Musculoskeletal risk reduction – cable-pulling and shovelling

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Construction Work Health and Safety Research @ RMIT

Musculoskeletal disorders are the most common injury sustained by Victorian construction workers*

*WorkSafe Victoria, Construction Safety Focus, February, 2018

1. Purpose of this guide

This guide presents considerations and suggestions for the reduction of work-related musculoskeletal injury risks in manual construction tasks. These considerations and suggestions are based on the findings of field-based research in which a whole body system of wearable sensors was used to understand the risks of musculoskeletal injury.

The sensors produced valuable information about the way that workers' muscles and joints are impacted when they perform manual work tasks, such as cable-pulling and shovelling.

Data was collected at rail construction projects in Melbourne being delivered as part of the Major Transport Infrastructure Program. The study considered simple and cheap options for redesigning tools and equipment that could help to reduce the risk of musculoskeletal injury.

2. Musculoskeletal injury risk in manual construction tasks

Many tasks in construction involve risk factors for musculoskeletal injury.

For example, working in awkward postures, being exposed to vibration, performing repetitive physical actions or needing to use excessive force.

Musculoskeletal injuries are often associated with poorly designed work or equipment.[1]

The research assessed the extent to which changes to the design of work methods or equipment could reduce risk factors for musculoskeletal injury.

3. Musculoskeletal injury risks in cable-pulling

Cable-pulling is performed by setting cables in place along the rail corridor for new signalling equipment. It involves feeding cables from vehicle-mounted reels and pulling the cables through an underground conduit that extends between access pits (FIGURES 1 AND 2).

The diameter of the cables varies, as does their length, which depends upon the distance between access pits.

FIGURE 1 AND 2: Cable pulling preparation and set up REFERENCE(S): 6.1.1, p. 146.*

1 Haslam, R. A., Hide, S. A., Gibb, A. G., Gyi, D. E., Pavitt, T., Atkinson, S., & Duff, A. R. (2005). Contributing factors in construction accidents. Applied Ergonomics, 36(4), 401-415.

* This footage was filmed or photographed in a controlled environment and should not be taken as an example of acceptable work practices in the field. Site and task specific risk assessments should always be undertaken before commencing work.

FIGURE 4: Cable pulling involves bending of the back and application of considerable force REFERENCE(S): 6.1.3, p. 146.*

High force is involved in pulling the cable through the conduits, which increases with the diameter of the cable. This force becomes greater as the length and size of the cable being pulled through increases [FIGURE 4]

The research showed that the combination of repeated forward bending of the trunk to reach down, as well as the force and posture during pulling, creates a high risk for injury to the back and shoulder [FIGURE 4].

4. Mechanised cable-pulling

Equipment, such as cable racks, stands and rollers can be used to reduce the risk of injury when cable-pulling. Wherever possible, mechanised methods of cable pulling should be used.

A truck mounted winch can be used to reduce manual pulling (FIGURE 5). Also, the placement of the cable drum on a spindle / frame can be used to ease run out. However, access, egress and work location can make using large equipment difficult and restrictive.

FIGURE 5: Mechanical cable-pulling equipment

5. Cable-pulling equipment re-design

If mechanised pulling equipment cannot be used, there are simple, cost-effective ways to modify the task of cable-pulling to reduce the risk of musculoskeletal injury risk.

A simple trestle was manufactured to guide the cable at hip height. At this height the cable was more accessible and the cable puller did not need to bend and reach down repeatedly to grasp and pull the cable (FIGURE 6).

FIGURE 6: Simple trestle device REFERENCE(S): 6.2.2, p. 151.*

Workers' body movements when cable-pulling with and without the trestle were measured when pulling cable through an underground conduit (FIGURE 7).

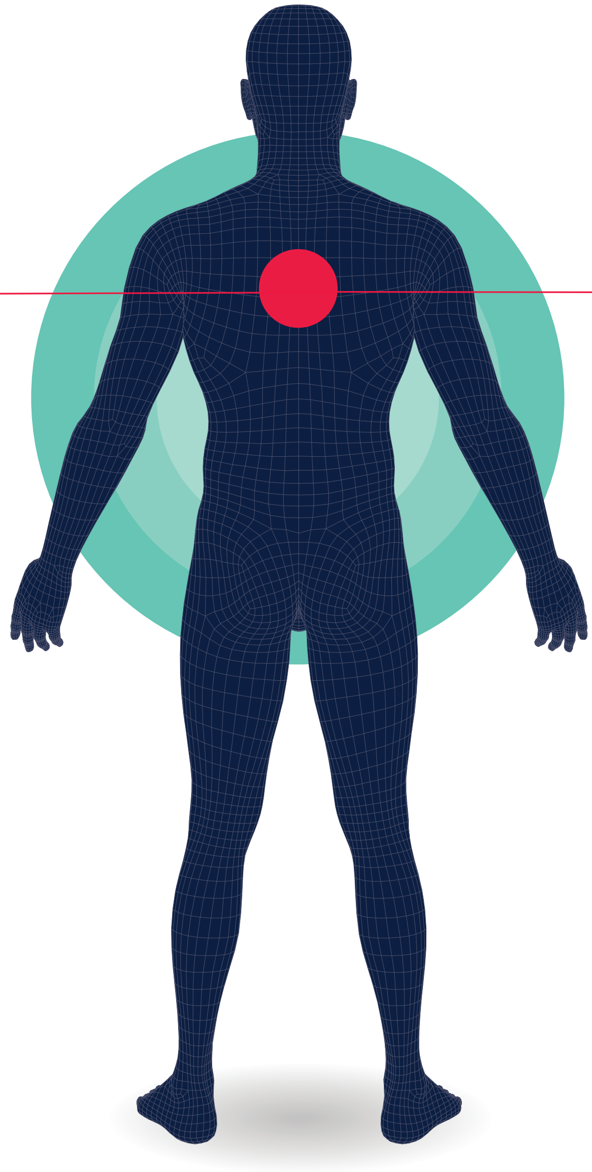
FIGURE 7: Cable-pulling without the trestle (A) and (B), compared to cable-pulling with the trestle (C).*

The results show a significant reduction in dangerous trunk (back) bending when the trestle was in use. The average forward bending of the trunk (back) was dangerously high when conventional cable pulling techniques were used but reduced by approximately 50 per cent when the trestle was used (FIGURE 8).

The trestle improved back and shoulder movement, enabling the worker to maintain a much safer, upright posture.

This demonstrates the potential for relatively simple modifications of tasks and equipment to reduce hazardous work postures.

However, where high forces need to be exerted to pull cables through, the preference is for this to be done mechanically, not manually.



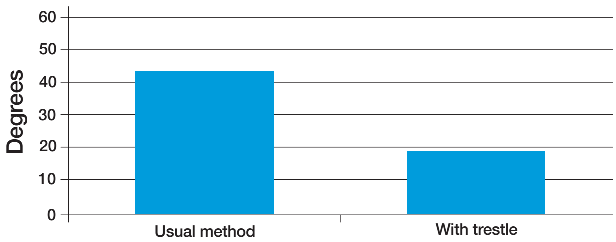


FIGURE 8: Average trunk (back) inclination without and with the trestle2 REFERENCE(S): 6.5.1.1, p. 156*

FIGURE 9: Musculoskeletal injury risks in shovelling REFERENCE(S): 8.1.1, p. 189*

6. Musculoskeletal injury risks in shovelling

Risk factors inherent in shovelling include:

- repeated bending of the back, often for long periods of time.
- repeated lifting and moving of heavy loads.
- stretching to reach the material being shovelled,
- sustained gripping of the shovel handle for long periods, and
- forceful use of the shovel to penetrate solid ground surfaces (FIGURE 9).

This poses the risk of injury to the back and wrist and shoulder.

7. Shovel handle re-design

A redesigned shovel handle was developed to enable the worker to maintain a straight position of the lower wrist (FIGURE 10).

FIGURE 10: Supplementary shovel handle REFERENCE(S): 8.2.2, p.191.

Compared to a conventional shovel handle, the supplementary handle reduced trunk inclination (bending of the back) for three shovelling actions:

— digging and moving sand at ground level,
— digging and loading sand from ground level to a height of 700mm, and
— scraping sand at ground level.

The use of the handle significantly reduced the percentage of time that the trunk (back) was spent in a forward bent position greater than 40 degrees (FIGURE 11).

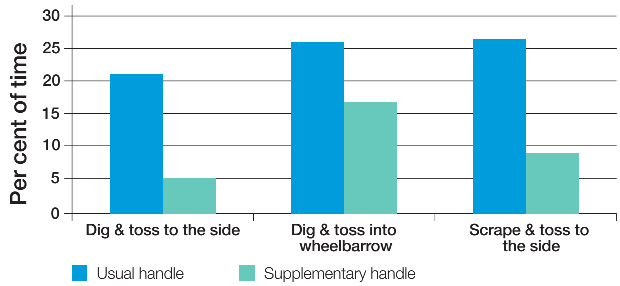
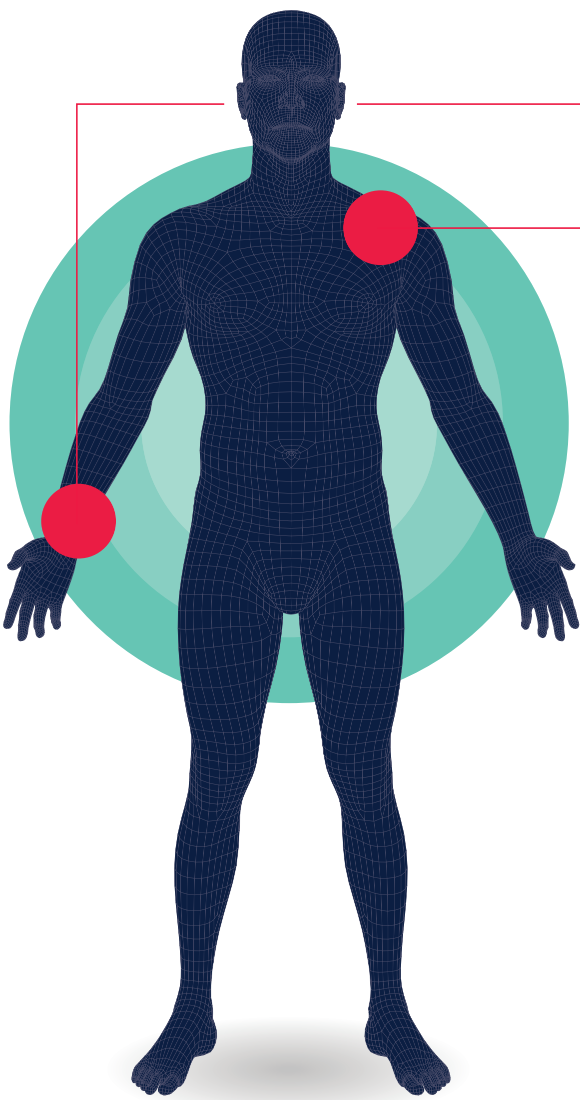


FIGURE 11: Per cent of time spent bent forward by more than 40 degrees
REFERENCE(S): 8.5.1, p. 199.



2 WorkSafe Victoria's Manual Handling Code of Practice identifies working with a trunk inclination greater than 20 degrees combined with undertaking a task for more than two hours over a whole shift, or continually for more than thirty minutes at a time, as a risk factor for musculoskeletal injury.

3 The WorkSafe Victoria Code of Practice for Manual Handling identifies excessive bending of the wrist when undertaking a task for more than two hours over a whole shift, or continually for more than thirty minutes at a time, as a risk factor for musculoskeletal injury.

The supplementary handle required less forward bending of the trunk (back) when loading material onto the shovel.

Peak force exertion when moving material was also reduced. The combination of working in a less bent posture and the need to use less force to move material reduces compression forces within the spine, reducing the risk of back injury.

The supplementary handle significantly reduced the rotation of the left (lower) wrist (as indicated by the values closer to zero in FIGURE 12). Being able to maintain a straight wrist when performing a repetitive shovelling action reduces the risk of wrist injury.

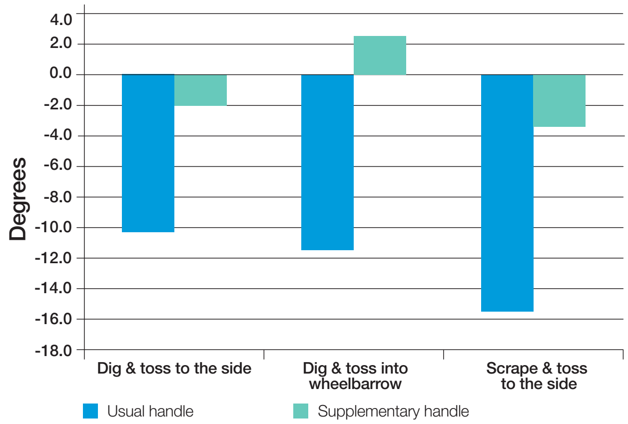


FIGURE 12: Mean rotation of the left wrist[3]

Movement of the left shoulder was also significantly lower when the supplementary handle was in use (FIGURE 13). In particular, the sideways movement of the shoulder away from the body (abduction) was significantly reduced when using the supplementary handle, reducing the potential for shoulder injury.

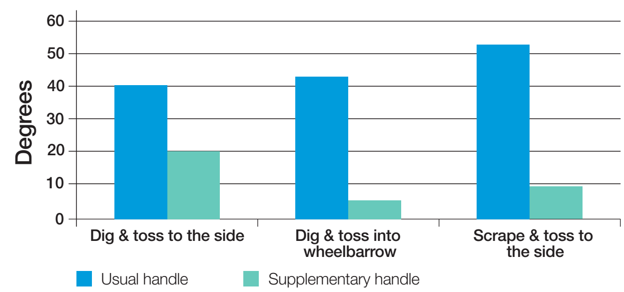


FIGURE 13: Average maximum left shoulder abduction

8. Consideration of equipment and work process design

Understanding the risk factors for musculoskeletal injury in manual construction tasks can help to identify improvements.

The challenge for the construction industry is to understand musculoskeletal injury risk factors inherent in everyday construction tasks and to identify opportunities for improvements.

In many instances, inexpensive and simple modifications to work processes or equipment can significantly reduce the risk of injury.

Evaluating the effectiveness of modified work methods and equipment can help to find solutions to long standing manual handling problems.

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In the last five years, WorkSafe Victoria has accepted over 6,200 compensation claims made by construction workers for musculoskeletal disorders*

Around 60% of those workers required more than four weeks off work*

The average compensation cost of a back injury claim is $136,0000**

* WorkSafe Victoria, Construction Safety Focus, February 2018

** WorkSafe Victoria, reported MSD claims in the construction industry between 01 July 2007 and 30 June 2017, excluding self-insured employers

For related content such as the full report, videos and training material, please see:
rmit.edu.au/musculoskeletalriskreductionresearch

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