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School of Property, Construction & Project Management
Building 8, Level 8
360 Swanston Street
Melbourne Vic 3000
Australia
GPO Box 2476
Melbourne VIC 3001
Australia
Tel. + 61 3 9925 1934
Fax + 61 3 9925 1939
www.rmit.edu.au

M. Dominique FONFREDE,
Gérant/Chairman,
RECEPIEUX,
ZAC du Rotey,
73460 NOTRE DAME DES MILLIERES,
France.

Dear M. Fonfrede,

Thank you very much for allowing me to observe the RECEPIEUX method for breaking the tops of concrete piles, during the demonstration that you gave in Melbourne in May 2018. The demonstration was extremely impressive and I have told many people about your method since I was able to observe it at the Melbourne Metro Tunnel Parkville precinct.

Thank you also for granting us permission to include some images and film footage of the RECEPIEUX method in the research documents and short videos we developed in relation to the prevention of work-related musculoskeletal disorders in the construction industry.

I am sending copies of four short summary reports that we produced on completion of the research. The RECEPIEUX technology is featured in the document titled 'Musculoskeletal risk reduction – jackhammering and shotcreting.' The films and full research report can be accessed at the following website: rmit.edu.au/musculoskeletalriskreductionresearch. I hope that this information is of interest to you.

Unfortunately we were not able to measure the biomechanical risk reduction associated with the RECEPIEUX method as our data collection was complete by the time that we became aware of the use of the method at the Melbourne Metro Tunnel project. However, we would welcome the opportunity to do an assessment using our system of wearable sensors at some point in the future.

Yours sincerely,

Helen Lingard

Helen Lingard,
Distinguished Professor,
Director, Work Health and Safety @ RMIT,
School of Property, Construction and Project Management,
RMIT University,
Melbourne, Australia.

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Musculoskeletal risk reduction – jackhammering and shotcreting

May 2018

Construction Work Health and Safety Research @ RMIT

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 move and are impacted when they perform manual work tasks, such as jackhammering and shotcreting.

Data was collected at rail construction projects in Melbourne being delivered as part of the Major Transport Infrastructure Program. The study considered ways of re-designing systems of work and using alternative technologies 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.

All of these factors increase the risk of musculoskeletal injury.

The parts of the body most affected by work-related musculoskeletal disorders are:

- the back (**35.1%**)
- the shoulder (**16.1%**)
- the knee (**13.2%**)
- the ankle (**6.0%**) and
- the wrist (**4.3%**).[1]

Musculoskeletal injuries are often associated with poorly designed systems of work.

The research explored the potential for changes to systems of work, particularly the use of alternative technologies or equipment, to reduce risk factors for musculoskeletal injury.

3. Musculoskeletal injury risks in jackhammering

Data was collected while a jackhammer was being used to break down the top section of concrete piles (FIGURE 1).

FIGURE 1: Breaking the top of concrete piles using a jackhammer* REFERENCE(S): 7.1.5, p. 173.

This work involved bending the back and the use of excessive force when lifting the jackhammer into position and when maintaining the jackhammer in position over an extended period of time (FIGURE 2). Workers were also exposed to noise, dust and vibration.

FIGURE 2: Lifting the jackhammer into position* REFERENCE(S): 7.2.2, p. 175.

The potential for injury to the back, when breaking back piles mechanically with a jackhammer, was found to be high.

The amount of time the trunk (back) was in a bent position, when breaking piles using a jackhammer varied depending on the height at which work was being carried out. However, when working between knee and hip height, a jackhammer operator worked with their back bent by more than 40 degrees for more than a third of the time.[2]

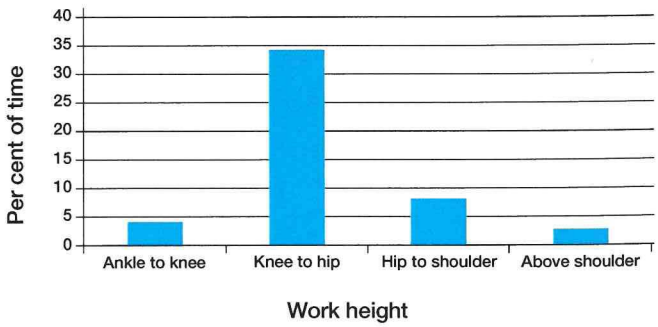


FIGURE 3: Percentage of time spent with trunk (back) inclination greater than 40 degrees REFERENCE(S): 7.3.1, p. 177.

1 Source: Safe Work Australia, 2016

2 The WorkSafe Victoria Code of Practice for Manual Handling identifies working with a trunk inclination greater than 20 degrees 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.

3 Source: www.recepieux.com, reproduced with permission.

* 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.

4. Alternative pile breaking systems

Alternative pile breaking methods that eliminate or substantially reduce these physical demands and injury risks are available. These can be implemented if considered at the early design and work planning stages.

In this case, an integrated de-bonding material, was to be incorporated in the pile around the steel bars above the cut-off level before the concrete was poured.

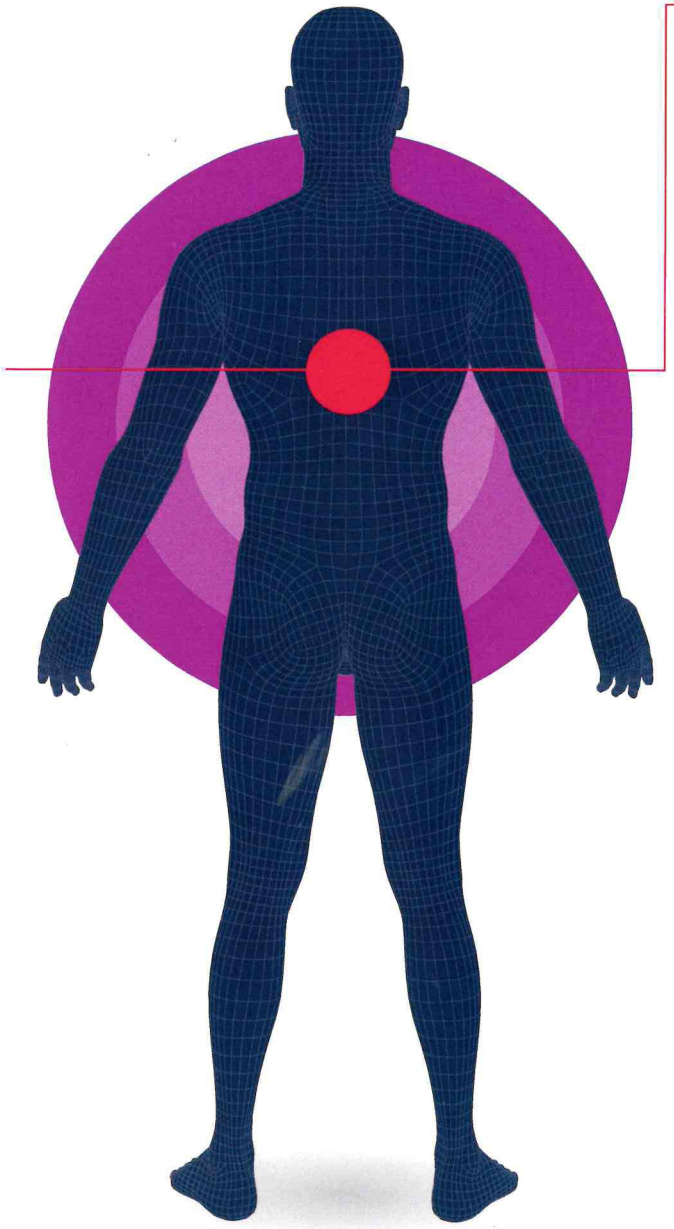
This material was to be used to make pile breaking and separation easier, significantly reducing the duration of jackhammering needed for this task.

However, to be effective the de-bonding material needs to be correctly installed around the bars, before the column is constructed. If the de-bonding material is not correctly installed when the concrete piles are poured, pile-breaking involves significantly greater physical effort, time and increased injury risk for the jackhammer operator. REFERENCE(S): 7.5.1, p. 186.

Alternatively, active pile breaking technologies that do not require mechanical breaking with a jackhammer can also be considered when designing the system of work (FIGURE 4).

Importantly, these need to be incorporated during the design and planning stages of construction work.

FIGURE 4: Alternative chemical pile breaking method[3]



5. Musculoskeletal injury risks in shotcreting

The research also examined musculoskeletal injury risks in the task of shotcreting, which involves using compressed air to spray concrete onto a surface at high velocity to create a dense and strong concrete layer (FIGURE 5).

Shotcreting involves repetitive forward leaning movements that coincide with the pumping cycle. This work also involves awkward arm, wrist and hand postures that result from grasping and holding the hose in front of the operator's body or over their shoulder for sustained periods of time to direct and control the flow of concrete.

The measurement of muscle activation during shotcreting indicated that muscles on the right side of the back (in the mid-thoracic and lumbar regions) were more active than those on the left side of the back. The muscles on the right side of the back exceeded the greatest amount of tension that the worker's muscle can generate and hold, even briefly (FIGURE 6). This high muscle activity would increase load on the spine and created a high risk of back injury.

FIGURE 5: Manual shotcreting* REFERENCE(S): 5.3.2, p. 131.

6. Alternative shotcreting systems

Excavator mounted hoses have been trialled and can reduce the need for someone to hold the hose while concrete is applied, potentially reducing the risk of musculoskeletal injury (FIGURE 7).

FIGURE 7: Excavator mounted shotcreting (image courtesy of Acciona Geotech Holdings)

Robotic shotcreting equipment is also commercially available, and is a modern, safe way to apply wet shotcrete (FIGURE 8).

FIGURE 8: Robotic application of wet shotcrete (image courtesy of Normet Asia-Pacific Pty Ltd)

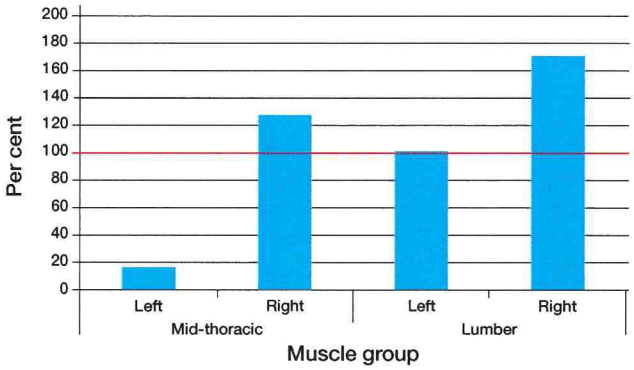


FIGURE 6: Muscle activation in the back during shotcreting
REFERENCE(S): 5.5.2.1, p. 139.

Shotcreters were also observed to work on rough and uneven ground surfaces and frequently drag the concrete and compressed air hoses for long distances as they moved position. The provision of flat work surfaces, attention to good housekeeping and assistance with moving equipment can also reduce the risk of slips, trips and falls, and the potential for strain and sprain injuries.

The potential benefits of adopting or adapting mechanised shotcreting methods to reduce physical work demands and injury risks for shotcreters are significant.

Wherever possible, mechanised options should be considered when designing safe systems of work for shotcreting.

7. Consideration of safe work system design

Providing a safe system of work involves careful planning and consideration of the interaction between workers, their equipment, the materials they are using and the broader work environment.

Effective control measures for the risk of work-related musculoskeletal injury should be identified and specified during the design stage of a project, when important decisions that affect workers health and safety are made.

Considering ways to alter systems of work to reduce the risk of work-related musculoskeletal injury is an important aspect of improving the construction industry's health and safety outcomes and ensuring construction workers are able to enjoy productive and healthy working lives.

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The incidence rate per 1,000 workers for serious claims is higher in the heavy and civil engineering sector of the construction industry (30.8) than in the building (12.6) or construction services (16.8) sectors.*

* Source: Safe Work Australia, Construction Industry Profile, 2015.

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Around 12,600 workers' compensation claims are accepted from the construction industry each year for injuries and diseases involving one or more weeks off work.*

This equates to 35 serious claims each day.*

Body stressing is the main cause of injury, accounting for 37% of claims made by construction workers.*

* Source: Safe Work Australia, Construction Industry Profile, 2015.

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

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