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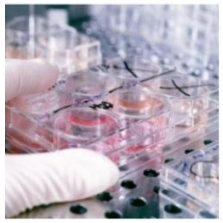

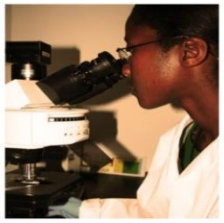

Ergonomics in the construction industry

Engineering perspective

NIOH and SAFCEC Webinar: The South African 2019, Ergonomics Regulations Implications for the Construction Industry

9 July 2021

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Outline

- Background
  - H&S in SA construction industry
  - H&S outcomes related to Ergonomics in SA construction industry
- Ergonomics
- Process of designing for H&S
- Examples of H&S in design through photographs
- Benefits of H&S in design
- Conclusions

Background

- Globally, construction industry has a positive role to play in the socio-economic development of a country[1]
- In South Africa (SA) statistics of quarter 1, 2020 shows[2]
  - 1 344 000 workers were employed in formal sector
  - Contributed 4% to the Gross Domestic Product

Health and safety (H&S) in South African construction industry

- SA construction industry is experiencing poor health and safety performance which is demonstrated by the occurrence of adverse health events
- This could be partly, due to challenges in implementing the Construction Health and Safety Accord or
- Not effectively incorporating ergonomics principles at the design stages of projects

Health outcomes related to ergonomics in SA construction industry

- Most commonly reported adverse health effects related to ergonomics in workplaces are Musculoskeletal Disorders (MSDs)
- Studies conducted on MSDs (upper limb and low back pain) in the construction industry are very few
- No studies on Hand- arm vibration syndrome could be found
- Prevalence of MSDs in construction workers is shown in Table 1

Prevalence of MSDs in SA construction workers

Table 1: Prevalence of MSDs and HAVS

STUDY (COUNTRY)	STUDY SAMPLE (N)	METHOD	PREVALENCE
MSDs **Deacon et. al., 2005[3]** **(South Africa)**	142 Construction workers	Standardised protocol for medical examination	15%
Himalowa and Franz, 2012[4] **(South Africa)**	212 Construction workers	Standardised Nordic Questionnaire Functional Limitation Scale Pain and Disability Questionnaire	25% LBP
Ekpengyong and Inyang, 2014[5] **(Nigeria)**	1200 Construction workers	Standardised Nordic Questionnaire Job Content Questionnaire	39%
HAVS **SIMRAC HEALTH 703, 2002[6]** **(South Africa)**	311 Mine workers	Standardised protocol for HAVS assessment	15%
Sue et. al., 2010[7] **(Malaysia)**	194 Construction workers	Hand transmitted Vibration Health Surveillance: Initial Questionnaire Clinical Assessment	18%

*=Studies conducted in Western Cape; **Study conducted on gold mineworkers

MSD studies in SA construction workers

- Studies indicate occurrence of MSDs in SA construction workers
- Not representative of SA construction industry
- Prevalences vary due to the methods used in the studies
- Ergonomic risks and functional limitation were identified as associated with MSDs
- Application of ergonomics in the construction industry was recommended

Safety outcomes related to ergonomics in SA construction industry

- In 2018, 8384 accidents occurred with 65 fatalities and 996 disabilities[8]
- A study[9] conducted by NIOH using FEMA data from 2004-2006 showed, 195 fatalities over the period
  - Top three causes of death were:
    - Motor vehicle accident (43.1%)
    - Struck by (22.1%)
    - Fall on different level (18.0%)
  - Study suggested enforcement of regulations may reduce fatalities on the MVAs

Ergonomics

Defined as a **scientific discipline** concerned with the understanding of **interactions** among workers and other elements of a **system**, and a profession that applies theory, principles, data and methods to **design** in order to optimise **worker well-being** and **overall system** performance

Ergonomics cont'd

- Applies to all industries including construction

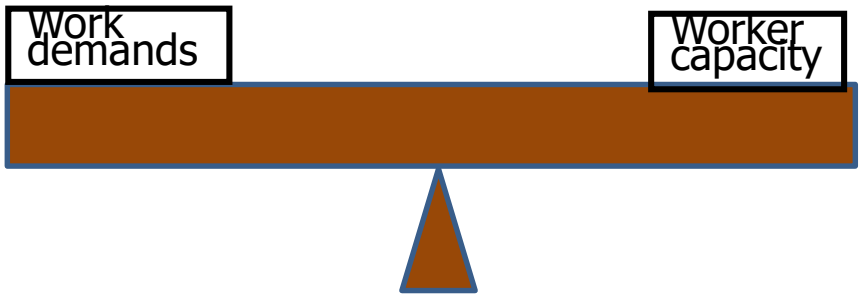
- As a **scientific discipline-**Draws its knowledge from other sciences for application in the workplace
- Aims to create equilibrium in the **interactions** that happen in the **system**
- Design/engineering driven for **health and safety** and **productivity**

Interactions in the system

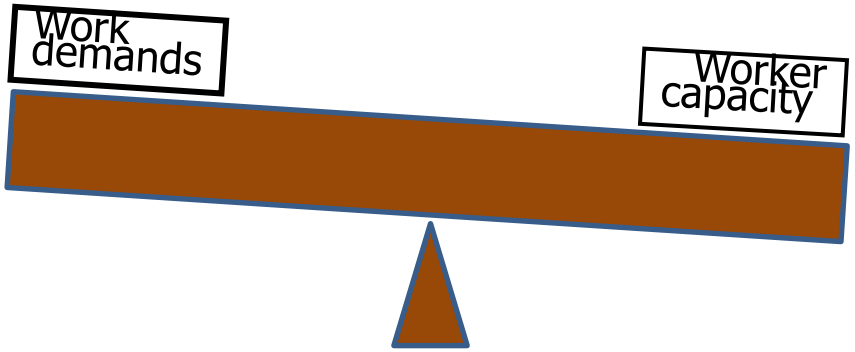
Elements of the system

- Elements comprise:
  - Equipment
  - Job/task
  - Work environment
  - Work organisation
  - Worker
- Interactions to promote health and safety

Equilibrium in the system



- To balance physical and psychological work demands with worker capacity



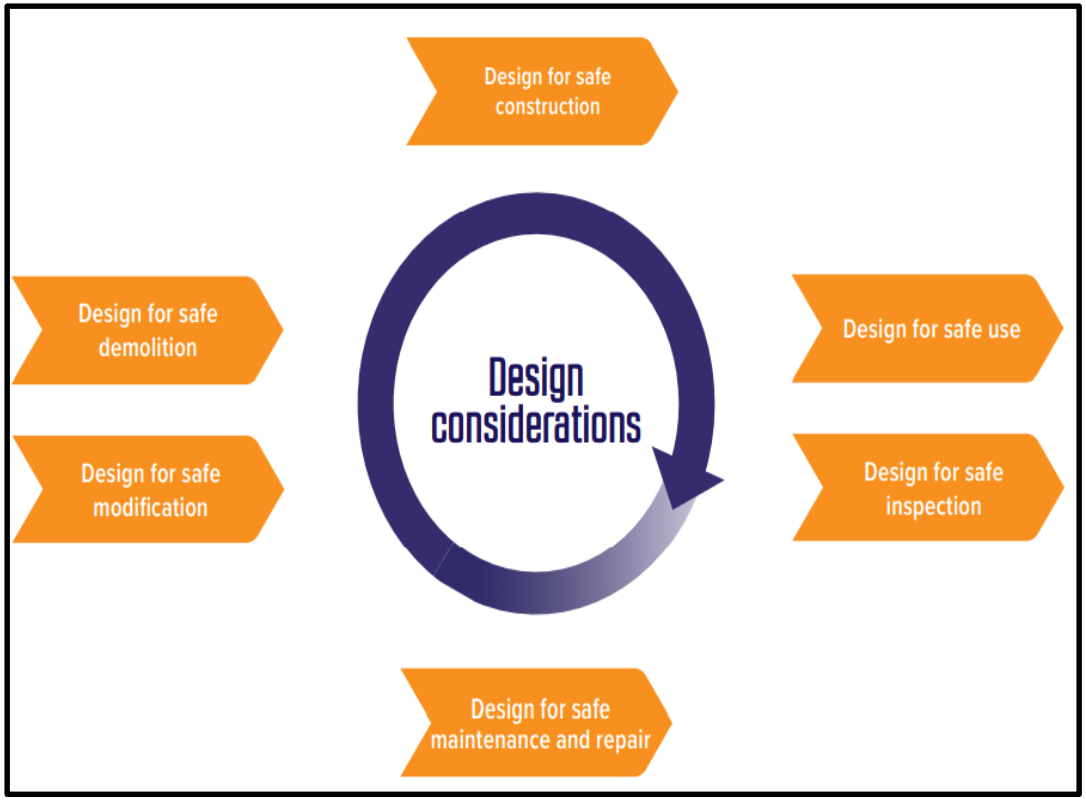
- Work demands exceed worker capacity

Levels of prevention in ergonomics

- Primary: Elimination
  - Applies at early stages of a project life cycle
  - Proactive in nature
- Secondary: Medical surveillance
  - Applies during construction stages and later
  - Reactive in nature
- Tertiary: – work disability prevention
  - Applies during construction stages and later
  - Reactive in nature

Designing for H&S

- Incorporate health and safety concepts throughout the life cycle of a project
  - Conception
  - Design
  - Construction
  - Use and maintenance
  - Decommission and repurpose
  - Demolition
- Foresee and eliminate risk at early stages of the project



Life cycle of a project[10]

Process of designing for H&S

1. Designers to engage with clients
2. Research and brainstorm with team members as the design development progresses
3. Understand H&S risks throughout the lifecycle of the design
4. Test the design
5. Provide information
6. Review

Designers engage with client

- To collect information related to the project
  - The information will enable identifying possible H&S risks from activities that will be undertaken
  - How will designing for those activities affect the way the structure is constructed?
  - What hazards may be involved in the activities?
  - Are there hazards that are activity and/or site specific?

Research and brainstorm with team members

- This happens as the design development progresses
  - Materials and features used in other structures for similar purposes and used in similar situations
  - Find out how H&S has been planned for in those structures
  - Find out about any H&S risks or issues with those structures
  - Find out ways the potential H&S issues can be designed out or managed in the design

Understand H&S risks through the life cycle of design

- The following are considered:
  - Who will construct the structure
  - Who will work in it
  - Who will inspect it or maintain it
  - Who may visit, live or work near it
  - Who will demolish it
  - Who will be affected in extreme conditions
- Consider how each group may be affected by each aspect of the structure and
- What aspects of the structure may pose H&S risks under what circumstances and how

Risk assessment and hazard management

- Identify hazard
- Assess the risk
- Control
- Reassess
- Review

RISK ASSESSMENT MATRIX	CONSIDER THE LIKELIHOOD OF A HAZARDOUS EVENT OCCURRING				
CONSIDER THE SEVERITY OF INJURY/ILLNESS	Very unlikely to happen	Unlikely to happen	Possibly could happen	Likely to happen	Very likely to happen
Catastrophic (e.g fatal)	Moderate	Moderate	High	Critical	Critical
Major (e.g Permanent Disability)	Low	Moderate	Moderate	High	Critical
Moderate (e.g Hospitalisation/Short or Long Term Disability)	Low	Moderate	Moderate	Moderate	High
Minor (e.g First Aid)	Very Low	Low	Moderate	Moderate	Moderate
Superficial (e.g No Treatment Required)	Very Low	Very Low	Low	Low	Moderate

Risk assessment matrix

Hierarchy of controls

Test the design

- To check if the design is without health and safety risks calculations, analysis, tests and examination are carried out.

Provide information

- The information should be about how the design has incorporated considerations about H&S and remaining risk to be managed
- The information should comprise
  - H&S file
  - H&S design report
  - Risk register

Review

- Once the design has been accepted and implemented, the whole process of its development can be reviewed to identify lessons for future designs

Health in design examples

Photo A
Using a screw gun at floor level promotes awkward posture of the back

Photo B
Using an automated screw gun with auto-feed results in improvement in posture

Health in design examples cont'd

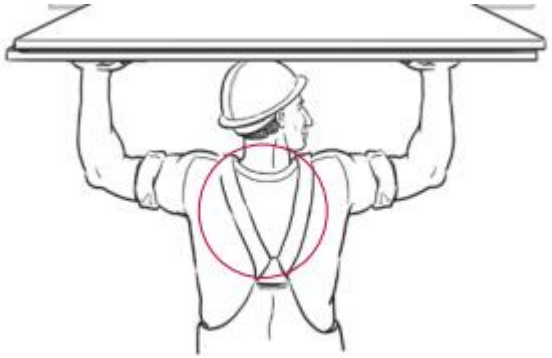
Photo A

Working in a kneeling position without any protection to the knees

Photo B

Working in a kneeling position with knees placed on a kneeling creeper for protection

Health in design examples cont'd



Manual handling

Power vacuum lifter to prevent strain from handling loads manually

Working above shoulder height

Person lift to provide stable platform for overhead work and eliminate handling of ladders and scaffolding

Safety in design examples

Photo A

Specify guard rails to prevent falls from floor openings

Photo B

Specify fixed ladders to prevent falls from ladders

Safety in design examples cont'd

Photo C

Specify positioning of equipment away from roof edge to reduce risk of falling when installing or maintaining equipment

Photo D

Specify roof hatch safety system to prevent falls from roof

H&S in design and Ergonomics

Physical risks

- Forceful exertions
- Manual handling
- Posture
- Repetitive movements
- Vibration
  - Hand arm
  - Whole body

Psychosocial risks

- Job dissatisfaction
- Job insecurity
- Job control
- Decision latitude
- Incentives
- Target system
- Social support

Ergonomics and H&S in design cont'd

- H&S process in design considers physical risks
- Psychosocial risks can be taken as residual risks
- Policies are suitable to deal with psychosocial risks

Benefits of health and safety in design

- Elimination of potential hazards at the beginning of the project – which is often cheaper and easier than minimising their effects later in the lifecycle
- Reductions in accidents and adverse health effects – particularly during the construction and maintenance stages of a project lifecycle
- Preservation of the health and safety of workers
- Reductions in damage to property and the environment – with associated reductions in related costs
- More efficient and effective risk management at the design stage rather than retrofitting for health and safety during the use and maintenance stages
- Reductions in operational maintenance and litigation costs when things go wrong

Conclusions

- More research on MSDs is needed to determine the magnitude of the problem
- Statistics on injuries are not readily available
- MSDs and accidents can be prevented through the incorporation of ergonomics principles during project design
- Ergonomics knowledge is needed in the process of designing for H&S
- Designers can benefit from attending relevant occupational health platforms
- Introduction of Ergonomics Regulations in SA is expected to assist in protecting construction workers against ergonomics risks

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