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ACHASM 'CLIENT LEAD CONSTRUCTION H&S' SYMPOSIUM

CAPE TOWN
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DESIGNING FOR H&S: LINKING CLIENTS, HIRAS, AND THE H&S SPECIFICATION

PROF JOHN SMALLWOOD

DEPARTMENT OF CONSTRUCTION MANAGEMENT,
NELSON MANDELA METROPOLITAN UNIVERSITY, SOUTH AFRICA
PRINCIPAL
CONSTRUCTION RESEARCH EDUCATION AND TRAINING ENTERPRISES (CREATE)

Introduction (1)

- Design occurs upstream of construction
- Designers are a construction industry stakeholder
- Designers advise clients
- Architectural designers often set the parameters for civil, electrical, interior, landscape, mechanical, and structural designers
- Designers have a legal and moral responsibility

Introduction (2)

Construction H&S occurs in a macro environment:

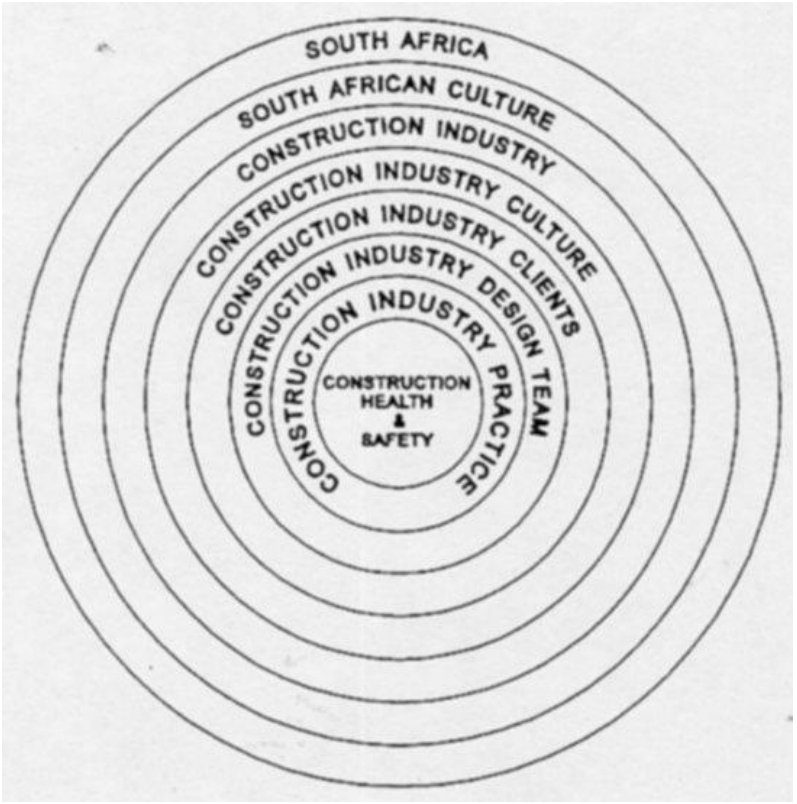
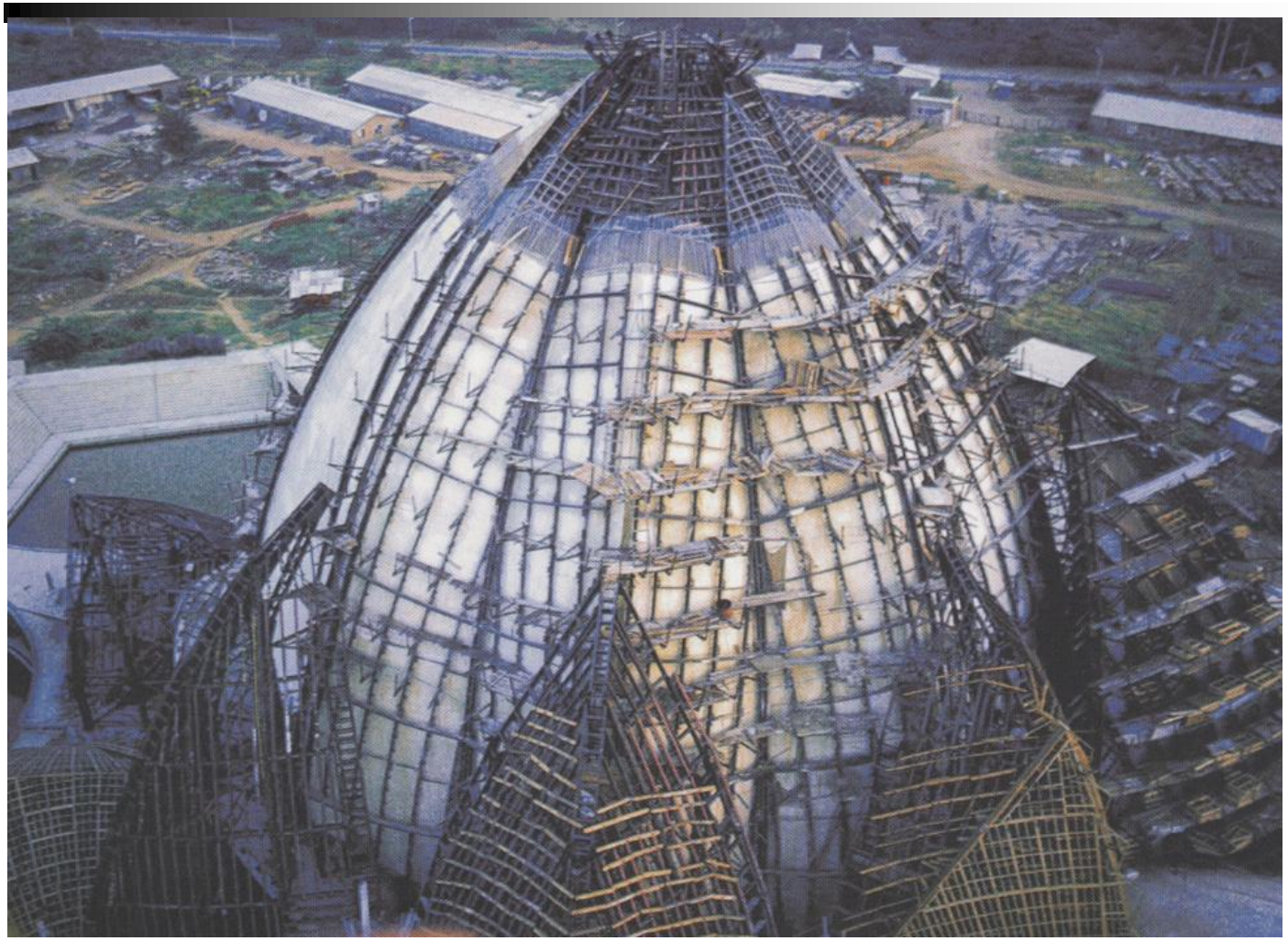


Figure 1: Construction H&S – the macro environment (Smallwood, 1995)

General design (1)

Bahia Temple, Delhi, India (Smallwood, 2005)

General design (2)

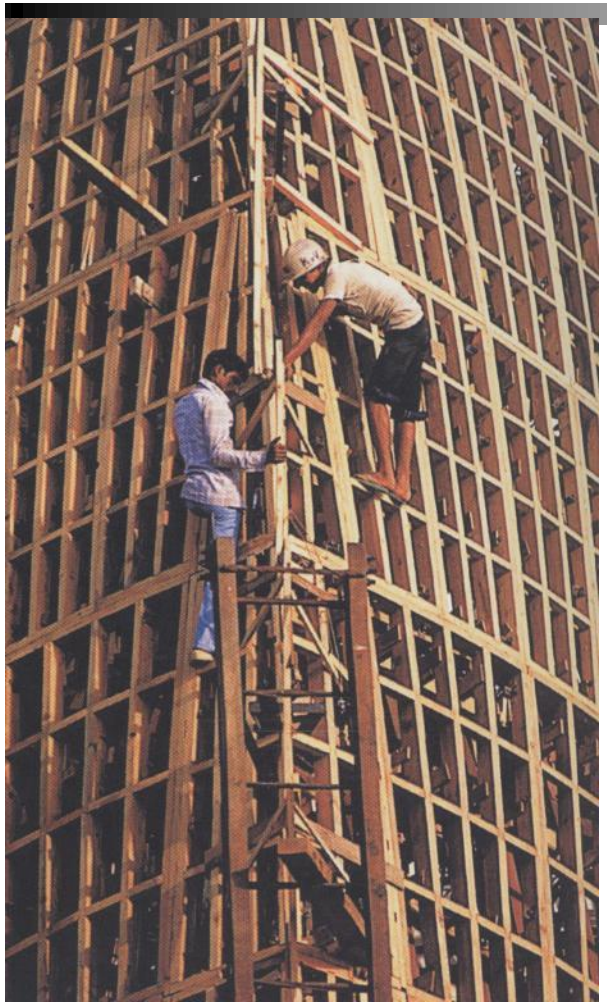


Bahia Temple, Delhi, India (The National Spiritual Assembly of the Bahia'is of India, 2002)

General design (3)

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

General design (4)



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

Designing for ergonomics and H&S (1)

Precast concrete stair flights, Port Elizabeth (Smallwood)

Designing for ergonomics and H&S (2)

Precast concrete stair flights, Port Elizabeth (Smallwood)

Construction Regulations (1)

- Clients required to:
  - 4 (1) (a) Prepare and provide Principal Contractor with H&S specifications (PM, designer, and QS input)
  - 4 (1) (b) Provide PC with any information that may affect H&S (PM, designer, and QS input)
  - 4 (1) (f) Provide sufficient H&S information when changes made to design and construction (PM and designer input)
  - 4 (1) (h) Ensure that PCs have made provision for the cost of H&S in their tenders (PM, designer, and QS input)
  - 4 (2) Discuss contents and approve H&S plan (PM, designer, and QS input)
- Clients may:
  - 4 (5) Appoint an agent in terms of the responsibilities, but in terms of 4 (6) must be competent and have the resources

Construction Regulations (2)

Relative to Structures 9 (2) designers are required to:

- (a) Provide clients with all relevant information that may affect the pricing of the work
- (b) Inform Principal Contractors (PCs) of any dangers or hazards and provide information for the safe construction of the design (H&S Specification)
- (c) Include a geo-science technical report, the design loading of the structure, and the methods and sequence of construction in a report made available to the PC
- (d) 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 (if not then include in the H&S Specification)
- (e) Consider H&S during maintenance subsequent to the completion of the project

Construction Regulations (3)

- (f) Conduct inspections to ensure conformance of construction to design
- (g) Stop construction work not in accordance with design
- (h) Conduct a final inspection and issue a completion certificate
- (i) Minimise ergonomic hazards – commissioning and other phases

Construction Regulations (4)

- To meet these requirements requires designers (and clients, PMs and QSs) to:
  - Identify hazards and assess the risk
  - Mitigate or eliminate the hazards and risks
  - Record the residual risk, if any (H&S Specification)
  - Document the design HIRA process
- All project phases: project initiation and briefing; concept and feasibility; design development; tender documentation and procurement; construction documentation and management, and project close out
- Required following any redesign during construction phase
- Ergonomic related hazards require analysis, evaluation and to be addressed in the risk assessment

Reduction of risk through design and specification (1)

- Optimum approach – prevent hazard arising and avoid risk – are there alternatives?
- If not reasonably practicable - then combat at source
- If not reasonably practicable - then priority for measures to control risk that provide communal protection
- Specification of PPE to control risk is a last resort

Reduction of risk through design and specification (2)

(Steel Construction, 2004)

Reduction of risk through design and specification (3)

(Steel Construction, 2004)

Reduction of risk through design and specification (4)

(Steel Construction, 2004)

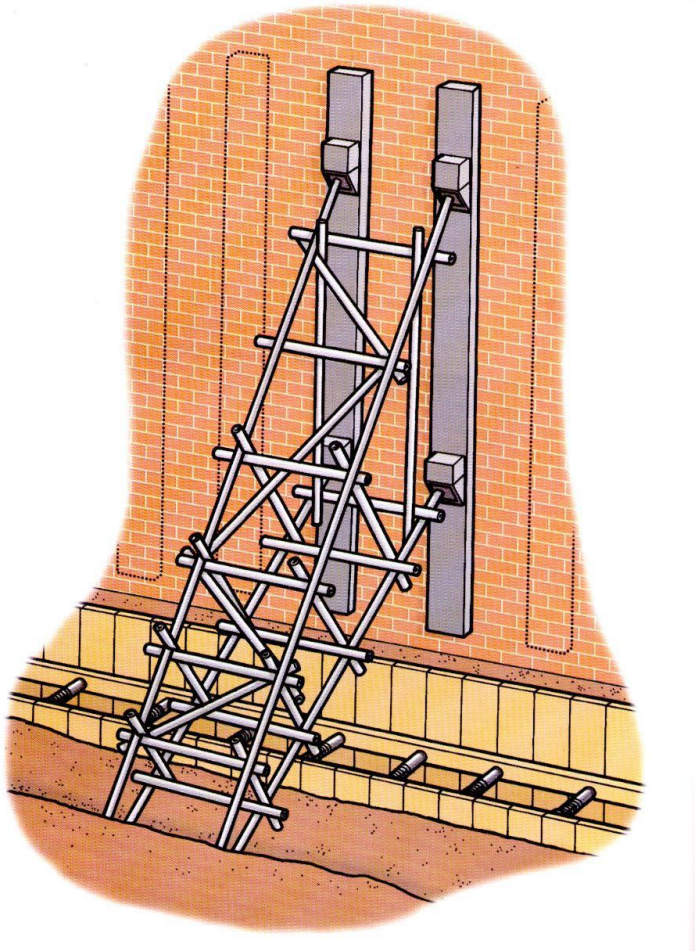
Reduction of risk through design and specification (5)

‘Bush-hammered’ concrete, Port Elizabeth (Smallwood)

Reduction of risk through design and specification (6)

'Melting' mastic asphalt, Canal Walk, Cape Town (Smallwood, 2000)

Reduction of risk through design and specification (7)



Shoring of building with excavation at base of building (HSE, 1999)

Reduction of risk through design and specification (8)

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

Documentation of process

- Name(s) and function(s) of the assessor(s) / team
- Date of HIRA
- Work breakdown structure (WBS) / Elements / Finishes / Activities
- Hazards and risk / the above
- Response
- H&S specification reference
- Details of subsequent monitoring arrangements e.g. construction and requirements for further risk assessments

Do designers consider / refer to H&S? (1)

Occasion	Response (%)						Mean score	Rank
	Never	Rarely	Some-times	Often	Always	Don't Know		
Site inspections/ discussions	3.0	17.2	23.2	26.3	30.3	0.0	3.64	1
Site meetings	3.1	17.3	23.5	32.7	23.5	0.0	3.56	2
Site handover	9.1	18.2	19.2	19.2	33.3	1.0	3.50	3
Preparing project documentation	7.1	26.3	24.2	18.2	23.2	1.0	3.24	4
Pre-tender meeting	11.2	24.5	20.4	20.4	22.4	1.0	3.19	5
Working drawings	11.2	25.5	20.4	18.4	23.5	1.0	3.18	6
Evaluating tenders	15.0	23.0	19.0	16.0	25.0	2.0	3.13	7
Detailed design	11.2	26.5	20.4	20.4	20.4	1.0	3.12	8
Pre-qualifying contractors	10.1	25.3	28.3	17.2	18.2	1.0	3.08	9
Constructability reviews	12.2	24.5	22.4	19.4	17.3	4.1	3.05	10
Design coordination meetings	10.3	34.0	24.7	15.5	14.4	1.0	2.90	11
Client meetings	11.1	30.3	29.3	14.1	13.1	2.0	2.88	12
Concept (design)	19.2	27.3	21.2	15.2	16.2	1.0	2.82	13
Deliberating project duration	15.8	29.5	23.2	15.8	11.6	4.2	2.77	14

Table 1: Frequency at which Architectural practices consider / refer to H&S on various occasions (MS: 1 - 5) (Smallwood, 2000)

Do designers consider / refer to H&S? (2)

Aspect	Response (%)						Mean score	Rank
	Never	Rarely	Some-times	Often	Always	Don't Know		
Specification	6.1	17.3	20.4	25.5	28.6	2.0	3.54	1
Method of fixing	6.1	16.2	19.2	34.3	23.2	1.0	3.53	2
Position of components	8.1	15.2	21.2	33.3	18.2	4.0	3.40	3
Edge of materials	11.1	20.2	15.2	22.2	27.3	4.0	3.36	4
Content of materials	8.1	20.2	22.2	25.3	22.2	2.0	3.34	5
Details	12.2	15.3	22.4	24.5	22.4	3.1	3.31	6
Finishes	9.2	21.4	20.4	23.5	21.4	4.1	3.28	7
Type of structural frame	9.1	22.2	19.2	25.3	20.2	4.0	3.26	8
Plan layout	12.2	19.4	21.4	19.4	22.4	5.1	3.22	9
Texture of materials	13.1	18.2	26.3	20.2	19.2	3.0	3.15	10
Design (general)	11.2	23.5	28.6	18.4	17.3	1.0	3.07	11
Schedule	14.4	20.6	21.6	21.6	15.5	6.2	3.03	12=
Surface area of materials	17.3	18.4	19.4	21.4	17.3	6.1	3.03	12=
Elevations	15.3	23.5	22.4	15.3	18.4	5.1	2.98	14
Site location	18.0	26.0	20.0	14.0	19.0	3.0	2.90	15
Mass of materials	13.3	26.5	26.5	16.3	12.2	5.1	2.87	16

Table 2: Frequency of which Architectural practices consider / refer to H&S relative to various design related aspects (MS: 1 - 5) (Smallwood, 2000)

Integrating design and construction ito H&S (1)

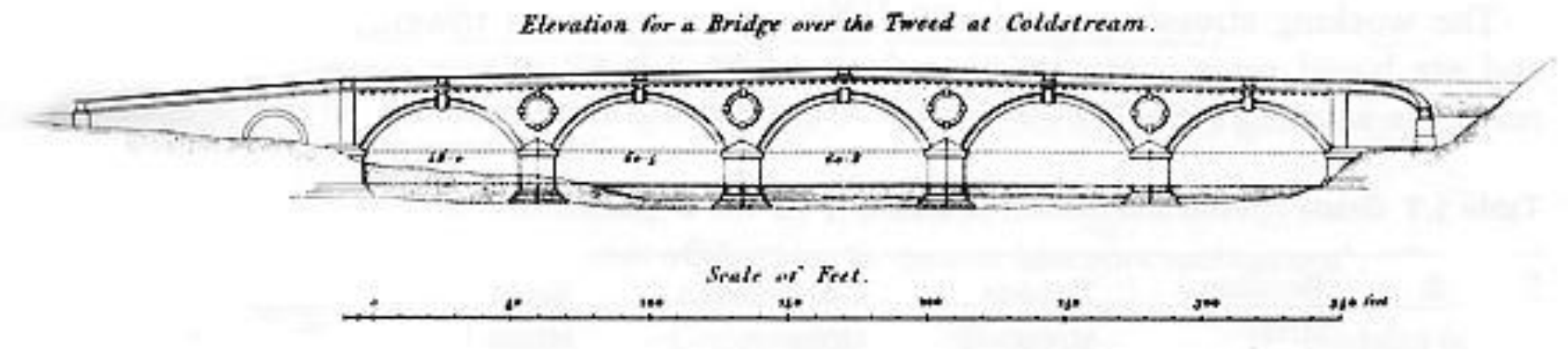


Figure 2: Elevation of masonry Bridge over the Tweed at Coldstream, 1866 (Irwin and Sibbald, 1983)

Integrating design and construction ito H&S (2)

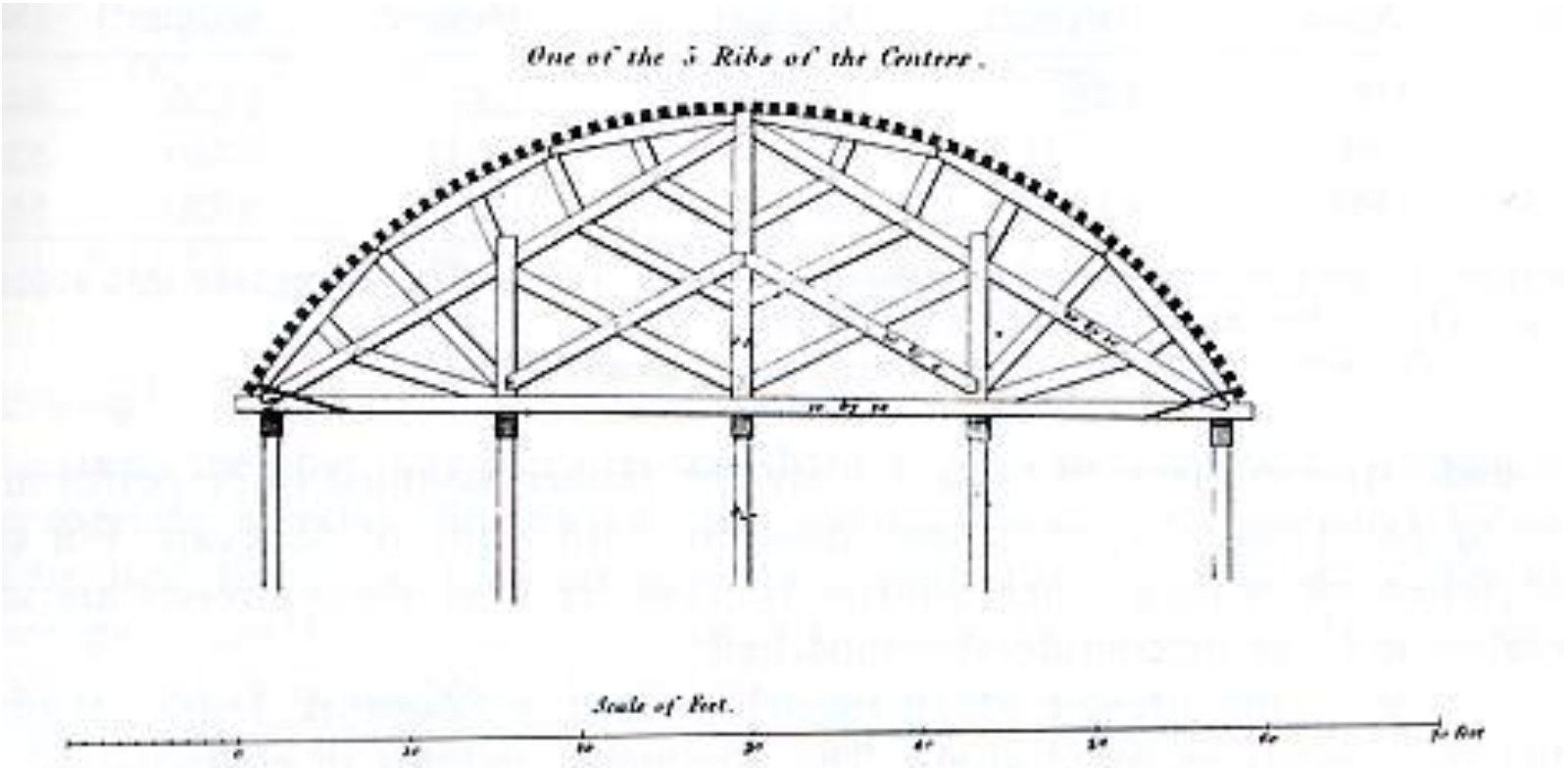
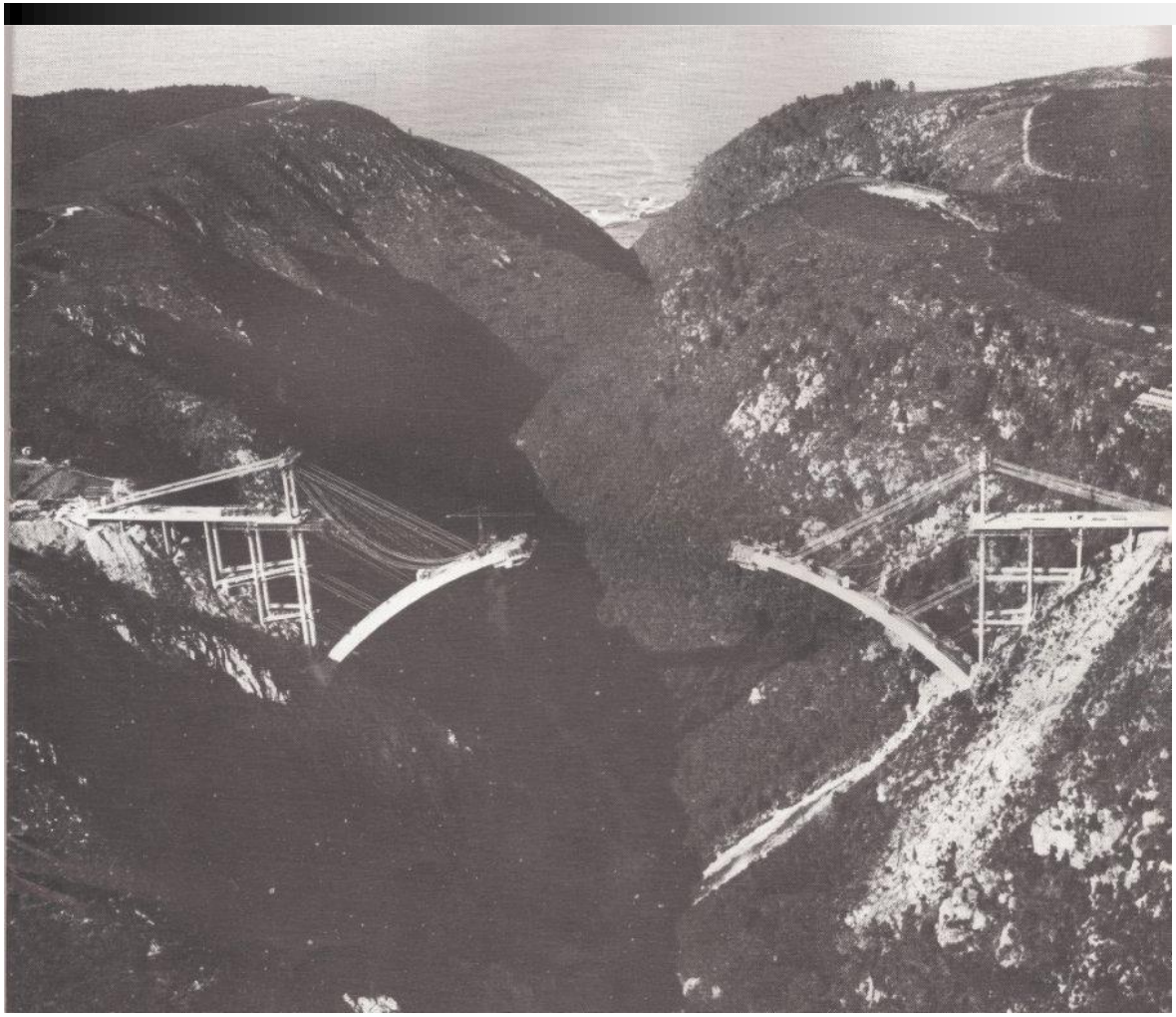


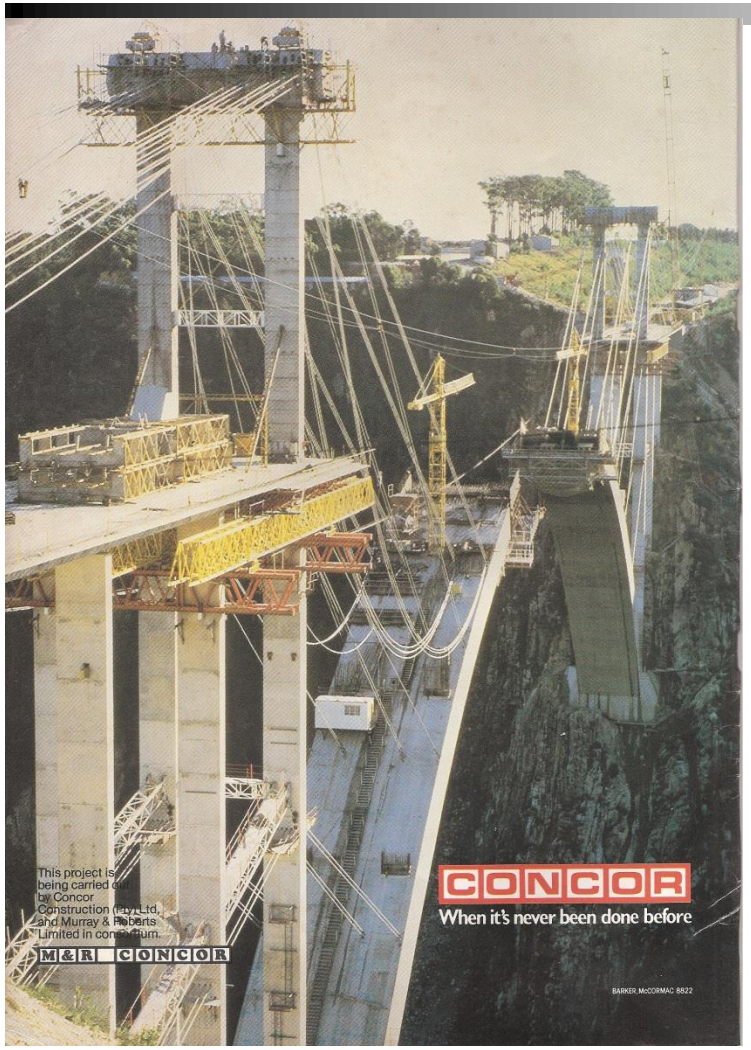
Figure 3: Centering for masonry Bridge over the Tweed at Coldstream, 1866 (Irwin and Sibbald, 1983)

Integrating design and construction ito H&S (3)



Bloukrans Bridge (p. 11, Concrete Beton, 1983)

Integrating design and construction ito H&S (4)



Bloukrans Bridge (Inside Front, Concrete Beton, 1983)

Integrating design and construction ito H&S (5)

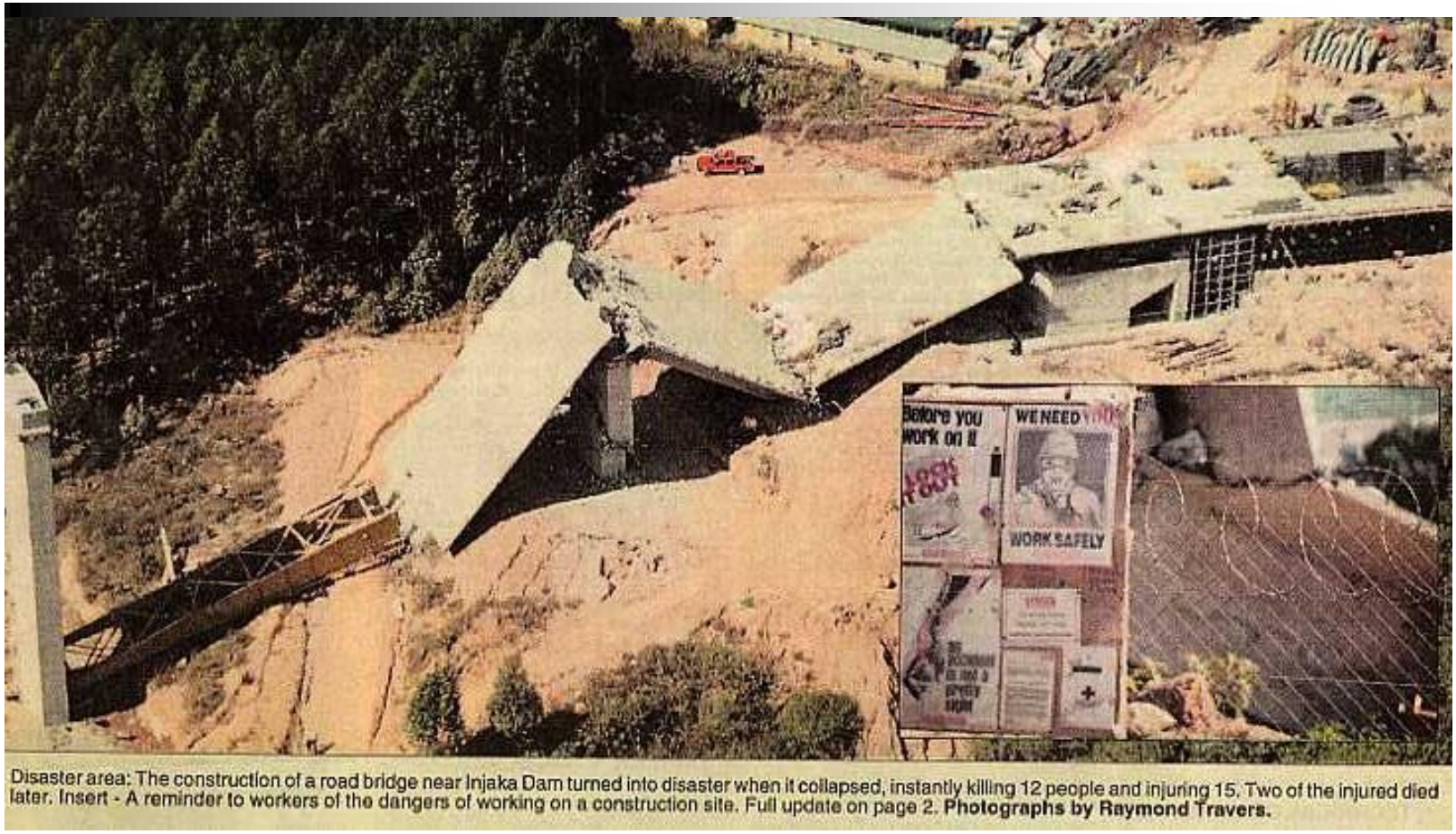
Bloukrans Bridge (Outside Back, Concrete Beton, 1983)

Integrating design and construction ito H&S (6)

Bloukrans bridge project (Steele, 1983):

- **"…notable for the close cooperation and team effort which were achieved by the consultant and contractor, and encouragement given by the client."**
- **"… consulting engineers had clearly indicated in their design how the task should be tackled and worked closely with the contractors in converting the drawings they had supplied to reality…"**

Injaka Bridge Collapse (1)



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 (Travers, 1998)

Injaka Bridge collapse (2)

- Causes (Department of Labour, 2002):
  - The slide path was not under the webs
  - The placing of the sliding pads between the deck and temporary bearings was not as specified
  - Insufficient reinforcement in the deck section, especially the bottom slab
  - The failure to fully appreciate the implications of the early cracks
  - The acceptance and approval of a launching nose which was substantially less stiff than that prescribed in the project specification
  - The deviation from the project specification regarding the automatic pier deflection monitoring at pier 2
  - The deviation from the project specification regarding the height tolerances of the temporary bearings on pier 3
  - The use of design and construction personnel, at decision-making level, without appropriate qualification and experience in incremental launched bridges

Injaka Bridge collapse (3)

- No independent design reviews were conducted of either the temporary or permanent works
- Contributory causes (Department of Labour, 2002):
  - The lack of experience on the part of design personnel in incremental launching techniques resulted in poor communications between the parties to clarify understandings and interpretations regarding the slide path position
  - The lack of clear instructions in the project specification and clear indications on the consulting engineers design drawings as to the position of the sliding path, resulted in incorrect interpretations being made

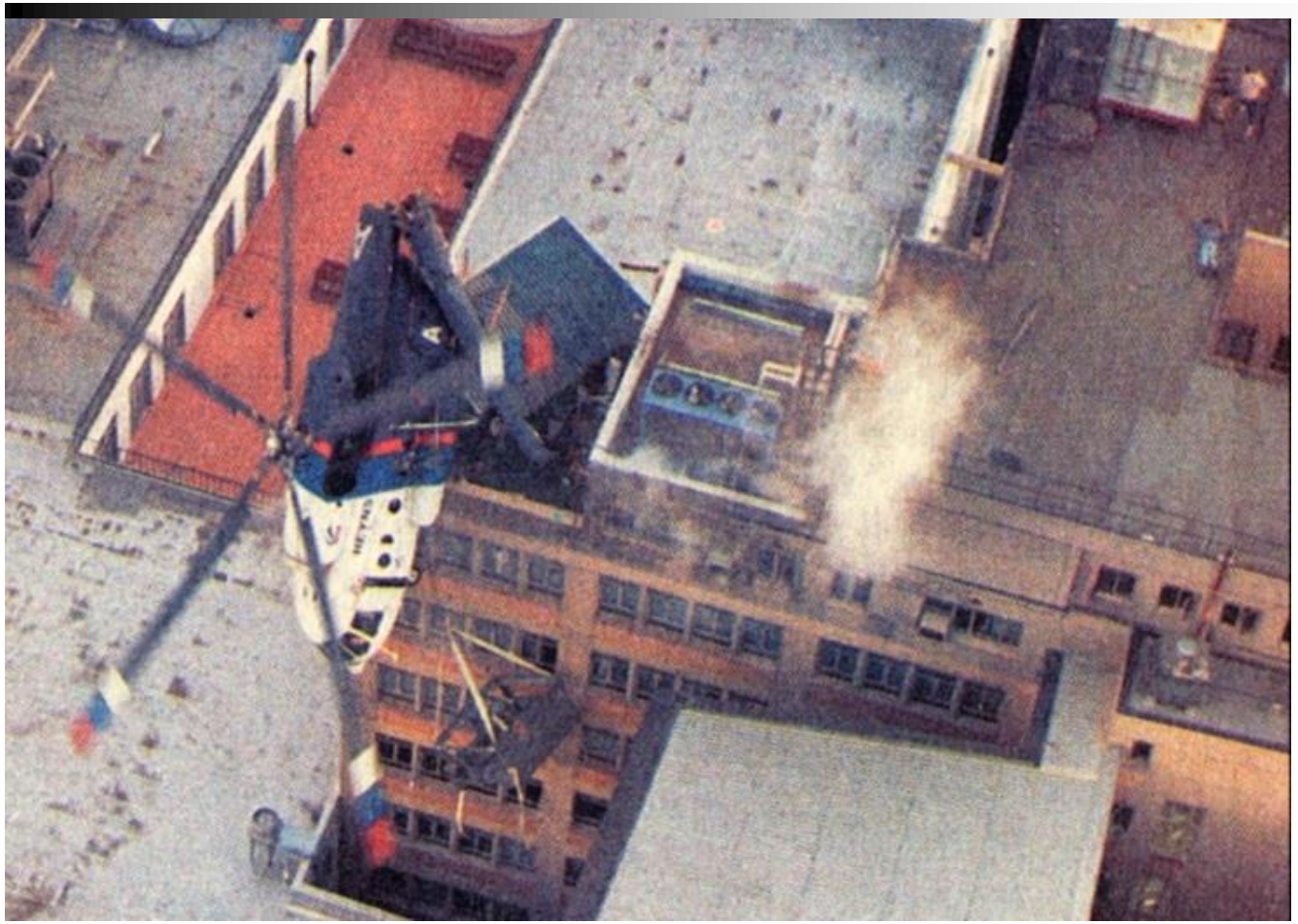
Helicopter crash (1)

Helicopter crash, Strand Street, Cape Town (Vosloo, 1999)

Helicopter crash (2)

Helicopter crash, Strand Street, Cape Town (Vosloo, 1999)

Helicopter crash (3)



Helicopter crash, Strand Street, Cape Town (Vosloo, 1999)

Helicopter crash (4)

FLAMES OF DEATH . . . The Russian Mi-8 helicopter crashes into the roof of Boston House in Cape Town's central business district early yesterday. A professional photographer, who had been photographing the helicopter as it loaded airconditioning equipment onto the building, ended up capturing these images of a horrific accident in which four people died. Pictures: AP

Helicopter crash, Strand Street, Cape Town (Amalgamated Press, 1999)

Rationale for H&S specifications (1)

Mist, Aerial Cableway Station, Table Mountain (Deacon, 1997)

Rationale for H&S specifications (2)

Site establishment, Aerial Cableway Station, Table Mountain (Deacon, 1997)

Rationale for H&S specifications (3)

Shear-face construction, Aerial Cableway Station, Table Mountain (Deacon, 1997)

Rationale for H&S specifications (4)

Shear-face construction, Aerial Cableway Station, Table Mountain (Deacon, 1997)

Rationale for H&S specifications (5)

Shear-face construction, Aerial Cableway Station, Table Mountain (Deacon, 1997)

Rationale for H&S specifications (6)

Transportation of materials and waste, Aerial Cableway Station, Table Mountain (Deacon, 1997)

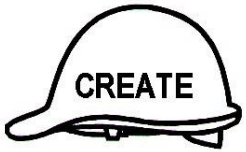
Design HIRA (1)

Precast planks / ribs and blocks to composite slab, Plettenberg Bay (Hamp-Adams, 1994)

Design HIRA (2)

Precast planks / ribs and blocks to composite slab, Plettenberg Bay (Hamp-Adams, 1994)

Design HIRA (3)



An example of a generic risk assessment form (GRA) -Page 1				
NAME OF ORGANIZATION				
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 4: Design HIRA for erecting precast plank and hollow block composite slab

Design HIRA (4)

Positioning pre-stressed precast hollow core slab using cranage and a lifting beam (SA Builder Bouer, 2004a)

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Design HIRA (5)

Positioning pre-stressed precast hollow core slab using cranage and a lifting beam (SA Builder Bouer, 2004b)

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H&S Specification - Sections

- Project details
- Client's considerations and management requirements
- Environmental restrictions and existing on-site risks
- Significant design and construction hazards
- H&S file

H&S Specification - Project details

- Project location including:
  - Access e.g. Infrastructure such as railway routes and roads
  - Fauna and related e.g. crocodiles, malaria, and snakes
  - Services e.g. electricity, gas, sewage, and water
  - Socio-economic issues such as crime, and vandalism
  - Weather e.g. precipitation, temperature, and wind
  - Other e.g. landmines
- Project description
- Phases and programme
- Details of client, designers, and other consultants
- Extent and location of existing records and plans

Client's considerations and management requirements

- Structure and organisation – general including H&S
- H&S goals for the project
- H&S monitoring and review
- Permit and authorisation requirements
- Emergency procedures
- Site rules and other restrictions on contractors, suppliers and others e.g. access arrangements to those parts of the site which continue to be used by the client, shift work, night work, restricted hours
- Mandatory client provided H&S training
- Activities on or adjacent to the site during the works
- Arrangements for liaison between parties

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H&S Specification - Environmental restrictions and existing on-site risks

- Safety hazards, including:
  - Boundaries and access, including temporary access
  - Adjacent land uses
  - Existing storage of hazardous materials
  - Location of existing services – water, electricity, gas, etc.
  - Ground conditions e.g. geotechnical report
  - Existing structures – degree of stability, or fragile materials
- Health hazards, including:
  - Asbestos, including results of surveys
  - Existing storage of hazardous materials
  - Contaminated land, including results of surveys
  - Existing structures - hazardous materials e.g. asbestos containing
  - Health risks arising from client's activities

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H&S Specification - Significant design and construction hazards

- Design assumptions and control measures e.g. design and construction method statements – composite slabs, and structural steel
- Arrangements for co-ordination of on-going design work and handling design changes e.g. Nominated subcontractors' shop drawings
- Information on significant hazards identified during design e.g. bush-hammered concrete
- Materials requiring particular precautions e.g. heavy blocks, and precast concrete kerbs

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H&S Specification - H&S file

- 'As built' drawings and plans
- Design criteria e.g. design loadings
- Potential hazards included in the structure
- Construction methods and materials used
- Record of hazardous processes e.g. removal of asbestos containing materials (ACMs)
- Equipment and maintenance facilities
- Maintenance procedures and requirements
- Manuals (operating and maintenance) for plant and equipment
- Location and nature of utilities and services

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H&S Specification - Research method and sample stratum

- 2007 Study (Smallwood, 2007):
  - 27 General contractors (GCs) which achieved a place in the Building Industries Federation South Africa (BIFSA) / Master Builders South Africa (MBSA) National H&S Competition on one or more of their projects during the period 1995 – 2005
  - 11 GCs responded, which represents a response rate of 39.3%
- 2010 Study:
  - 13 Members of the Association of Construction Health and Safety Management (ACHASM) responded
  - 81 Delegates attending Construction Research Education and Training Enterprises (CREATE) H&S Specification Workshops responded

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H&S Specification - Research findings (1)

- Mean percentage (approximate) of projects for which H&S specifications are provided is:
  - ACHASM: 56% (2010)
  - Workshops: 71% (2010)
  - GCs: 59% (2007)
- These are notable findings in that H&S specifications are required for all projects

H&S Specification - Research findings (2)

- Degree to which H&S specifications are project specific:
  - GCs: 3.57 / 5.00 (2007)
  - ACHASM and Workshops: 3.09 / 5.00 (2010)

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H&S Specification - Research findings (3)

Category	Response per range of number of pages (%)							
	Unsure	1-5	6-10	11-20	21-30	31-40	41-50	> 51
Shortest	9.1	54.5	9.1	27.3	0.0	0.0	0.0	0.0
Average	0.0	0.0	9.1	63.6	18.2	0.0	9.1	0.0
Longest	9.1	0.0	0.0	9.1	9.1	18.2	18.2	36.4

Table 3A: Length of H&S specifications provided to respondents (GCs: 2007)

Category	Response per range of number of pages (%)							
	Unsure	1-5	6-10	11-20	21-30	31-40	41-50	> 51
Shortest	27.3	18.2	9.1	36.4	0.0	9.1	0.0	0.0
Average	9.1	0.0	9.1	18.2	36.4	9.1	18.2	0.0
Longest	9.1	0.0	0.0	0.0	27.3	9.1	18.2	36.4

Table 3B: Length of H&S specifications provided to respondents (ACHASM: 2010)

Category	Response per range of number of pages (%)							
	Unsure	1-5	6-10	11-20	21-30	31-40	41-50	> 51
Shortest	27.0	25.7	16.2	16.2	10.8	0.0	2.7	1.3
Average	27.0	5.4	12.2	10.8	21.6	14.9	5.4	2.7
Longest	26.7	1.3	4.0	6.7	10.7	5.3	20.0	25.3

Table 3C: Length of H&S specifications provided to respondents (Workshops: 2010)

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H&S Specification - Research findings (4)

Aspects / Issues	ACHASM		Workshops		Mean	
	MS	Rank	MS	Rank	MS	Rank
Existing services e.g. high voltage cables	2.92	5	3.82	1	3.37	1
H&S file e.g. format & frequency of amendment	3.00	3	3.62	3	3.31	2
Client restrictions e.g. traffic	3.00	2	3.52	4	3.26	3
Client's activities e.g. sewerage works	3.15	1	3.30	11	3.23	4
Client specific requirements e.g. daily removal of rubbish / waste & security cards	2.92	4	3.47	5	3.20	5
Health hazards e.g. sewerage works	2.92	6	3.46	6	3.19	6
Client specific H&S requirements e.g. permit to work procedure	2.69	9	3.65	2	3.17	7
Materials containing hazardous chemical substances (HCSs)	2.92	7	3.38	10	3.15	8

Table 4: Extent to which various aspects / issues are addressed in H&S specifications (Part A) (2010).

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H&S Specification - Research findings (5)

Aspects / Issues	ACHASM		Workshops		Mean	
	MS	Rank	MS	Rank	MS	Rank
Project location details e.g. adjoining structures or geographical features	2.75	8	3.39	8	3.07	9
Hazardous processes e.g. bush-hammering concrete	2.62	10	3.13	13	2.88	10
Environmental hazards e.g. contaminated ground	2.31	14	3.39	9	2.85	11
Heavy materials e.g. blocks & precast concrete kerb sections	2.54	11	3.11	14	2.83	12
Details of existing structures e.g. fragile materials	2.23	15	3.41	7	2.82	13
'Designer' design & construction method statement e.g. reference to temporary works required	2.42	13	3.11	15	2.77	14
Design principles & assumptions e.g. stages of instability	2.45	12	2.84	16	2.65	15
Permissible design loadings for stages of structures	2.00	17	3.16	12	2.58	16
Geotechnical reports	2.11	16	2.83	17	2.47	17

Table 4: Extent to which various aspects / issues are addressed in H&S specifications (Part B) (2010).

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H&S Specification - Research findings (5)

Aspects / Issues	ACHASM		Workshops		Mean	
	MS	Rank	MS	Rank	MS	Rank
H&S specifications should be a useful reference	4.77	1	4.48	1	4.63	1
H&S specifications are a useful form of reference	4.23	4	3.95	2	4.09	2
Designers are incapable of compiling H&S specifications	4.31	3	3.05	7	3.68	3
Project managers are incapable of compiling H&S specifications	4.38	2	2.95	8	3.67	4
H&S specifications are a 'regurgitation' of the Construction Regulations	3.58	6	3.49	3	3.54	5
Clients are incapable of compiling H&S specifications	3.85	5	3.13	6	3.49	6
Contractors are expected to provide H&S plans when inappropriate H&S specifications are provided	3.50	8	3.40	4	3.45	7
Contractors are expected to provide H&S plans when H&S specifications are not provided	3.50	7	3.32	5	3.41	8
H&S consultants are incapable of compiling H&S specifications	2.62	9	2.63	9	2.63	9

Table 5: Extent to which respondents concur with various H&S specification related statements (2010).

CREATE

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