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# Musculoskeletal risk reduction – steel-fixing

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Construction Work Health and Safety Research @ RMIT

RMIT UNIVERSITY
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Body stressing is muscular stress from manual handling: lifting, carrying, pushing, pulling objects; or stress from physical movements such as holding a posture or making repetitive movements.*

Body stressing causes nearly 40% of serious workers' compensation claims in Australia.*

*Source: Safe Work Australia, Australian Workers' Compensation Statistics 2015-2016

## 1. Purpose of this guide

This purpose of this guide is to present considerations and suggestions for the reduction of work-related musculoskeletal disorder risks in steel-fixing. These considerations and suggestions are based on the findings of field-based research in which construction workers' body movements were continuously measured in time during their usual work activities utilising a whole body system of wearable sensors.

The sensors produced valuable information about the way that workers' bodies move and are impacted when they perform the selected work tasks.

Data was collected at rail construction projects in Melbourne being delivered as part of the Major Transport Infrastructure Program. The study compared the use of three different tools/methods for steel-fixing.

## 2. Musculoskeletal injury risk in steel-fixing

Placing and securing steel bars used in reinforced concrete involves heavy manual materials handling and work in awkward postures.

International research shows that steel-fixers spend 40% of their work time in awkward trunk postures.[1] Steel-fixing also involves a high risk of work-related musculoskeletal injury affecting the hand, wrist or fingers, with up to 48 per cent of steel-fixers reporting symptoms in these areas of the body.[2]

This study found that hotspots for musculoskeletal injury in steel-fixing are the back, the shoulder and the wrist.

## 3. Steel-fixing tools

Some ergonomic tools have been developed to reduce the amount of bending involved in fixing steel below knee heights.

The study evaluated the impact of using three different tools for steel-fixing. These were:

A. a long-handled stapler tool
B. a conventional pincer-cutter tool and
C. a power tying tool


FIGURE 2: The long-handled stapler tool (A), conventional pincer-cutter tool (B) and power tying tool (C). REFERENCE(S): 4.2.1, p. 88.

## 4. The back

When working below knee level, a steel-fixer usually needs to bend their back and reach down. Average trunk (back) flexion when working at this level exceeds 70 degrees and peaks at over 80 degrees.

Over long periods of time poor back postures like this can lead to lower back injury.

FIGURE 3: Steel-fixing at ground level*

Some ergonomic tools have been developed to reduce the amount of bending involved in fixing steel below knee height.

The conventional pincer-cutters and the power tying tool did not differ in terms of the extent to which steel-fixers had to work in a bent posture when fixing steel at lower work heights. However, the long-handled stapler tool significantly reduced bending of the back when working below knee level (FIGURE 4).

The average trunk (back) inclination was reduced from 74 degrees using conventional pincer-cutters to 34 degrees using the long-handled stapler tool when fixing steel at ground level (FIGURE 5).

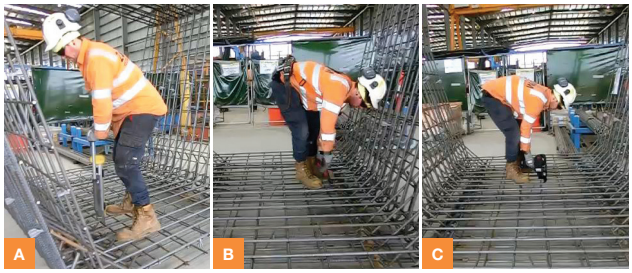



FIGURE 4: Steel-fixing at ground level with different tools. The long-handled stapler tool (A), conventional pincer-cutter tool (B) and the power tying tool (C).*

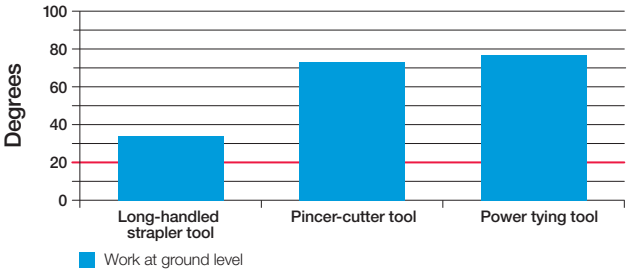



FIGURE 5: Average trunk inclination using there different tools for fixing steel at ground level. REFERENCE(S): 4.6, p. 96.

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.

1 Buchholz, B., Paquet, V., Wellman, H., & Forde, M. (2003). Quantification of ergonomic hazards for ironworkers performing concrete reinforcement tasks during heavy highway construction. AIHA Journal, 64(2), 243-250

2 Forde, M. S., Punnett, L., & Wegman, D. H. (2005). Prevalence of musculoskeletal disorders in union ironworkers. Journal of Occupational and Environmental Hygiene, 2(4), 203-212.

* 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.

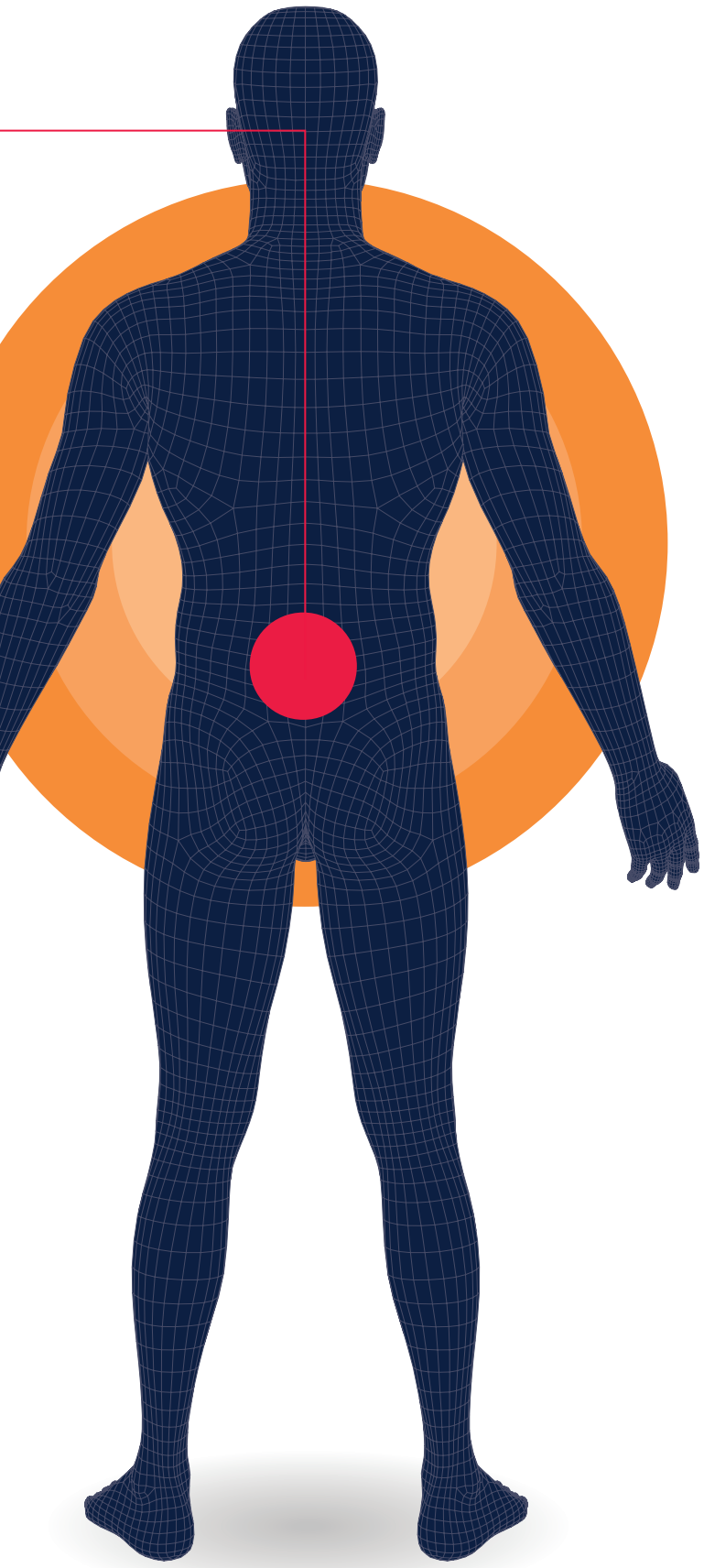


FIGURE 1: Injury hotspots in steel-fixing

## 5. The wrist

Conventional steel-fixing involves repeated rotation of a pincer-cutter tool to twist and tighten wire. Repeating this action over a working day increases the risk of wrist injury because it involves repetitive twisting and turning.

When using the power tool, the wrist was almost straight when working at both knee-to-hip and hip-to-shoulder heights (indicated by range of movement values close to zero in FIGURE 6). In contrast, the pincer-cutter tool involved significantly greater bending of the wrist (indicated by high positive values), increasing the risk of work-related musculoskeletal injury to the wrist (FIGURE 6).

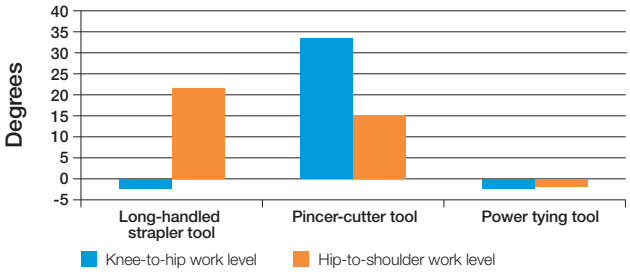



FIGURE 6: Peak right wrist flexion/extension (positive values indicate wrist flexion and negative values indicate wrist extension) REFERENCE(S): 4.6.5, p. 110.

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 long-handled stapler tool performed differently in terms of the risk of wrist injury depending on whether steel-fixing was undertaken at knee-to-hip or hip-to-shoulder height. When work was at knee-to-hip height, a steel-fixers' wrist remained relatively straight when using the long-handled stapler tool. However, when the height of work moved to between the hip-to-shoulder, the long-handled stapler produced a greater range of wrist movement which could be hazardous.

The power tying tool also significantly reduced the amount of wrist rotation when fixing steel (FIGURE 7). The values close to zero reflect that, when steel was fixed using the power tying tool, there was little or no rotation of the wrist.

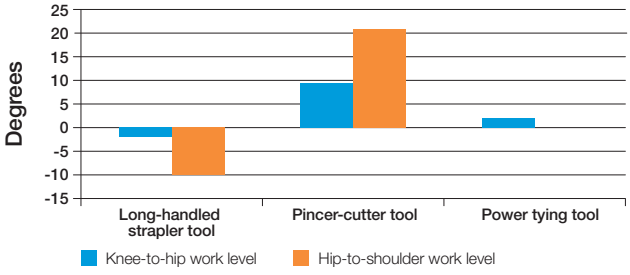



FIGURE 7: Right wrist rotation

## 7. Considerations for tool selection and design

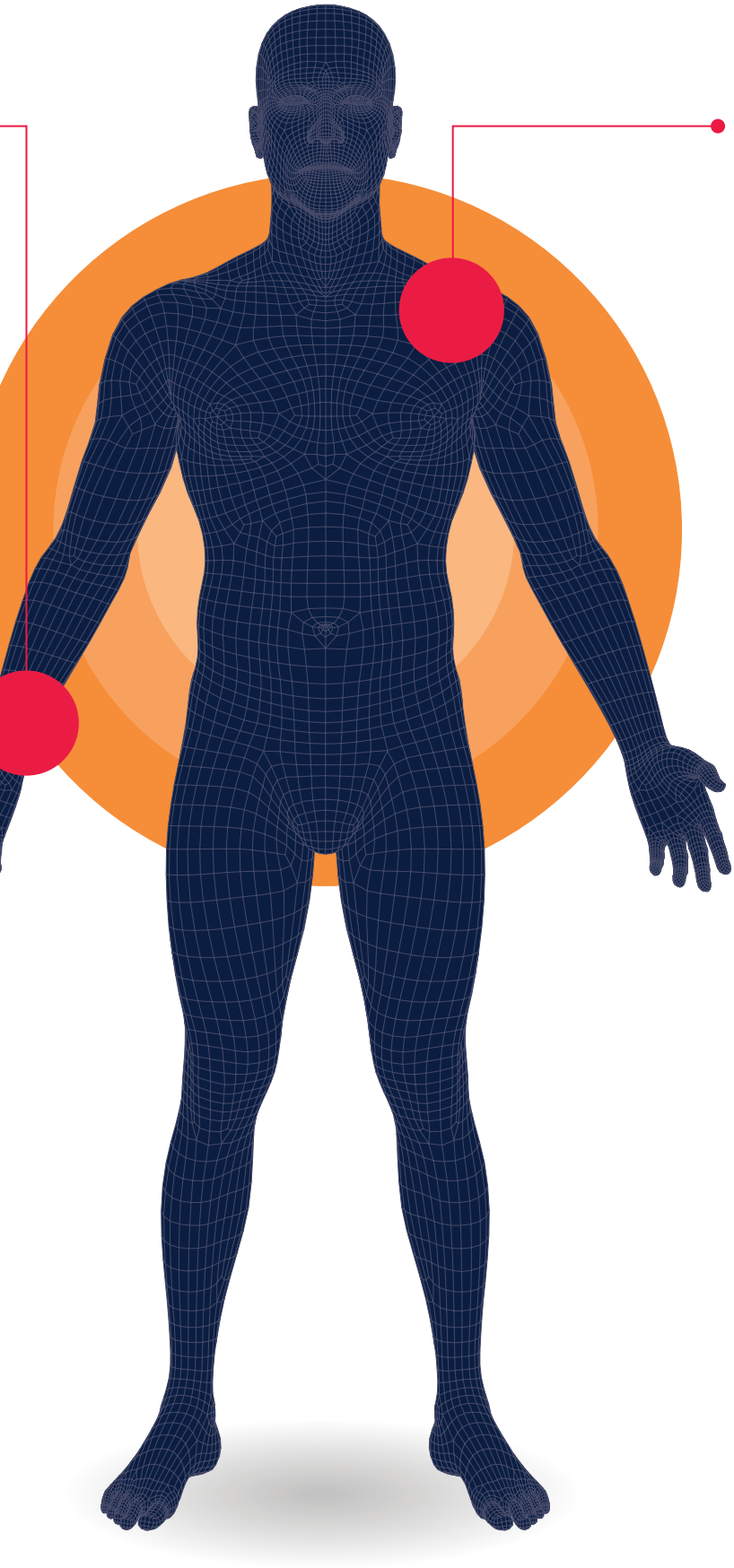
**Wherever possible, steel-fixing tasks should be designed to avoid awkward postures, excessive bending of the back or work above shoulder height.**

Consideration should be given to the height at which steel bars are to be fixed and, where possible, work should be designed to reduce bending of the back (for example when working below knee level) or extension of the shoulders (for example when working above shoulder height).

Where this is not possible, care should be taken in selecting the most ergonomically effective tools for the job.

The research showed that ergonomic tools can make a difference in reducing the risk of work-related musculoskeletal injury when fixing steel.

**But no single steel-fixing tool was ideal in all situations.**



## 6. The shoulder

Working overhead uses awkward shoulder postures and movements that may lead to shoulder injury.

**Work overhead should be avoided wherever possible.**

However, if work overhead cannot be eliminated, the use of a long-handled stapler tool reduces awkward shoulder movements, reducing the risk of shoulder injury (FIGURE 8).


FIGURE 8: Steel-fixing overhead with different tools. The long-handled stapler tool (A), conventional pincer-cutter tool (B) and the power tying tool (C).*

FIGURE 9 shows the high range of shoulder movement involved in performing steel-fixing work above the shoulder and overhead. **A high range of movement presents a high level of risk of work-related musculoskeletal injury to the shoulder.**

When work is performed overhead, the range of shoulder movement was 151 degrees when using conventional pincer-cutters. This reduced to 13 degrees when the long-handled stapler tool was used, significantly reducing the risk of musculoskeletal injury to the shoulder (also shown in FIGURE 8).

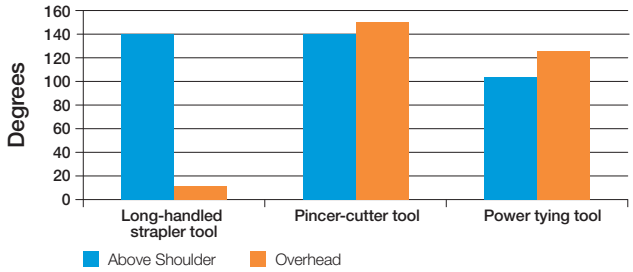



FIGURE 9: Peak right shoulder elevation. REFERENCE(S): 4.6.4, p. 106.

The WorkSafe Victoria Code of Practice for Manual Handling identifies working with one or both hands above shoulder height 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 work-related musculoskeletal injury factor for musculoskeletal injury.

While the long-handled stapler tool reduced bending of the back while fixing steel at lower work heights, the stapler tool required the use of a forceful pushing and pulling action to fix and twist the wire tie.

The power tying tool significantly reduced the repetitive movement of the hand and wrist, but was heavy to hold in one hand and did not reduce the need to bend the back while working below knee level.

**The challenge for the construction industry is to encourage the further development and use of well-designed ergonomic tools and methods of work to reduce musculoskeletal injury risks in steel-fixing.**

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

More than a third of serious workers' compensation claims for body stressing involve non-powered hand tools appliances or equipment.**

The average compensation cost of a body stressing injury has doubled since 2000-01.**

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

** Source: Safe Work Australia, Australian Workers' Compensation Statistics 2015-2016.

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

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