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DESIGN HAZARD IDENTIFICATION AND RISK ASSESSMENT (HIRA)

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Introduction (1)

- **Twenty-three years ago the International Labour Office (ILO) (1992) specifically stated that designers should:**
 - **Receive training in H&S**
 - **Integrate the H&S of construction workers into the design and planning process**
 - **Not include anything in a design which would necessitate the use of dangerous structural or other procedures or hazardous materials which could be avoided by design modifications or by substitute materials**
 - **Take into account the H&S of workers during subsequent maintenance**
- **The South African Construction Regulations (2014) state designers are required to, inter alia:**
 - **Inform the client of any known or anticipated dangers or hazards relating to the construction work**

Introduction (2)

- **Make available all relevant information required for the safe execution of the work upon being designed or when the design is changed**
- **Modify the design or make use of substitute materials where the design necessitates the use of dangerous procedures or materials hazardous to H&S**
- **Consider hazards relating to subsequent maintenance of the structure and make provision in the design for that work to be performed to minimise the risk**
- **The aforementioned requirements in turn clearly require that designers conduct design HIRA**
- **Thorpe (2006) states that there is no more important stage in the construction process than that of design, as at this stage conceptual ideas are converted into constructable realities:**
 - **'Designing for H&S' being one of the designing for constructability principles**

Introduction (3)

- A variety of considerations need to be balanced simultaneously, inter alia, designing for H&S, which is an integral part of the wider design process
- Therefore, needs to be included in design planning as doing so will result in safer construction and maintenance of structures and facilities
- The aforementioned highlight the relevance of design HIRA, and the rationale for the study reported on, the objectives being to determine:
 - Designers' perceptions and practices relative to design HIRA
 - Other issues related to 'designing for construction H&S'

Construction Regulations (1)

Clients required to:

- **5 (1) (a) Prepare a baseline risk assessment (BRA)**
- **5 (1) (b) Prepare an H&S specification based on the BRA**
- **5 (1) (c) Provide the designer with the H&S specification**
- **5 (1) (d) Ensure that the designer takes the H&S specification into account during design**
- **5 (1) (e) Ensure that the designer carries out the duties in Regulation 6 ‘Duties of designers’**
- **5 (1) (f) Include the H&S specification in the tender documents (Republic of South Africa, 2014)**

Regrettably, it is not stated that the H&S specification must be revised to include amendments required in terms of the designer report

Construction Regulations (2)

Designers of a structure must:

- **(a) ensure that the H&S standards incorporated into the regulations are complied with in the design**
- **(b) take the H&S specification into consideration**
- **(c) include in a report to the client before tender stage:**
 - **all relevant H&S information about the design that may affect the pricing of the work**
 - **the geotechnical-science aspects**
 - **the loading that the structure is designed to withstand**
- **(d) inform the client of any known or anticipated dangers or hazards relating to the construction work, and make available all relevant information required for the safe execution of the work upon being designed or when the design is changed**
- **(e) modify the design or make use of substitute materials where the design necessitates the use of dangerous procedures or materials hazardous to H&S**

Construction Regulations (3)

- **(f) consider hazards relating to subsequent maintenance of the structure and make provision in the design for that work to be performed to minimize the risk (Republic of South Africa, 2014)**

H&S and the six stages of projects

Stage		No. of interventions						
No.	Description	Project Managers	Construction Managers	Architects	Landscape Architects	Quantity Surveyors	Engineers	Property Valuers
1	Project initiation and briefing	0	N/A	0	0	0	0	0
2	Concept and feasibility	1	N/A	0	1	1	1	0
3	Design development	1	1	0	0	1	1	0
4	Tender documentation and procurement	1	1	0	0	0	0	0
5	Construction documentation and management	2	3	0	1	1	1	0
6	Project close out	1	1	0	0	0	0	0

Table 1: No. of H&S interventions recorded in the respective identities of work for the seven 'statutory' built environment disciplines (adapted from Deacon, 2016)

Influence of design on construction H&S

- **Design influences and impacts on construction H&S directly and indirectly (Smallwood, 2008):**
 - **Directly through: concept design; selection of structural frame; detailed design; selection of cladding, and specification of materials**
 - **Indirectly through: the selection of procurement system; related interventions such as prequalification; decision regarding project duration, and selection of contractor**

Impact of designers on construction ergonomics

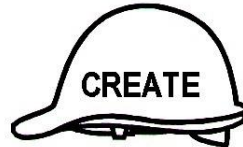
- Behm (2006) analysed 450 reports of construction workers' deaths and disabling injuries in the USA - in 151 cases (33.6%), the hazard that contributed to the incident could have been eliminated or reduced if 'design-for-H&S' measures had been implemented

Designing for ergonomics (1)



Plank and hollow-block composite slab, Plettenberg Bay (Hamp-Adams, 1994)

Designing for ergonomics (2)



An example of a generic risk assessment form (GRA)				
NAME OF ORGANISATION				
NAME OF PROJECT				
ACTIVITY COVERED	Erecting precast plank and hollow block composite slab			
SIGNIFICANT HAZARDS		ASSESSMENT OF RISK		
		LOW	MEDIUM	HIGH
1	People falling			3 X 3 = 9
2	Materials falling			3 X 2 = 6
3	Collapse of structure	1 X 3 = 3		
4	Pinching	3 X 1 = 3		
5	Manual handling			3 x 2 = 6
6	Tripping			3 x 2 = 6
7	Failure of blocks (material)			2 X 3 = 6

Figure 1: Design HIRA for erecting precast plank and hollow block composite slab

Designing for ergonomics (3)



Pre-cast pre-stressed hollow core slab section (SA Builder Bouer, 2004a)

Designing for ergonomics (4)



Pre-cast pre-stressed hollow core slab section (SA Builder Bouer, 2004b)

Research – Sample stratum and method

- A convenience sample of 88 predominantly architectural, but also engineering designers based in the Nelson Mandela Metropolitan metropole
- A self-administered 12-question questionnaire was delivered to the potential respondents per e-mail
- Six demographic questions, five Likert scale type questions, and one open-ended question
- Ten e-mail messages RTS
- Ten completed questionnaires were returned and included in the analysis of the data, which equates to a response rate of 13.5%
- Two further e-mail requests were sent, but failed to elicit further responses
- Mean scores (MSs) – a measure of central tendency, between 1.00 (lower) and 5.00 (upper), 3.00 being the midpoint

Design HIRA practices (1)

Stage	Response (%)						MS	Rank
	Unsure	Never	Rarely	Some-times	Often	Always		
Construction documentation and management	0.0	0.0	10.0	30.0	20.0	40.0	3.90	1
Tender documentation and procurement	0.0	0.0	20.0	30.0	20.0	30.0	3.60	2
Design development	0.0	10.0	20.0	20.0	20.0	30.0	3.40	3
Concept and feasibility	0.0	20.0	10.0	30.0	20.0	20.0	3.10	4
Project initiation and briefing	0.0	20.0	10.0	30.0	30.0	10.0	3.00	5
Project close out	0.0	40.0	20.0	10.0	0.0	30.0	2.60	6

Table 2: Frequency respondents' practices conduct design HIRAs during the stages of projects (MS = 1.00 – 5.00)

Design HIRA practices (2)

Aspect	Response (%)						MS	Rank
	Unsure	Never	Rarely	Some-times	Often	Always		
Design (general)	0.0	0.0	10.0	40.0	20.0	30.0	3.70	1
Site location	0.0	0.0	20.0	30.0	20.0	30.0	3.60	2
Specification	0.0	0.0	30.0	30.0	0.0	40.0	3.50	3
Finishes	10.0	0.0	20.0	40.0	0.0	30.0	3.44	4
Method of fixing	0.0	10.0	10.0	30.0	30.0	20.0	3.40	5
Details	0.0	20.0	0.0	30.0	20.0	30.0	3.40	6
Schedule	0.0	20.0	10.0	20.0	10.0	40.0	3.40	7
Type of structural frame	10.0	20.0	20.0	0.0	10.0	40.0	3.33	8
Elevations	0.0	20.0	10.0	30.0	10.0	30.0	3.20	9
Position of components	0.0	10.0	20.0	40.0	10.0	20.0	3.10	10
Plan layout	0.0	20.0	30.0	0.0	20.0	30.0	3.10	11
Mass of materials	0.0	20.0	10.0	30.0	30.0	10.0	3.00	12
Content of material	0.0	20.0	10.0	40.0	20.0	10.0	2.90	13
Texture of materials	0.0	20.0	20.0	40.0	0.0	20.0	2.80	14
Edge of materials	11.1	22.2	22.2	22.2	0.0	22.2	2.75	15
Surface area of materials	0.0	20.0	30.0	30.0	10.0	10.0	2.60	16

Table 3: Frequency respondents' practices consider / refer to aspects when conducting design HIRAs (MS = 1.00 – 5.00)

Design HIRA practices (3)

Action	Response (%)						MS	Rank
	Unsure	Never	Rarely	Some-times	Often	Always		
Amend details	0.0	0.0	0.0	33.3	22.2	44.4	4.11	1
Review the client H&S specification	0.0	0.0	0.0	20.0	50.0	30.0	4.10	2
Amend designs	0.0	0.0	0.0	30.0	30.0	40.0	4.10	3
Avoid / Eliminate hazards	10.0	0.0	10.0	20.0	30.0	30.0	3.89	4
Focus on significant / unusual / difficult risks	0.0	10.0	0.0	30.0	30.0	30.0	3.70	5
Identify hazards	0.0	0.0	20.0	30.0	20.0	30.0	3.60	6
Revisit the process if the design changes at any point	0.0	10.0	10.0	20.0	30.0	30.0	3.60	7
Assemble H&S expertise e.g. consult an H&S Agent	0.0	0.0	20.0	20.0	50.0	10.0	3.50	8
Monitor construction activities relative to design HIRAs	0.0	20.0	20.0	10.0	0.0	50.0	3.40	9
Substitute materials	0.0	0.0	20.0	50.0	10.0	20.0	3.30	10
Review the construction phase H&S plan	0.0	0.0	30.0	40.0	0.0	30.0	3.30	11
Gather H&S information relative to projects	0.0	20.0	10.0	20.0	20.0	30.0	3.30	12
Provide H&S information for tender documentation	0.0	10.0	30.0	20.0	0.0	40.0	3.30	13

Table 4A: Frequency respondents' practices undertake actions relative to projects / their practice
(MS = 1.00 – 5.00)

Design HIRA practices (4)

Action	Response (%)						MS	Rank
	Unsure	Never	Rarely	Some-times	Often	Always		
Maintain a register of project hazards and risk	0.0	20.0	20.0	10.0	10.0	40.0	3.30	14
Identify residual hazards	10.0	10.0	10.0	40.0	10.0	20.0	3.22	15
Identify risks from residual hazards	10.0	10.0	10.0	40.0	10.0	20.0	3.22	16
Consider H&S during maintenance	0.0	10.0	10.0	50.0	10.0	20.0	3.20	17
Contribute to the H&S file	0.0	0.0	50.0	10.0	10.0	30.0	3.20	18
Prepare design and construction method statements	0.0	22.2	11.1	22.2	22.2	22.2	3.11	19
Assess / Prioritise / Investigate selected risks	0.0	20.0	10.0	30.0	20.0	20.0	3.10	20
Conduct site risk assessments and actions / directions	0.0	20.0	30.0	0.0	20.0	30.0	3.10	21
Document the design HIRA process	0.0	30.0	10.0	10.0	20.0	30.0	3.10	22
Prepare a 'design loop' for temporary works	20.0	10.0	30.0	10.0	10.0	20.0	3.00	23
Provide information on residual risks e.g. on drawings	0.0	20.0	20.0	30.0	10.0	20.0	2.90	24
Compile a project H&S 'lessons learnt' report	0.0	40.0	10.0	10.0	10.0	30.0	2.80	25
Maintain a practice register of hazards and risk	0.0	30.0	20.0	10.0	30.0	10.0	2.70	26
Prepare a 'designer report' (H&S) for clients	0.0	33.3	33.3	0.0	0.0	33.3	2.67	27

Table 4B: Frequency respondents' practices undertake actions relative to projects / their practice
(MS = 1.00 – 5.00)

Design HIRA practices (5)

Aspect	Response (%)						MS	Rank
	Un- sure	Limited.....Extensive						
		1	2	3	4	5		
Prevention through design	0.0	0.0	20.0	20.0	60.0	0.0	3.40	1
Designing for construction H&S	0.0	0.0	20.0	30.0	50.0	0.0	3.30	2
Design HIRAs	0.0	20.0	10.0	10.0	60.0	0.0	3.10	3

Table 5: Respondents' rating of their knowledge relative to aspects (MS = 1.00 – 5.00)

Conclusions (1)

- **Given the small sample stratum and the response rate the study can best be described as exploratory**
- **Respondents are likely to constitute the more committed designers in terms of construction H&S and ‘designing for construction H&S’**
- **Low response rate may also be attributable to the ‘non-respondents’ not considering construction H&S, which correlates with anecdotal evidence**
- **Findings provide an important first indication of designer commitment and practices related to ‘designing for construction H&S’**
- **The focus of design HIRAs is during the stages of ‘construction documentation and management’ and ‘tender documentation and procurement’, and thereafter ‘design development’:**

Conclusions (2)

- Therefore, it can be concluded that there is more focus on design HIRAs during procurement and construction, than design
- **Designers do consider / refer to various design related aspects when conducting design HIRA:**
 - However, between rarely to sometimes / sometimes, and sometimes to often/ often, and in the case of the former frequency, certainly relative to materials related issues
- **Designers do undertake H&S related actions relative to projects and their practice, particularly amendment of designs and details:**
 - However, the frequency relative to formal documentation in terms of communication of hazards and risks, including the 'designer report', the HIRA process, and 'lessons learnt', and registers, is less frequent

Conclusions (3)

- **Can be concluded that designers do have an understanding and appreciation of the concept of ‘designing for construction H&S’, design HIRAs included, but that there needs to be focus on the formalisation of the process**
- **This is underscored by the respondents’ rating of their knowledge relative to aspects, which rating is between below average to average / average, which implies there is a need for continuing professional development (CPD)**

Recommendations

- **Tertiary designer built environment education should address construction H&S**
- **‘Designing for construction H&S’ should be included in such programmes, and the assessment and evaluation of design projects should include construction H&S as a criterion**
- **Accreditation panels should review the extent to which construction H&S is addressed in such programmes**
- **Design practices should evolve a formal ‘designing for construction H&S’ process:**
 - **Follow a documented process in terms of design HIRAs**
 - **Record the residual risk remaining after the raw risk has been addressed in the ‘design’ report submitted to the client for amendment of the client’s H&S Specification**

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