

# **SAPOA EC 'THE RANDS AND CENTS OF GREEN BUILDINGS'**

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**PORT ELIZABETH**

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## **GREEN BUILDING AND CONSTRUCTION WORKER HEALTH, SAFETY AND ERGONOMICS: ARCHITECTS' AND CONTRACTORS' PERCEPTIONS**

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# Introduction (1)

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- **Gambatese, Rajendran & Behm (2007):**
  - **'Green' building and sustainability are not exactly the same things**
  - **'Green' refers to the design and construction practices which will have an influence on the environment**
  - **Sustainability, however, is a broader notion that not only refers to the environmental impacts, but also to the economic, resource, and social facets of humanity**

## Introduction (Designing and ergonomics and OH) (2)



**'Bush-hammered' concrete, Port Elizabeth (Smallwood)**

## Introduction (Designing for ergonomics and OH) (3)



Thermal Lance, Mount Road Police Station, Port Elizabeth (Smallwood, 1987)

# Introduction (General design) (4)



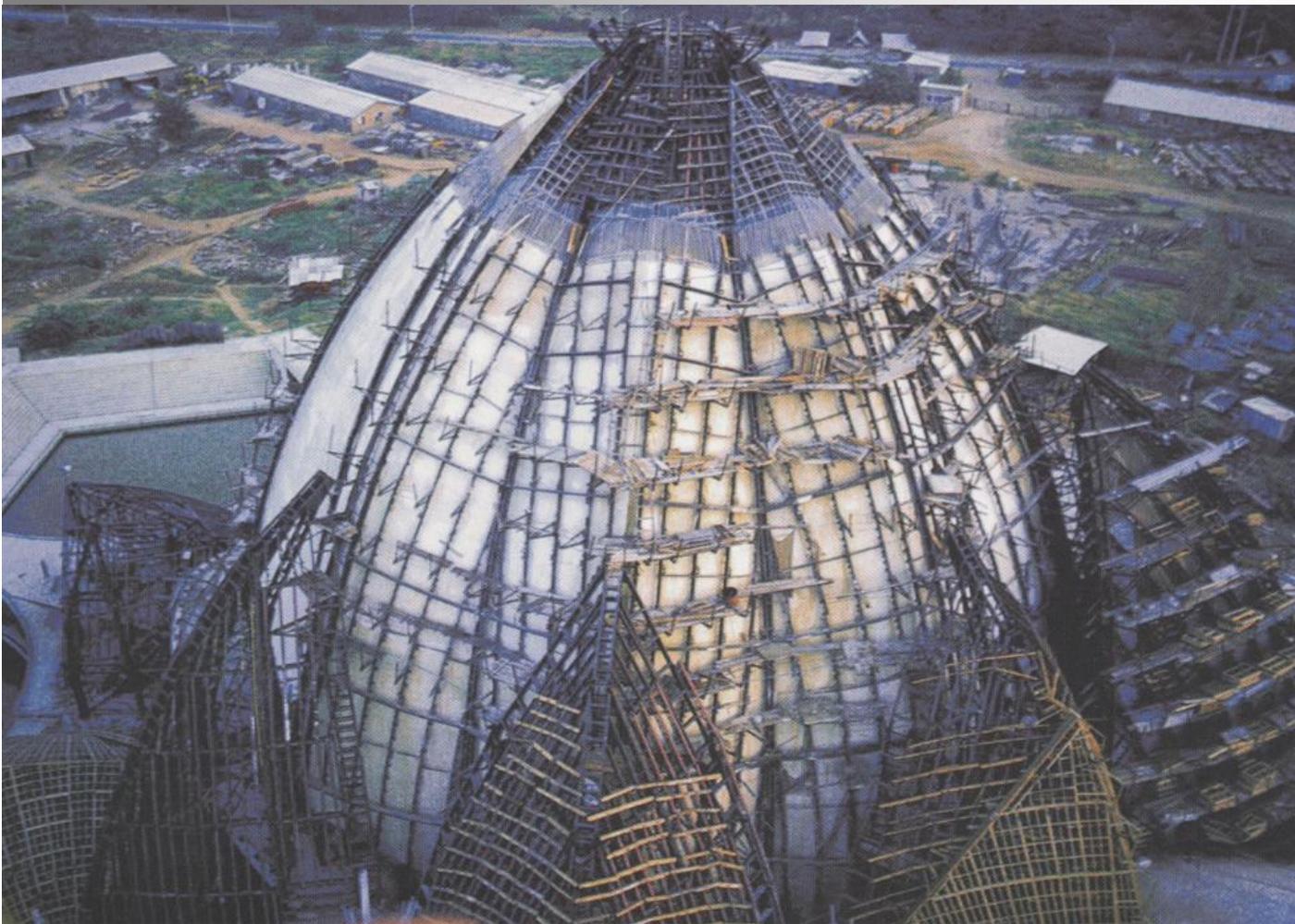
**Bahia Temple, Delhi, India (Smallwood, 2005)**

## Introduction (General design) (5)



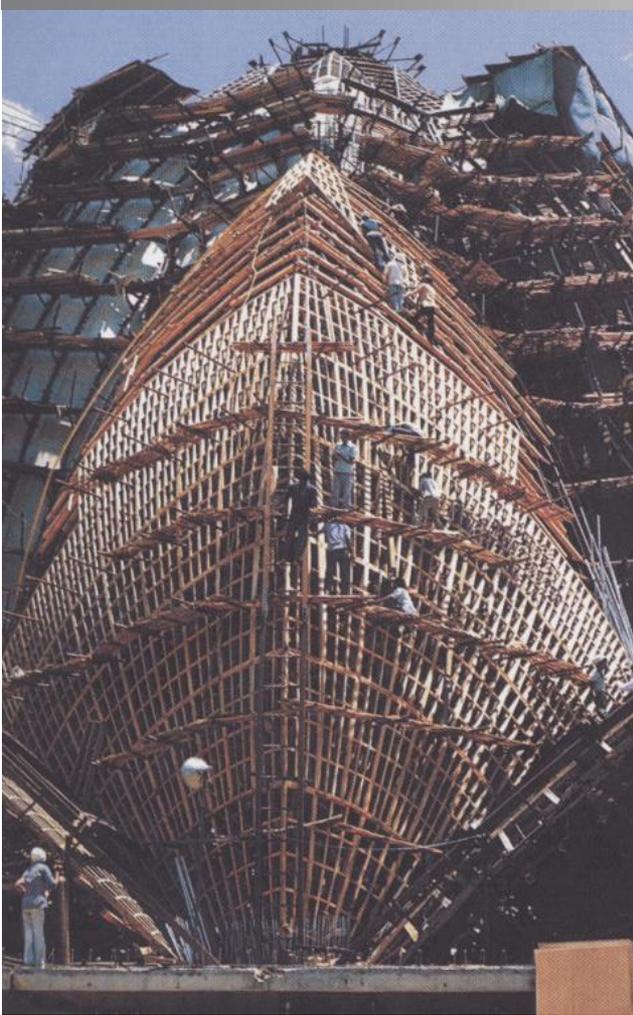
**Bahia Temple, Delhi, India (The National Spiritual Assembly of the Bahai's of India, 2002)**

## Introduction (General design) (6)



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## Introduction (General design) (7)



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## Introduction (General design) (8)



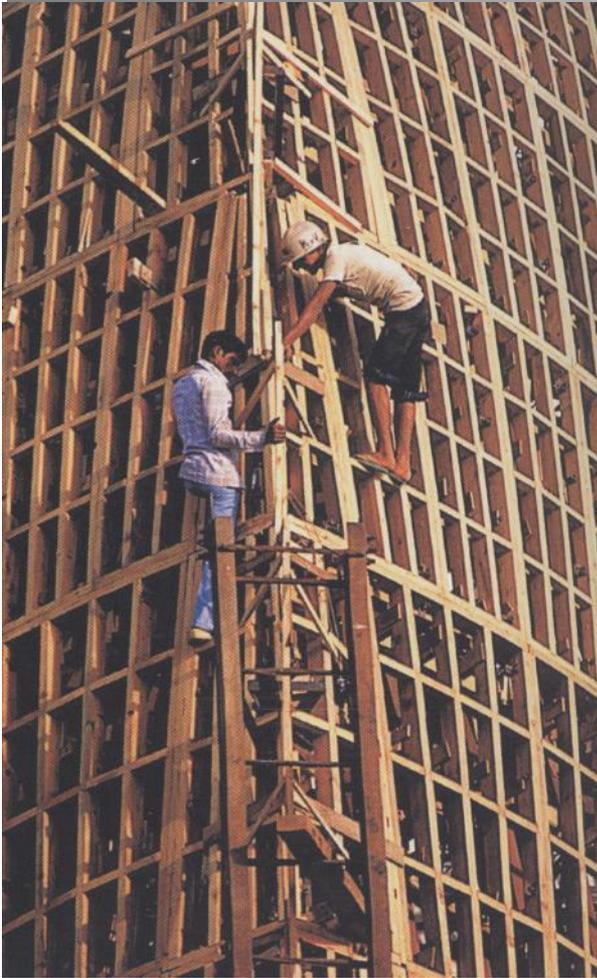
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## Introduction (General design) (9)



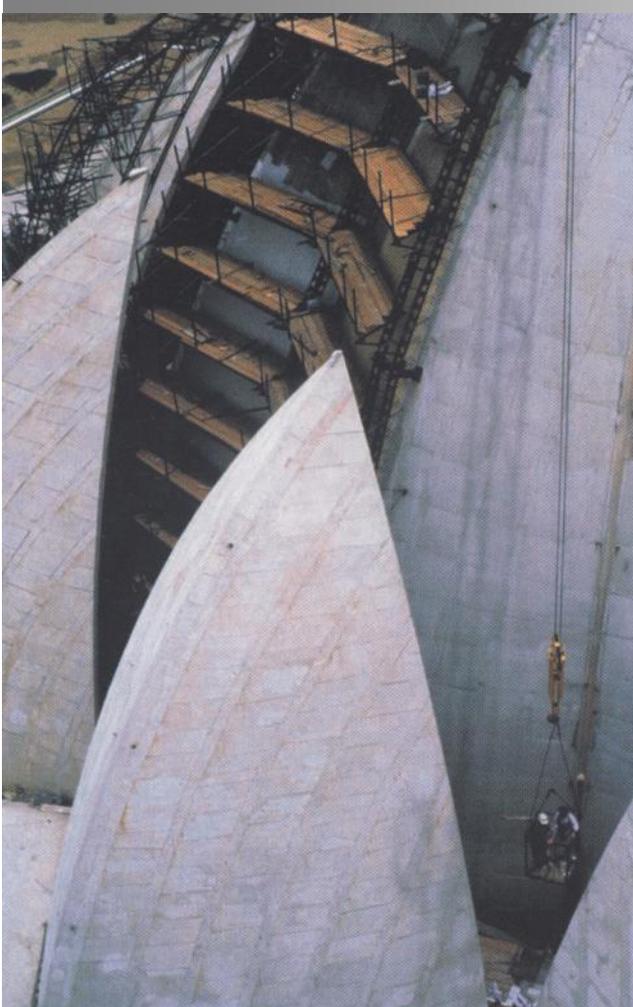
**Bahia Temple, Delhi, India (The National Spiritual Assembly of the Bahai's of India, 2002)**

# Introduction (General design) (10)



**Bahia Temple, Delhi, India (The National Spiritual Assembly of the Bahi'is of India, 2002)**

# Introduction (General design) (11)



**Bahia Temple, Delhi, India (The National Spiritual Assembly of the Bahai's of India, 2002)**

## Introduction (General design) (12)



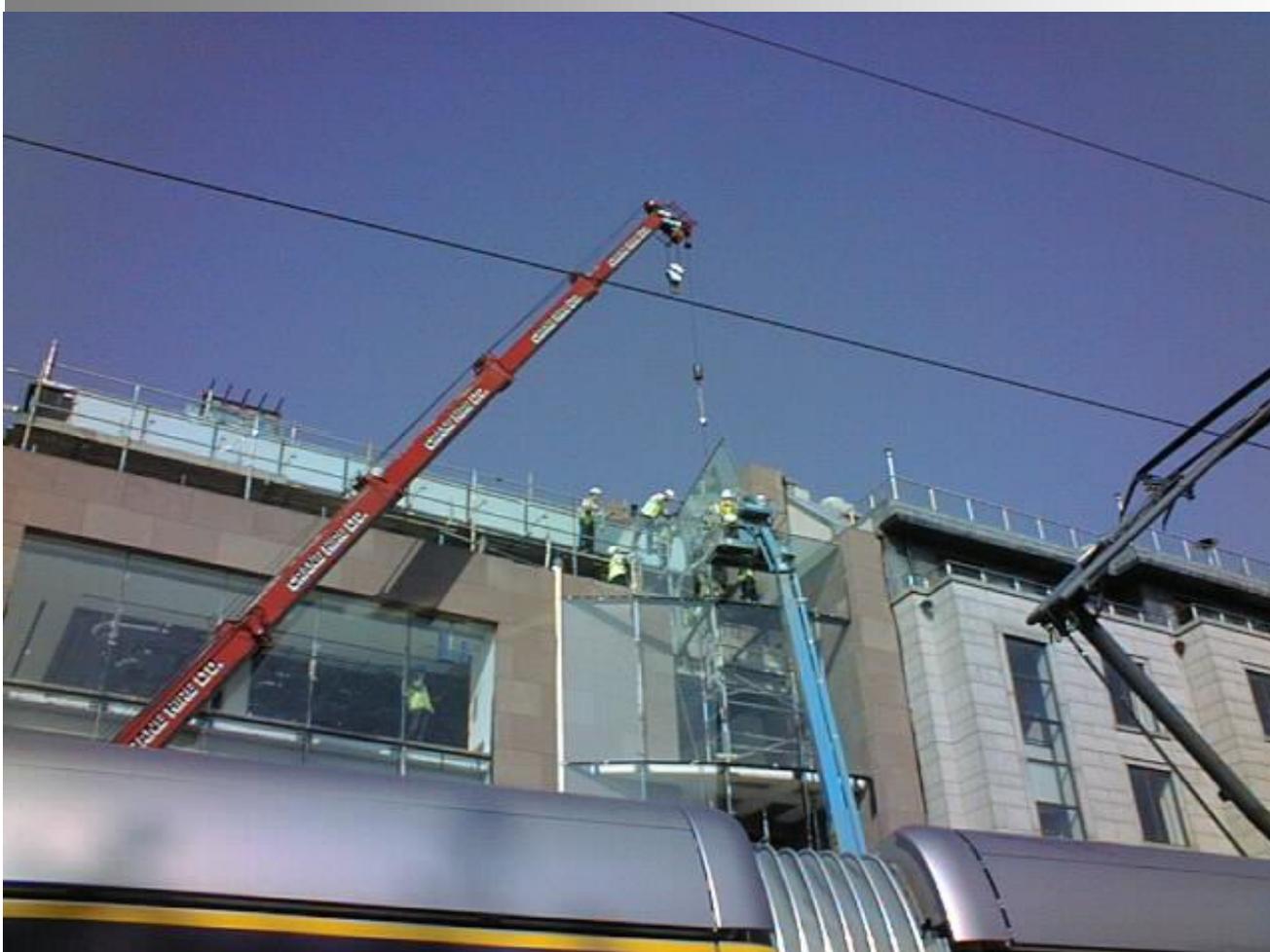
**Investec Office Complex scaffolding collapse, Sandton, August, 1997 (Prinsloo, 1997)**

## Introduction (Details) (13)



**Externally installed full fenestration, Dublin (Smallwood, 2004)**

## Introduction (Details) (14)



Externally installed full fenestration, Dublin (Smallwood, 2004)

# Introduction (Position of fittings) (15)



**Porte Cochere, Nelspruit Airport (Smallwood, 2004)**

## Introduction (Position of fittings) (16)



Light fittings, Porte Cochere, Nelspruit Airport (Smallwood, 2004)

## Introduction (17)

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- **Given the aforementioned, a study was conducted to interrogate ‘green’ building and construction H&S and ergonomics related issues, the specific objectives of the study being to:**
  - **investigate the need for ‘green’ building to address construction worker H&S and ergonomics**
  - **investigate the causes of construction workers becoming stressed**
  - **determine the frequency at which construction workers experience H&S and ergonomic problems**
  - **discover why workers experience WMSDs and what the effects are**

# The nature of construction and the implications

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- **Construction is one of the most hazardous industries due to the continuous utilisation of machinery and power tools, working on elevated work surfaces, manual handling of heavy materials, endlessly changing working environments, ever changing works to be completed, and constant changes in the composition of the workforce - all these factors expose the workers to unforeseen and unfamiliar hazards (Maiti, 2008)**

## Rands and Cents of H&S

- Based upon the value of construction work completed in the year 2002, namely R 56 343m (the total COA could have been between 4.3% (R 2 401.2m / R 56 343m), and 5.4% (R 3 041.5m / R 56 343m) [Smallwood, 2004 in Construction Industry Development Board (cidb), 2009]
- Recent study – 2010:
  - Members of the Association of Construction Health and Safety Management (ACHASM)
  - General Contractor (GC) members of the Kwazulu Natal Master Builders (KZNMB) that achieved places in the regional H&S competition

Cost type	Yes (%)		Mean (%)		
	ACHASM	KZNMB	ACHASM	KZNMB	Mean
Tender cost	38.9	66.7	2.0	1.6	1.8
Project cost	33.3	33.3	1.0	1.0	1.0

Table 1: Percentage H&S constitutes of tender cost and project cost

## **'Green' building issues (1)**

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- **Chen (2010) states that new technology which 'green' building presents can expose workers to the risk of falls from heights:**
  - **Skylights are not built to withstand heavy loads – risk of falls**
  - **Atriums – risk of falls**
  - **Falls from roofs while installing solar panels**
  - **Electrical hazards posed by wind turbines**
  - **Exposure to toxic materials used in insulation products, recycled materials, and solar panels**
  - **Recycling exposes workers to the risk of sprains, strains, punctures, slips, and falls**
- **Rajendran, Gambatese, & Behm (2009):**
  - **'Sustainable' building - sustainability of the building needs to be considered across the whole life-cycle**
  - **Industry's sustainability philosophy and principles should include construction worker H&S**

## **‘Green’ building issues (2)**

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- **Historically, ‘green’ rating systems have not addressed the H&S of construction workers (Center to Protect Workers’ Rights) (CPWR), 2011)**
- **Chen (2010) suggests four ways to protect workers’ health in the emerging sector of ‘green’ building:**
  - **Incorporate worker health into the debate over ‘green’ jobs**
  - **Promote prevention through design**
  - **Incorporate worker health into ‘green’ building certificate programmes**
  - **Promote construction H&S training**

# Research method

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- **BSc (Honours) (Construction Management) study (Sass, 2012)**
- **Two separate self-administered questionnaires:**
  - Contractor's - 12 questions
  - Architect's - 9 questions
- **Sample strata:**
  - 18 / 62 Medium and large sized general contractor members of the East Cape Master Builders Association (ECMBA) = 29% response rate
  - 21 / 95 East Cape Institute of Architects' members = 22.1% response rate
- **Descriptive statistics – frequencies and a measure of central tendency (MS)**

# Research findings (1)

Material / Substance	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
UV rays (sunlight)	4.95	1	4.76	3	4.86	1
Noise	4.85	2	4.82	2	4.84	2
Dusts e.g. brick or concrete	4.55	3	4.71	4	4.63	3
Heat / Cold	4.47	4	4.63	5	4.55	4
Cement mortar / plaster / screeds / Self-levelling screeds	4.25	5	4.82	2	4.54	5
Concrete	3.95	6	4.53	6	4.24	6
Handling treated wood	3.19	7	3.94	7	3.56	7
Paint / Paint finishes (solvent based)	3.16	8	3.59	8	3.37	8
Concrete additives e.g. retarders	2.93	9	2.73	11	2.83	9

**Table 2A: Frequency at which workers are exposed to certain materials / substances according to architects and GCs (MS = 1.00 to 5.00)**

## Research findings (2)

Material / Substance	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Sealants (joint)	2.71	10	2.94	9	2.83	10
Shutter oil	2.64	12	2.82	10	2.73	11
Insulation	2.71	11	2.33	14	2.52	12
Epoxies	2.36	15	2.50	12	2.43	13
Waterproofing (torch-on)	2.53	13	2.13	17	2.33	14
Welding	2.46	14	2.14	16	2.30	15
Bituminous coatings	2.25	17	2.33	14	2.29	16
Carpeting	2.06	18	2.29	15	2.17	17
Vinyl floor coverings	2.35	16	1.87	18	2.11	18
Mastic asphalt	1.90	20	1.55	19	1.72	19
Insecticide	2.00	19	1.21	20	1.61	20
Lead	1.83	21	1.07	21	1.45	21

**Table 2B: Frequency at which workers are exposed to certain materials / substances according to architects and GCs (MS = 1.00 to 5.00)**

## Research findings (3)

Factor	Response (%)						MS	Rank
	Un sure	Minor.....Major				5		
		1	2	3	4			
Job insecurity	5.6	5.6	0.0	16.7	38.9	33.3	4.00	1=
Unrealistic time for activities	5.6	0.0	11.1	16.7	27.8	38.9	4.00	1=
Hazardous work	16.7	0.0	11.1	16.7	38.9	16.7	3.73	3
Demanding construction activities / tasks	5.6	0.0	11.1	22.2	44.4	16.7	3.71	4
Poor remuneration	11.1	5.6	0.0	33.3	33.3	16.7	3.63	5
Incompetent staff	5.6	5.6	0.0	33.3	44.4	11.1	3.59	6
Long working hours	5.6	0.0	16.7	27.8	27.8	22.2	3.59	7
Unsafe and unhealthy sites	5.6	11.1	5.6	27.8	22.2	27.8	3.53	8
Lack of training	5.6	5.6	11.1	33.3	38.9	5.6	3.29	9
Unsatisfactory working conditions	5.6	0.0	22.2	33.3	33.3	5.6	3.24	10
Poor welfare facilities	16.7	0.0	22.2	38.9	5.6	16.7	3.20	11

**Table 3A: Extent to which various factors contribute to workers experiencing stress according to GCs (MS = 1.00 to 5.00)**

## Research findings (4)

Factor	Response (%)						MS	Rank
	Un sure	Minor.....Major				5		
		1	2	3	4			
Temperature	5.6	11.1	5.6	44.4	27.8	5.6	3.12	12
Travelling long distances	16.7	5.6	27.8	16.7	22.2	11.1	3.07	13
Poor illumination	11.1	5.6	11.1	44.4	27.8	0.0	3.06	14
Poor career opportunities	5.6	5.6	16.7	50.0	11.1	11.1	3.06	15
Temporary accommodation	16.7	0.0	22.2	38.9	22.2	0.0	3.00	16
Inadequate ventilation	16.7	11.1	22.2	22.2	22.2	5.6	2.87	17
Shift work	11.1	11.1	27.8	27.8	11.1	11.1	2.81	18
Excessive noise	11.1	16.7	16.7	33.3	11.1	11.1	2.81	19
Inadequate supervision	5.6	5.6	44.4	22.2	22.2	0.0	2.65	20
Repetitive construction activities / tasks	5.6	16.7	38.9	27.8	5.6	5.6	2.41	21
Lack of privacy	11.1	27.8	27.8	22.2	11.1	0.0	2.19	22

**Table 3B: Extent to which various factors contribute to workers experiencing stress according to GCs (MS = 1.00 to 5.00)**

## Research findings (5)

Problem	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Exposure to noise	4.75	1	4.76	1	4.76	1
Climbing / Descending	4.70	4	4.50	2	4.60	2
Bending and twisting	4.75	2	4.35	4	4.55	3
Repetitive motions	4.63	6	4.41	3	4.52	4
Handling heavy materials	4.68	5	4.13	5	4.40	5
Use of body force	4.72	3	3.64	8	4.18	6
Working in the same position for long periods of time	4.40	7	3.94	6	4.17	7
Handling heavy equipment	4.33	8	3.69	7	4.01	8
Overexertion in lifting	4.20	9	3.00	11	3.60	9
Psychosocial factors e.g. stress	4.08	10	3.00	11	3.54	10
Hand arm vibration	3.87	12	3.13	9	3.50	11
Working in awkward / cramped positions	3.65	13	3.00	11	3.32	12
Overexertion, except lifting	3.93	11	2.67	14	3.30	13
Whole body vibration	3.64	14	2.92	13	3.28	14
Working when injured or hurt	2.13	15	1.50	15	1.81	15

**Table 4: Frequency at which construction workers experience ergonomic problems according to architects and GCs (MS = 1.00 to 5.00)**

## Research findings (6)

Activity / Event / Material / Process	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Noise	4.84	2	4.82	1	4.83	1
Moving objects	4.95	1	4.63	3	4.79	2
Manual handling	4.84	3	4.65	2	4.74	3
Electricity	4.31	4	3.63	5	3.97	4
Working at heights	3.94	8	3.94	4	3.94	5
Vibration	4.18	5	3.56	6	3.87	6
Contact with moving machinery	4.17	6	3.35	8	3.76	7
Tripping	4.07	7	3.33	9	3.70	8
Cutting e.g. brick / concrete block pavers	3.58	9	3.56	7	3.57	9
Harmful substances	2.77	12	2.75	10	2.76	10
Being struck by mobile plant	2.91	10	1.94	12	2.42	11
Collapse e.g. excavations, structures	2.67	13	2.13	11	2.40	12
Fire	2.89	11	1.40	13	2.14	13

**Table 5: Frequency at which workers are exposed to / required to undertake certain activities / events / materials / processes according to architects and GCs (MS = 1.00 to 5.00)**

## Research findings (7)

Aspect	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Energy efficiency e.g. lighting & electricity	4.81	1	4.76	2	4.79	1
Water efficiency	4.62	5	4.88	1	4.75	2
Optimize site selection and structural design efficiency	4.71	2	4.65	4	4.68	3
Heating ventilation and air conditioning efficiency	4.67	4	4.44	8	4.55	4
Overall sustainability	4.57	7	4.50	6	4.54	5
Quality and durability	4.57	7	4.47	7	4.52	6
Indoor environmental quality	4.71	3	4.25	12	4.48	7
Waste and toxics reduction	4.26	9	4.69	3	4.48	8
Sustainable materials	4.33	8	4.35	10	4.34	9
Material efficiency	4.20	10	4.38	9	4.29	10
Operations and maintenance optimization	4.19	12	4.27	11	4.23	11
Sustainable landscape architecture	4.20	11	4.06	15	4.13	12
On-site power generation e.g. ground source heat pumps	3.52	16	4.56	5	4.04	13
Design for reuse and recycling	3.86	14	4.18	13	4.02	14
Noise reduction	3.90	13	4.13	14	4.01	15
Construction worker H&S	3.81	15	3.71	16	3.76	16

Table 6: Importance of certain aspects when designing a 'green' building according to architects and GCs (MS = 1.00 to 5.00)

## Research findings (8)

Type	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Green	4.45	1	4.07	1	4.26	1
Traditional	4.40	2	3.88	2	4.14	2

**Table 7: Importance of addressing the H&S of construction workers during the design of ‘traditional’ and ‘green’ buildings according to architects and GCs (MS = 1.00 to 5.00)**

Type	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Green	3.38	1	2.67	2	3.03	1
Traditional	2.86	2	2.69	1	2.77	2

**Table 8: Extent to which the design of ‘traditional’ and ‘green’ buildings address H&S of construction workers according to architects and GCs (MS = 1.00 to 5.00)**

Type	Architects		GCs		Mean	
	MS	Rank	MS	Rank	MS	Rank
Green	4.52	1	4.13	2	4.33	1
Traditional	4.43	2	4.13	2	4.28	2

**Table 9: Extent to which the design of ‘traditional’ and ‘green’ buildings should address the H&S of construction workers according to architects and GCs (MS = 1.00 to 5.00)**

## Conclusions (1)

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- **The construction industry is a very hazardous industry to work in**
- **Construction workers are exposed to many ergonomic and H&S hazards which can cause them to become ill, experience stress, experience WMSDs, experience injuries and in some cases death, and also be absent from work**
- **A range of stakeholders trigger and contribute to the factors which cause worker stress:**
  - **Job insecurity has its origins in the cyclical nature of construction and contract employment**
  - **Unrealistic time for activities and long working hours have their origins in project duration, which is prescribed by clients and the principal agent or project manager**

## Conclusions (2)

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- Hazardous work and demanding construction activities / tasks have their origins in lack of consideration for construction ergonomics and H&S by designers and poor work organisation
- Inadequate management is the cause of, inter alia, incompetent staff, unsafe and unhealthy sites, lack of training, unsatisfactory working conditions, and poor welfare facilities
- A range of stakeholders trigger and contribute to the existence of ergonomic hazards:
  - Ergonomic problems experienced by construction workers have their origins in design, the nature of the construction process and activities, and work organisation
- A range of stakeholders trigger and contribute to the exposure of workers to various activities / events / materials / processes:

## Conclusions (3)

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- Noise, moving objects, manual handling, electricity, working at heights, vibration, and cutting, as in the case of brick or concrete block pavers, have their origins in design, the nature of the construction process and activities, and work organisation
- Construction worker H&S is important to 'green' building, but it has yet to be afforded its deserved status:
  - 16 other aspects more important
- Need for focus on 'designing for construction ergonomics and H&S'

## Recommendations (1)

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- **Clients and principal agents and / or project managers should deliberate project duration to ensure that it is compatible with the nature, scope, volume, complexity, and monetary value of the works**
- **Need for focus on ‘designing for construction ergonomics and H&S’**
- **Designers should conduct design hazard identification and risk assessments (HIRAs) and consider construction worker ergonomics and H&S regardless of whether a project is ‘traditional’ or ‘green’:**
  - **Mass and density of materials**
  - **Work at elevated heights**

## Recommendations (2)

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- **Green Building Councils and sustainable building systems should include construction ergonomics and H&S as a criterion for inclusion in the assessment of ‘green’ building status**
- **Subsequent to the study:**
  - **Green Building Council South Africa (GBCSA) established a Socio-Economic Technical Working Group in 2012**
  - **Lead to the establishment of a Socio-Economic category for Green Star SA and other rating tools**
  - **H&S is one of seven credits**
  - **GBCSA has set a precedent by recognizing H&S in terms of sustainability and real ‘green’ building and the construction thereof**

## Recommendations (3)

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- **Contractors should:**
  - **Include stress and ergonomics in construction H&S programmes**
  - **Be conscious and mindful of ergonomic hazards when conducting construction HIRAs**

## References (1)

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