extent that they should.

RECOMMENDATIONS

Tertiary architectural education should address construction H&S and ergonomics, and highlight the role thereof in overall project performance. Furthermore, designing for construction H&S and ergonomics should be introduced in architectural tertiary education programs.

The South African Institute of Architects (SAIA) should evolve construction H&S and ergonomics practice notes and promote continuing professional development relative to construction H&S and ergonomics.

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