

HILTI

Study into benefits of Hilti EXO-S

Exoskeleton for work above shoulder level

Introduction

Musculoskeletal injuries caused by overhead construction work are a **major problem for the construction industry's businesses and employees.**

Companies see productivity losses because of these injuries, and employee well-being is also at risk.

Exoskeletons such as the Hilti EXO-S aim to enhance productivity by **reducing stress on the body during overhead jobs**, helping to cause less pain and fatigue due to a reduced load on muscles and joints. But just how effective is the EXO-S when it comes to relieving the strain?

Putting the EXO-S to the test: drywall use case

That's what researchers at Germany's Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) set out to explore. They constructed a drywall test stand at the Exoworkathlon® – a circuit of work tasks enabling industrial exoskeletons to demonstrate their functions, ergonomics and production quality.

The IPA asked ten trade apprentices and students from the Steinbeis School of Technology and Engineering in Stuttgart, Germany to perform **two repetitive, strenuous activities in an overhead position:**

1. Sanding plaster joints between drywall panels
2. Screwing sheetrock using a cordless drywall screwdriver

To achieve an objective evaluation, participants performed each activity for one hour (six times eight minutes) with an EXO-S exoskeleton and for one hour without an exoskeleton. There was a two-hour break between each session. After each trial, the physical strain of the activity on the participants' individual body parts was recorded, and the usability of the EXO-S was surveyed.

Test set-up

- Number of applicants: 9
- Activities: Screwing/sanding on wall/ceiling
- Muscles tested: Right/left shoulder muscles (acromial and clavicular parts)
- No. of trials: 6
- Duration of each trial: 8 minutes
- Total time wearing EXO-S: 1 hour
- Total time without EXO-S: 1 hour



EXO-S exoskeleton reduces muscle activity

On average, wearing the exoskeleton **significantly reduced muscle activity across all test subjects** while performing overhead work.

The trials showed **average muscle activity was between 25% to 35% lower** across the shoulder muscles using the EXO-S. This reduction was particularly evident when screwing. For screwing to a ceiling, muscle activity was 48% lower using the EXO-S.

The EXO-S also **helped the test subjects achieve a more precise finish**. Typically, the number of inaccurately installed screws increases towards the end of a task. Thanks to the EXO-S, however, it was possible to slightly reduce this number and ensure more precise screwing.

What's more, the **study participants reported that they felt comfortable wearing the EXO-S**, with the test participants ranking usability close to "good".

Test results (wearing EXO-S)

31%

decrease in left
shoulder muscle
activity (acromial)

25%

decrease in left
shoulder muscle
activity (clavicular)

32%

decrease in right
shoulder muscle
activity (acromial)

35%

decrease in right
shoulder muscle
activity (clavicular)

5%

increase in accurately
installed screws with
exoskeleton

Conclusion

Whether it's fastening drywall track, installing piping or surface grinding, overhead work is physically demanding, time-consuming and error-prone – and it can have a damaging effect on your employees' health. And with muscle fatigue known to be a precursor of work-related musculoskeletal disorders¹, that effect can be long-term.

The results of the IPA study into the EXO-S, however, show some positive developments. **Statistically significant effects of wearing the EXO-S on the users' physiological strain were observed with all methods used in the study and reduced fatigue led to fewer errors.**

REFERENCES

1. "Muscle Fatigue at Work" <https://sms.hest.ethz.ch/research/past-research-projects/muscle-fatigue-at-work.html>



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