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MASS AND DENSITY OF MATERIALS: CONSTRUCTION MANAGEMENT AND QUANTITY SURVEYING STUDENTS' KNOWLEDGE AND PERCEPTIONS

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Introduction (1)

- Materials may be heavy and / or inconveniently sized and shaped, thus presenting manual materials handling problems (Schneider & Susi, 1994; Monk, 2005)
- 62% of back injuries are attributable to manual materials handling (Construction Safety Association of Ontario,1993)
- One-third of all construction industry accidents reported to the HSE in the United Kingdom involve manual handling (Health & Safety Executive) (2000)
- Regulation 7 'Risk Assessment' of the South African Construction Regulations (Republic of South Africa, 2003), requires contractors to conduct a risk assessment - knowledge of the mass and density of materials is a pre-requisite

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Introduction (2)

- Handling heavy materials – ranked 3 / 18 ergonomics problems in three previous self-administered questionnaire based research studies conducted in South Africa (Smallwood, 1997; Smallwood *et al.*, 2000; Smallwood, 2002)
- Ergonomic aspects requiring attention - 92.6% of workers indentified materials handling (ranked 1 / 9) (Smallwood *et al.*, 2000)

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Objective(s)

Given the role of manual materials handling, and in particular, heavy materials, in the occurrence of injuries, the role of Construction Managers in mitigating, reducing, and controlling such injuries, and the importance of knowledge of the mass and density of materials in terms of conducting risk assessments, a study was conducted to determine students' knowledge of the mass and density of materials

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Research – Sample stratum

The sample stratum consisted of BSc (Construction Economics) students registered for the Quantity Surveying programme and BSc (Construction Studies) students registered for the Construction Management programme registered for the subject Material and Methods 2 and BSc (Honours) (Construction Management) students registered for the subject Materials and Methods 4

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Research – Method

- The questionnaire consisted of seven closed ended questions, two of which consisted of five and four sub-questions pertaining to the mass and density of materials respectively
- The other five questions were five-point likert scale type questions.
- The survey was administered at the beginning of the presentation of the subjects in February 2012
- 53 Responses were included in the analysis of the data
- Mean scores (MSs) are between 1.00 (lower end) and 5.00 (upper end), 3.00 being the midpoint

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Summary of mass and density responses

Material	Response (%)	No response (%)
Solid clay brick	88.7	11.3
Two-cell concrete block	81.1	18.9
Precast concrete kerb	69.8	30.2
Double Roman concrete roof tile	79.3	21.7
m^2 glass 5 mm thick	71.7	28.3
Concrete	75.5	24.5
Marble	75.5	24.5
Sandstone	75.5	24.5
Steel	75.5	24.5
Mean	77.0	23.0

Table 1: Summary of mass and density of materials responses

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Analysis of mass and density responses

Material	Actual	Mean response	Difference (%)	Responses within range (%)
Solid clay brick (kg)	3.0 – 3.5	2.2	32.3	25.5
Two-cell concrete block (kg)	17.5	5.5	68.6	1.5
Precast concrete kerb (kg)	95	33.8	64.4	0.0
Double Roman concrete roof tile (kg)	4.8	3.3	31.3	19.1
m^2 glass 5 mm thick (kg)	13.5	4.7	65.2	2.6
Concrete (kg / m^3)	2 400	2160	10.0	15.0
Marble (kg / m^3)	2 755	3968	44.0	20.0
Sandstone (kg / m^3)	2 323	2315	0.03	10.0
Steel (kg / m^3)	2 393	6545	173.5	5.0
Mean			54.4	11.0

Table 2: Actual and mean response mass / density, percentage difference, and summary of responses within a 10% range of the actual mass or density

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Extent of impact of mass and density of materials

Response (%)						MS
Unsure	Minor…….……. Major					
	1	2	3	4	5	
13.2	7.5	7.5	26.4	22.6	22.6	3.52

Table 3: Extent to which the mass and density of materials impacts on ergonomics

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Knowledge of the mass and density of materials

Response (%)						MS
Unsure	Limited……Extensive					
	1	2	3	4	5	
11.3	37.7	24.5	22.6	0.0	3.8	1.96

Table 4: Respondents' rating of their knowledge of the mass and density of materials

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Consideration of mass and density of materials (1)

Response (%)						MS
Unsure	Never…….....Always					
	1	2	3	4	5	
13.2	0.0	3.8	9.4	18.9	54.7	4.43

Table 5: Frequency at which construction managers should consider the mass and density of materials when managing projects

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Consideration of mass and density of materials (2)

Response (%)						MS
Unsure	Never…….....Always					
	1	2	3	4	5	
11.3	3.8	3.8	22.6	9.4	49.1	4.09

Table 6: Frequency at which quantity surveyors should consider the mass and density of materials when preparing bills of quantities and other project documentation

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Potential of the consideration of the mass and density of materials to contribute to an improvement

Response (%)						MS
Unsure	Minor….. ……..…Major					
	1	2	3	4	5	
22.6	0.0	9.4	22.6	24.5	20.8	3.73

Table 7: Potential of the consideration of the mass and density of materials to contribute to an improvement in construction ergonomics

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Conclusions

- Respondents are lacking in knowledge relative to the mass and density of materials:
  - 77% of respondents attempted to record a mass or density
  - Only 11% of the 77% were within a 10% range of the actual mass or density
  - Reinforced by the respondents' rating of their knowledge of the mass and density of materials, namely 1.96
- Respondents appreciate, to a degree, the extent to which the mass and density of materials impact on construction ergonomics:
  - Actual impact
  - Extent to which Construction Managers should consider
  - Extent to which Quantity Surveyors should consider
  - Potential of the consideration of the mass and density of materials to contribute to an improvement

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Recommendations

- Tertiary built environment education should:
  - Address construction ergonomics, in particular construction management
  - Engender an awareness of the mass and density of common construction materials
  - Optimise the level of awareness relative to construction ergonomics, and the role of mass and density of materials
- Continuing professional development (CPD) should address construction ergonomics and the role of mass and density of materials

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