WOMEN IN CONSTRUCTION 2012

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WOMEN, CONSTRUCTION, ERGONOMICS AND HEALTH AND SAFETY

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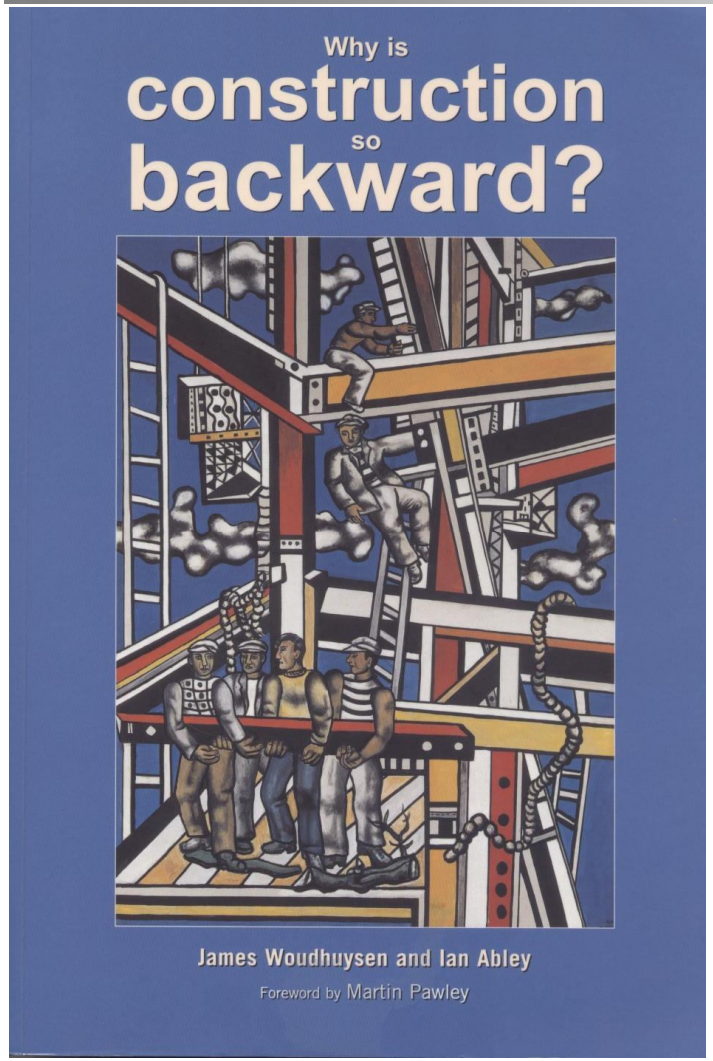
Why is construction so backward?



(Woudhysen and Abley, 2004)

Introduction (1)

Ergonomics, derived from the Greek ergon, ‘to work’, and nomos, ‘study of’, is literally the study of work, or the work system, including the worker, his or her tools, and his or her workplace (La Dou, 1994) - “it 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.”

Introduction (2)

- Health is defined as “The degree of physiological and psychological well being of an individual.” and safety as both “The state of being safe: freedom from injury or danger.” and “The quality of insuring against hurt, injury, danger or risk.” (Taylor, Easter and Hegney, 1998)
- 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 (Schneider and Susi, 1994)
- Numerous construction tasks pose significant ergonomic & H&S risks to workers (Gibbons and Hecker, 1999)

Introduction (3)

Figure 1: Construction H&S – the macro environment (Smallwood, 1995)

Introduction (4)

Pretoria North Shopping Centre slab collapse, October, 1996 (Davis, 1996)

Introduction (5)

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

Introduction (6)

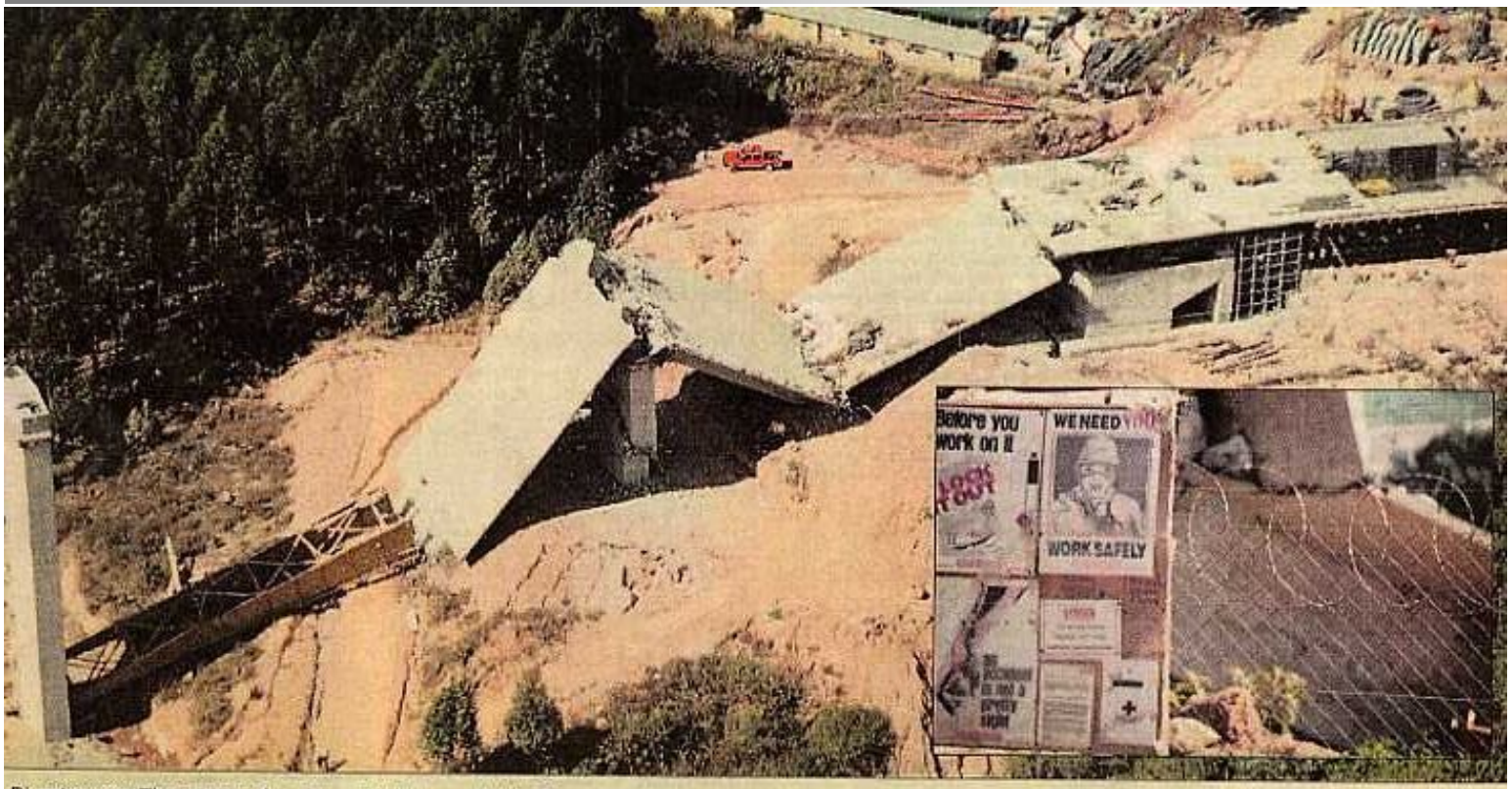
Investec Office Complex scaffolding collapse, Sandton, August, 1997 (Prinsloo, 1997)

Introduction (7)

Sombre ... workers survey the scene yesterday at the Investec building where they say heavy marble tiles caused an overload.

Investec Office Complex scaffolding collapse, Sandton, August, 1997 (Nesbitt, 1997)

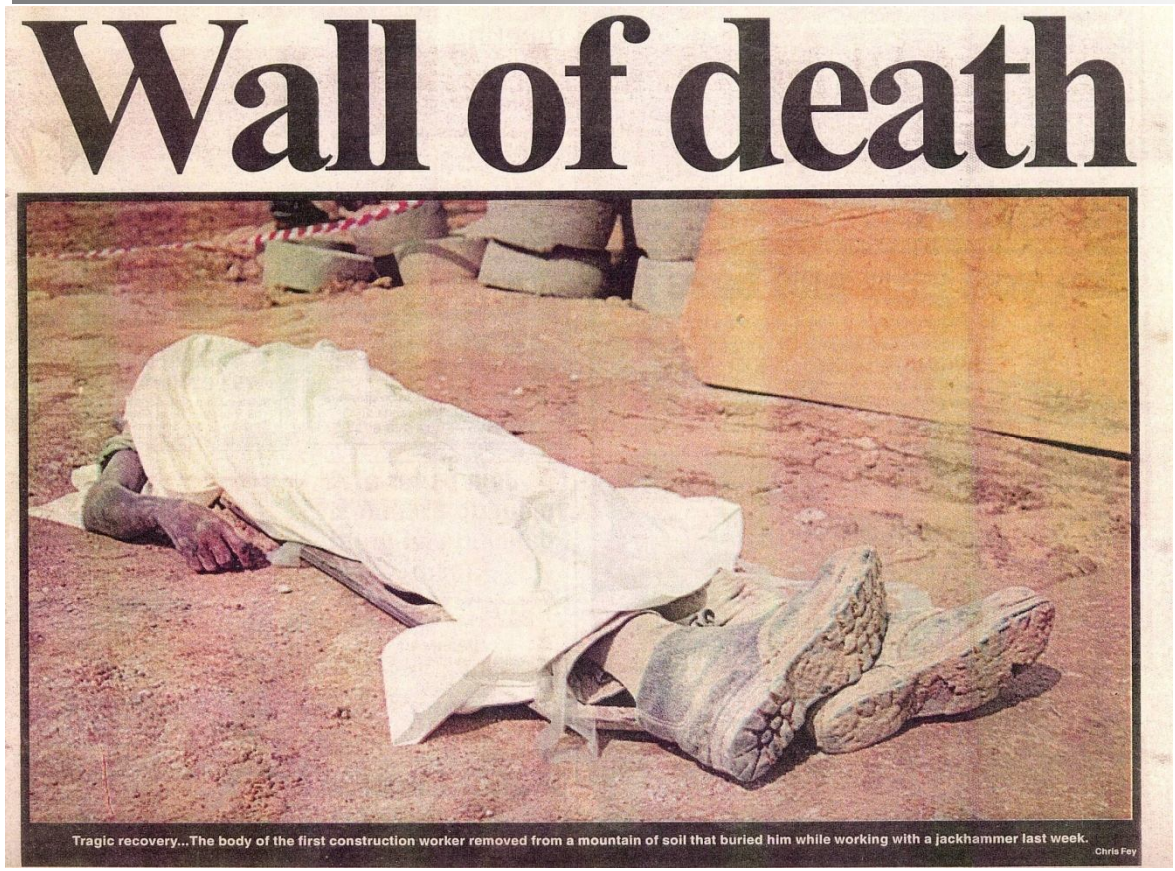
Introduction (8)



Disaster area: The construction of a road bridge near Injaka Dam turned into disaster when it collapsed, instantly killing 12 people and injuring 15. Two of the injured died later. Insert - A reminder to workers of the dangers of working on a construction site. Full update on page 2. **Photographs by Raymond Travers.**

Injaka Bridge collapse, Mpumalanga, July, 1998 (Travers,1998)

Introduction (9)


Wall of death

Tragic recovery...The body of the first construction worker removed from a mountain of soil that buried him while working with a jackhammer last week.

Chris Fey

Wall (earth) collapse, Randburg, February, 1999 (Frey, 1999)

Introduction (10)

Suspended platform (scaffold) collapse, Hillbrow, February, 2001 (Safodien, 2001)

Respect for people (Lack of) (1)

Contents of portable toilet, Humansdorp (Pierce-Jones, 2006)

Respect for people (Lack of) (2)

Contents of portable toilet, SEP (Smallwood, 2007)

Respect for people (1)

Workers change room, shower, and lockers, Max 4 project, Lund, Sweden (Smallwood, August 2012)

Respect for people (2)

Workers' mess area, Max 4 project, Lund, Sweden (Smallwood, August 2012)

Nature of ergonomic problems

Problem	GC*		Worker*		Worker**		BPGC***		Mean	
	II	Rank	II	Rank	II	Rank	II	Rank	II	Rank
Repetitive movements	3.29	1	3.56	1	2.97	3	3.78	1	3.40	1
Climbing and descending	2.88	2	3.01	4	3.23	1	3.56	2	3.17	2
Handling heavy materials	2.63	4=	2.68	10=	3.00	2	3.44	3	2.94	3
Use of body force	2.80	3	2.82	8	2.77	5	3.00	9	2.85	4
Exposure to noise	2.53	7	2.93	6	2.65	6	3.11	6=	2.81	5
Bending or twisting the back	1.96	11	3.47	2	2.38	7	3.22	4=	2.76	6
Reaching overhead	2.61	6	2.99	5	2.00	13	3.11	6=	2.68	7
Reaching away from the body	2.41	8	3.19	3	2.03	12	2.63	12	2.57	8
Working in awkward positions	1.70	12	2.85	7	2.30	9	3.22	4=	2.52	9
Handling heavy equipment	2.03	10	2.17	13	2.87	4	2.78	10	2.46	10
Working in hot conditions	2.29	9	2.68	10=	2.15	10	2.33	13	2.36	11
Vibrating tools and equipment	2.63	4=	1.43	16	1.96	14	3.11	6=	2.28	12
Working in cramped positions	1.46	15	2.48	12	2.13	11	2.67	11	2.19	13
Staying in the same position for long periods	1.29	17	2.76	9	2.30	8	2.11	14	2.12	14
Working in humid conditions	1.60	13	1.53	15	1.66	17	1.89	15	1.67	15
Working in cold conditions	1.38	16	1.80	14	1.85	15	1.22	17	1.56	16
Working in wet conditions	1.57	14	1.21	17	1.70	16	1.67	16	1.54	17
Working while injured or hurt	0.19	18	0.84	18	0.48	18	0.44	18	0.49	18

Table 1: Frequency of ergonomic problems encountered in construction according to management and workers (adapted from Smallwood, 1997*; Smallwood, Deacon and Venter, 2000; Smallwood, 2002***) (II = 0-4).**

Improving construction ergonomics (1)

Aspect	Response (%)						MS	Rank
	Unsure	Minor…… Major						
		1	2	3	4	5		
Contractor planning	0.0	0.0	0.0	12.1	21.2	66.7	4.55	1=
Safe working procedures	0.0	0.0	0.0	12.1	21.2	66.7	4.55	1=
Constructability (general)	3.0	0.0	0.0	9.1	27.3	60.6	4.53	3
Awareness	0.0	0.0	0.0	9.1	30.3	60.6	4.52	4
Mechanisation	0.0	0.0	0.0	12.1	30.3	57.6	4.45	5
Workshops on site	0.0	0.0	0.0	12.1	33.3	54.5	4.42	6
Prefabrication	3.0	0.0	3.0	21.2	15.2	57.6	4.31	7
Design of equipment (construction)	0.0	3.0	0.0	12.1	33.3	51.5	4.30	8
Design of tools	0.0	6.1	0.0	12.1	24.2	57.6	4.27	9
General design	3.0	3.0	3.0	6.1	42.4	42.4	4.22	10
Reengineering	3.0	0.0	0.0	15.2	48.5	33.3	4.19	11
Specification	3.0	6.1	0.0	12.1	39.4	39.4	4.09	12
Details	3.0	6.1	3.0	9.1	42.4	36.4	4.03	13

Table 2: Extent to which aspects could contribute to an improvement in construction ergonomics (Smallwood, 2006a) (MS = 1-5).

Improving construction ergonomics (2)

Aspect	Management		Workers		Mean	
	Yes (%)	Rank	Yes (%)	Rank	Yes (%)	Rank
Materials handling	78.8	3=	76.3	1	77.6	1
Working platforms	81.7	2	70.5	3	76.1	2
Housekeeping	78.8	3=	70.8	2	74.8	3
Means of ascending / Descending	83.8	1	65.6	5=	74.7	4
Materials storage	74.1	5	69.7	4	71.9	5
Walkways	71.8	6	65.6	5=	68.7	6
Mechanisation	64.9	7	50.4	7	57.7	7
Circulation paths	53.2	8	41.3	8	47.3	8
Circulation roads	51.3	9	37.2	9	44.3	9

Table 3: Construction ergonomic related aspects which require attention according to management and workers (adapted from Smallwood, 1997).

Improving construction ergonomics (3)

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

Improving construction ergonomics (4)

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

Improving construction ergonomics (5)

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

Improving construction ergonomics (6)

Precast concrete stair flights, Port Elizabeth (Smallwood)

Improving construction ergonomics (7)

Precast concrete stair flights, Port Elizabeth (Smallwood)

Factors which affect wellness and performance on site

A survey of 32 workers (Smallwood, 2006b) – agreement that:

- **Overall project performance is affected by: site offices; entrance; housekeeping; major plant; organisation of work area; location of site, and site coverage of building / space for site establishment**
- **Wellness of people is affected by: ablutions; materials store; noise; major plant; type of building; lighting levels; temperature; location of site; housekeeping; organisation of work area; height of building; circulation paths; type of site hoarding, and site coverage of building / space for site establishment**

Research 1 – Methodology and sample stratum

- Objectives of the study being to determine the:
  - Frequency at which ergonomics problems are encountered
  - Suitability of various aspects which affect performance and wellness on site
  - Extent to which various activities and interventions could contribute to an improvement in construction ergonomics
  - Gender differences relative to the abovementioned
- GC's production workers – primarily carpenters:
  - 14 Female
  - 12 Male
- MS: 1.00 = Unsuitable / Minor and 5.00 = Suitable / Major

Research 1 – Findings (1)

Activities	Unsure	Minor……Major					Mean score	Rank
		1	2	3	4	5		
Handling heavy materials	0.0	7.7	7.7	15.4	38.5	30.8	3.77	1
Handling heavy equipment	0.0	14.3	0.0	21.4	28.6	35.7	3.71	2
Exposure to noise	0.0	0.0	16.7	33.3	16.7	33.3	3.67	3
Working in cold conditions	7.1	7.1	14.3	14.3	21.4	35.7	3.43	4
Working in awkward positions	0.0	21.4	0.0	28.6	28.6	21.4	3.29	5
Working in humid conditions	7.1	0.0	21.4	35.7	7.1	28.6	3.21	6
Staying in the same position for long periods	0.0	21.4	7.1	35.7	14.3	21.4	3.07	7
Working in wet conditions	7.1	14.3	7.1	28.6	21.4	21.4	3.07	8
Working in hot conditions	7.1	14.3	7.1	28.6	28.6	14.3	3.00	9
Working while hurt or injured	14.3	14.3	7.1	14.3	21.4	28.6	3.00	10
Use of body force	7.1	14.3	21.4	21.4	7.1	28.6	2.93	11
Bending or twisting the back	0.0	21.4	21.4	14.3	35.7	7.1	2.86	12
Working in cramped positions	7.1	21.4	7.1	21.4	28.6	14.3	2.86	13
Vibrating tools and equipment	0.0	14.3	28.6	35.7	7.1	14.3	2.79	14
Repetitive movements	0.0	15.4	38.5	23.1	7.7	15.4	2.69	15
Climbing and descending	7.7	7.7	38.5	15.4	23.1	7.7	2.62	16
Reaching overhead	0.0	23.1	38.5	23.1	7.7	7.7	2.38	17
Reaching away from the body	7.1	35.7	21.4	14.3	21.4	0.0	2.07	18

Table 4: Extent to which activities constitute an ergonomics problem (Female) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (2)

Activities	Unsure	Minor…….Major					Mean score	Rank
		1	2	3	4	5		
Working while hurt or injured	0.0	16.7	16.7	8.3	16.7	41.7	3.50	1
Handling heavy materials	0.0	8.3	16.7	25.0	50.0	0.0	3.17	2
Exposure to noise	0.0	16.7	25.0	33.3	16.7	8.3	2.75	3
Handling heavy equipment	0.0	9.1	27.3	45.5	18.2	0.0	2.73	4
Working in wet conditions	0.0	16.7	16.7	50.0	16.7	0.0	2.67	5
Working in cramped positions	0.0	25.0	16.7	33.3	25.0	0.0	2.58	6
Working in awkward positions	0.0	25.0	25.0	25.0	16.7	8.3	2.58	7
Staying in the same position for long periods	0.0	33.3	16.7	8.3	41.7	0.0	2.58	8
Bending or twisting the back	0.0	25.0	25.0	33.3	16.7	0.0	2.42	9
Working in cold conditions	0.0	25.0	25.0	41.7	8.3	0.0	2.33	10
Working in hot conditions	0.0	25.0	33.3	33.3	0.0	8.3	2.33	11
Reaching overhead	0.0	25.0	33.3	33.3	8.3	0.0	2.25	12
Reaching away from the body	0.0	25.0	50.0	16.7	8.3	0.0	2.08	13
Working in humid conditions	0.0	33.3	33.3	25.0	8.3	0.0	2.08	14
Use of body force	8.3	33.3	16.7	33.3	0.0	8.3	2.08	15
Repetitive movements	0.0	41.7	25.0	25.0	8.3	0.0	2.00	16
Vibrating tools and equipment	0.0	50.0	25.0	8.3	8.3	8.3	2.00	17
Climbing and descending	0.0	54.5	9.1	18.2	18.2	0.0	2.00	18

Table 5: Extent to which activities constitute an ergonomics problem (Male) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (3)

Activities	Female		Male		Mean		Diff
	MS	Rank	MS	Rank	MS	Rank	
Working in humid conditions	3.21	6	2.08	14	2.65	11	1.13
Working in cold conditions	3.43	4	2.33	10	2.88	6	1.10
Handling heavy equipment	3.71	2	2.73	4	3.22	3	0.98
Exposure to noise	3.67	3	2.75	3	3.21	4	0.92
Use of body force	2.93	11	2.08	15	2.50	13	0.85
Vibrating tools and equipment	2.79	14	2.00	17	2.39	14	0.79
Working in awkward positions	3.29	5	2.58	7	2.93	5	0.71
Repetitive movements	2.69	15	2.00	16	2.35	15	0.69
Working in hot conditions	3.00	9	2.33	11	2.67	10	0.67
Climbing and descending	2.62	16	2.00	18	2.31	17	0.62
Handling heavy materials	3.77	1	3.17	2	3.47	1	0.60
Staying in the same position for long periods	3.07	7	2.58	8	2.83	8	0.49
Bending or twisting the back	2.86	12	2.42	9	2.64	12	0.44
Working in wet conditions	3.07	8	2.67	5	2.87	7	0.40
Working in cramped positions	2.86	13	2.58	6	2.72	9	0.28
Reaching overhead	2.38	17	2.25	12	2.32	16	0.13
Reaching away from the body	2.07	18	2.08	13	2.08	18	-0.01
Working while hurt or injured	3.00	10	3.50	1	3.25	2	-0.50

Table 6: Extent to which activities constitute an ergonomics problem (Comparison of female and male) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (4)

Aspect	Unsure	Unsuitable……Suitable					Mean score	Rank
		1	2	3	4	5		
Attire (Work clothing)	0.0	0.0	0.0	15.4	23.1	61.5	4.46	1
Personal protective equipment (PPE)	0.0	0.0	0.0	21.4	28.6	50.0	4.29	2
Housekeeping	0.0	0.0	0.0	35.7	28.6	35.7	4.00	3
Plant	0.0	0.0	21.4	7.1	50.0	21.4	3.71	4
Equipment	0.0	0.0	7.7	38.5	30.8	23.1	3.69	5
Vertical access	7.7	7.7	0.0	23.1	23.1	38.5	3.62	6
Work / Access platforms	0.0	15.4	7.7	15.4	23.1	38.5	3.62	7
Organisation of work area	0.0	16.7	8.3	8.3	41.7	25.0	3.50	8
Site layout	7.1	14.3	0.0	35.7	7.1	35.7	3.29	9
Materials storage	0.0	14.3	14.3	14.3	50.0	7.1	3.21	10
Tools	14.3	0.0	7.1	28.6	35.7	14.3	3.14	11
Circulation paths	0.0	16.7	8.3	41.7	25.0	8.3	3.00	12
Toilet facilities	0.0	35.7	14.3	21.4	7.1	21.4	2.64	13
Lighting	0.0	23.1	30.8	15.4	23.1	7.7	2.62	14
Change room facilities	0.0	38.5	15.4	30.8	7.7	7.7	2.31	15
Canteen / Mess room	14.3	35.7	14.3	7.1	21.4	7.1	2.07	16
Wash facilities	7.7	53.8	7.7	15.4	7.7	7.7	1.85	17

Table 7: Suitability of various aspects (Female) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (5)

Aspect	Unsure	Unsuitable……..Suitable					Mean score	Rank
		1	2	3	4	5		
Personal protective equipment (PPE)	0.0	0.0	8.3	16.7	25.0	50.0	4.17	1
Attire (Work clothing)	0.0	0.0	8.3	25.0	25.0	41.7	4.00	2
Lighting	0.0	0.0	0.0	33.3	41.7	25.0	3.92	3
Materials storage	0.0	0.0	8.3	16.7	50.0	25.0	3.92	4
Housekeeping	0.0	0.0	8.3	25.0	41.7	25.0	3.83	5
Tools	0.0	0.0	16.7	8.3	50.0	25.0	3.83	6
Site layout	0.0	8.3	0.0	25.0	41.7	25.0	3.75	7
Organisation of work area	0.0	0.0	25.0	8.3	33.3	33.3	3.75	8
Equipment	0.0	0.0	8.3	25.0	58.3	8.3	3.67	9
Plant	0.0	0.0	16.7	16.7	58.3	8.3	3.58	10
Vertical access	0.0	0.0	18.2	18.2	54.5	9.1	3.55	11
Work / Access platforms	0.0	0.0	16.7	41.7	33.3	8.3	3.33	12
Circulation paths	0.0	0.0	0.0	75.0	25.0	0.0	3.25	13
Canteen / Mess room	0.0	25.0	25.0	8.3	25.0	16.7	2.83	14
Toilet facilities	0.0	18.2	36.4	9.1	18.2	18.2	2.82	15
Change room facilities	0.0	16.7	25.0	33.3	16.7	8.3	2.75	16
Wash facilities	8.3	25.0	25.0	25.0	8.3	8.3	2.25	17

Table 8: Suitability of various aspects (Male) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (6)

Aspect	Female		Male		Mean		Diff
	MS	Rank	MS	Rank	MS	Rank	
Lighting	2.62	14	3.92	3	3.27	12	-1.30
Canteen / Mess room	2.07	16	2.83	14	2.45	16	-0.76
Materials storage	3.21	10	3.92	4	3.57	8	-0.71
Tools	3.14	11	3.83	6	3.49	10	-0.69
Site layout	3.29	9	3.75	7	3.52	9	-0.46
Change room facilities	2.31	15	2.75	16	2.53	15	-0.44
Wash facilities	1.85	17	2.25	17	2.05	17	-0.40
Organisation of work area	3.50	8	3.75	8	3.63	6	-0.25
Circulation paths	3.00	12	3.25	13	3.13	13	-0.25
Toilet facilities	2.64	13	2.82	15	2.73	14	-0.18
Equipment	3.69	5	3.67	9	3.68	4	0.02
Vertical access	3.62	6	3.55	11	3.58	7	0.07
Personal protective equipment (PPE)	4.29	2	4.17	1	4.23	1	0.12
Plant	3.71	4	3.58	10	3.65	5	0.13
Housekeeping	4.00	3	3.83	5	3.92	3	0.17
Work / Access platforms	3.62	7	3.33	12	3.47	11	0.29
Attire (Work clothing)	4.46	1	4.00	2	4.23	2	0.46

Table 9: Suitability of various aspects (Comparison of female and male) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (7)

Activities	Unsure	Minor…….. Major					Mean score	Rank
		1	2	3	4	5		
Mechanisation (use of machines)	14.3	0.0	0.0	21.4	21.4	42.9	4.25	1
Less manual handling (lifting and carrying)	0.0	0.0	0.0	28.6	35.7	35.7	4.07	2
Lighter materials (bending and lifting)	0.0	0.0	7.1	28.6	28.6	35.7	3.93	3
More help (extra hands)	7.1	0.0	7.1	42.9	21.4	21.4	3.62	4
Task rotation (shorter shifts)	14.3	7.1	0.0	35.7	21.4	21.4	3.58	5
Less climbing	0.0	7.1	14.3	28.6	28.6	21.4	3.43	6
Less walking	0.0	14.3	28.6	28.6	14.3	14.3	2.86	7

Table 10: Extent to which actions / interventions would make respondents' working life easier (Female) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 1 – Findings (7)

Activities	Unsure	Minor……Major					Mean score	Rank
		1	2	3	4	5		
Mechanisation (use of machines)	0.0	25.0	8.3	0.0	16.7	50.0	3.58	1
Lighter materials (bending and lifting)	0.0	25.0	0.0	16.7	16.7	41.7	3.50	2
Less manual handling (lifting and carrying)	0.0	33.3	0.0	25.0	25.0	16.7	2.92	3
More help (extra hands)	0.0	33.3	8.3	16.7	25.0	16.7	2.83	4
Less climbing	0.0	33.3	16.7	16.7	25.0	8.3	2.58	5
Task rotation (shorter shifts)	0.0	33.3	8.3	50.0	8.3	0.0	2.33	6
Less walking	0.0	33.3	33.3	8.3	25.0	0.0	2.25	7

Table 11: Extent to which actions / interventions would make respondents' working life easier (Male) (Smallwood and Haupt, 2009) (MS = 1-5).

Research 2 – Methodology and sample stratum

- Objectives of the study being to determine the:
  - Participation of women in general;
  - Their role;
  - Their capacity;
  - Their impact;
  - Their potential contribution;
  - Barriers to their participation;
  - General and gender specific issues, and
  - Engendering of their participation.
- Multi-stakeholder respondents attending a two-day seminar and a four-day programme:
  - South Africa – 37 No. (81.1% male and 18.9% female)
  - Tanzania – 23 / 24 No. (82.6% male and 17.4% female)
- MS: 1.00 = Strongly disagree and 5.00 = Strongly agree

Research 2 – Findings (1)

Statement	Mean score		
	South Africa	Tanzania	Mean
Women have a role to play in construction	4.31	4.27	4.30
Increased participation by women will contribute to improving the image of construction	4.14	4.16	4.15
Women are likely to be sexually harassed on site	3.90	4.09	4.00
Women are not respected to the same extent men are	4.07	3.70	3.89
Current welfare facilities for women are inadequate	3.74	3.90	3.82
Women have 'special' personal hygiene issues / requirements	3.53	3.95	3.74
Some construction materials present a manual materials handling problem to women	3.35	3.71	3.53
Mechanisation of the construction process will promote participation by women	3.55	3.50	3.53
Women are less likely to accept unsafe conditions than men	3.52	3.50	3.51
Older (> 40 years) women are less suited to the physical construction process than men of the same age	3.13	3.70	3.42
Women are not as physically capable as men	3.07	3.48	3.28

Table 12: Comparison of 'overall' South African and Tanzanian degree of concurrence (English, Haupt, and Smallwood, 2006) (MS = 1-5) (Part A).

Research 2 – Findings (2)

Statement	Mean score		
	South Africa	Tanzania	Mean
Some construction materials present a manual materials handling problem to men	3.03	3.38	3.21
Women are less likely to accept inadequate welfare facilities than men	3.13	3.29	3.21
Appropriate work attire is not readily available for women	2.69	3.32	3.01
Women are as physically capable as men	3.07	2.74	2.91
Current provision for vertical movement (access) on site is inappropriate for women	2.32	3.43	2.88
Women are less likely to be willing to work in extreme temperatures than men	2.33	3.20	2.77
Ultra violet radiation poses more of a threat to women than to men	2.71	2.60	2.66
Women are more suited to administrative than production functions on site	1.89	3.17	2.53
Generally personal protective equipment (PPE) is not suited to women	2.43	2.45	2.44
Transport to and from, and between sites is inappropriate for women	2.29	2.57	2.43
Women are more likely to be absent from work than men	1.88	2.90	2.39

Table 12: Comparison of 'overall' South African and Tanzanian degree of concurrence (English, Haupt, and Smallwood, 2006) (MS = 1-5) (Part B).

Conclusions

- Certain construction activities constitute more of an ergonomic problem than others
- Construction activities constitute more of an ergonomics problem to females than males
- Females find many work related aspects less suitable than males
- Welfare facilities are not deemed suitable by both females and males
- Certain activities / interventions would make females' and males' working lives easier, however, more so relative to females

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