Developing and testing of ergonomically tools for tile-setters work

J. Wakula\textsuperscript{1}, M. Adelmann\textsuperscript{B}, G. Linke-Kaiser\textsuperscript{B}, K. Landau\textsuperscript{A}

\textsuperscript{A}Ergonomics Institute, Darmstadt University of Technology
Petersenstr. 30, D-64287 Darmstadt, Germany

\textsuperscript{B}Bau-Berufsgenossenschaft Frankfurt am Main, An der Festeburg 27-29,
D-60389 Frankfurt am Main, Germany.

Selected tools for tile-setters (a transportable work station including a work table and platform with adjustable height, a device for transportation and tipping out mortar, and a tool box) were developed and designed in order to reduce the tile-setters' strain. Two prototypes of transportable work station were tested in 8 tile-setting companies and a learning centre. A questionnaire was worked out for the testing. Considering the test results and in co-operation with industrial manufacturers, the development will be finished so that the work station can go into production.

Introduction

Ergonomic and occupational medical studies of tile-setters work have shown detailed results of stress-strain situations in the tile-setters' work, and of musculoskeletal complaints and diseases (Adelmann et al., 1994). In order to reduce the tile-setters' strain, ergonomic design requirements were derived (Adelmann/Wakula, 1997). Selected tools for tile-setters were developed and designed in a research project (Wakula, 1997; Landau and Wakula, 1997).

A transportable work station including a work table and platform with adjustable height (fig.1), a device for transportation and tipping out mortar (fig.2), and a tool box were developed.

Several of the tile-setters' jobs that were particularly subject to stress up to now (e.g. cutting the tiles on the floor in a kneeling position; working above shoulder level; transporting and tipping out mortar; transportation of tools) can be facilitated with these devices.

During the development of the tools, criteria of technical safety, ergonomics, economy and ecology were considered.

\textsuperscript{1} Contact: Tel: +49 6151 16 3189 / Fax: +49 6151 16 3488; wakula@iud.tu-darmstadt.de.
The project was supported the Statutory Occupational Accident Insurances (Bau-Berufsgenossenschaften) in Germany. In the project a group of tile-setters (employers and employees), physicians of occupational health, and engineers of the „Bau-Berufsgenossenschaften“ worked together with the institute.

Two prototypes of the transportable work station, including a work table and platform with adjustable height, were built for testing in tile-setting companies.

The graduated height adjustment from 25 cm to 90 cm makes it possible to use the work station as a platform (fig. 3) in three heights (25 cm; 45; 60 cm). Because of this, the higher areas of the wall are easier to search when setting tiles. When using the works station as a table (fig. 1), it can be adjusted to five different heights (70 cm; 75 cm; 80 cm; 85 cm; 90 cm). Thus, it can be adjusted to the individual height of the tile-setter in a standing position. Tools and working material can also be placed on the table.

Because of the folded compactness and weight (approx. 25 Kg) of the work station, it can be transported in an average automobile. It can also be hard carried almost anywhere without a problem. Two added rollers on the side ensure mobility at the construction site, even in the unfolded position (s. fig.4).

Fig. 3: Using a transportable work station as platform

Fig. 4: Mobility of the work station at the construction site

Method
A questionnaire was worked out for the testing of the transportable work station prototypes.

The questionnaire was divided into three sections and contained 22 questions. The first section pertained to the question of interest of tile-setters. For a work station, satisfactory usefulness of the main functions of the prototype, the cost and potential sales. The second section pertained to the function and construction of the prototype with suggestions for possible improvement. The third section pertained to the instructions to the tile-setters and the company. The questionnaire was first tested in a tile setting company.

Fifteen tile-setters from five small tile-setting companies (up to 5 employee's) and three large companies (up to 20 employee's) as well four persons from a learning centre for tile-setters took part in the study.

Results
The developed prototype of the work station was found to be suitable by all who completed the questionnaire. About 40% of tile-setters questioned are interested in a work table with adjustable height and about 47% of them are interested for platform and
work table (s. fig. 5).

Abb. 5: Answers of tile-setters to using areas of the work station

The prototype received mostly negative results on the questions of weight and transportability. Almost 90% of those questioned the prototype to be too heavy.

The weight was the main cause of the unsatisfactory results during transportation of the prototype (about 50% negative votes [fig. 6]).

Fig. 6: Answers to question: good transportability of prototype

The adjustable height of the prototype, when used as a table was found to be satisfactory by all questioned. When used as a platform, it was often found to be too small. Because of this, all those questioned had to work for over 1/2 hour each day in heights they could not reach from the platform. The adjustable height of the prototype is necessary when used as a table, as confirmed by the majority of these questioned.

An important question was the price for this work station. Only two tile-setters are prepared to pay about $ 450,- for this work station. One third of tile-setters gave no information concerning the price.

The wishes on suggestions for improvement were wide spread (table 1). Most desired a weight reduction to make carrying and transport easier. Two tile-setters want to use the prototype only as a work table with a constant height. Two tile-setters require a large work area top. Other suggestions were for an easier height adjustment mechanism and one for a hook type height adjustment.

Table 1: Wishes on suggestions for improvement of prototype

<table>
<thead>
<tr>
<th>Ultimate height adjustment mechanism</th>
<th>Work table only with 90 cm constant height</th>
<th>Weight reduction</th>
<th>Larger work area top</th>
<th>Hook type height adjustment</th>
<th>Rounded hand grip</th>
<th>Side/corner protection for the table top</th>
<th>Non-slip table top</th>
<th>Aluminium table top</th>
<th>Brakes</th>
<th>Sliding grips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier height adjustment mechanism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The idea of adding a sliding grip for moving the prototype as well as adding brakes to ensure stability when standing, were forthcoming.

The prototype will be certified as German standard for safe equipment.

Conclusions
Considering the test results and in co-operation with industrial manufacturers, the development will be finished so that the work station can go into production.

References
Adelmann, M.; Wakula, J.; Bunk, W.; Schildge, B.; Linke-Kaiser, G.; Roehmert, W.: Der Fliesen-, Platten- und Mo-
