Ergonomic Job Analysis

Dowel By Substitution

Construction Occupational Health Project
Department of Work Environment
University of Massachusetts Lowell
One University Ave.
Lowell, MA 01854
PREFACE

The Construction Occupational Health Program (COHP) is part of a national effort to conduct research to increase the understanding of the health risks to workers in the construction industry and to reduce the exposure to those risks. The COHP works with both unions and contractors in order to conduct exposure assessment and to provide participatory approaches to intervention in the areas of ergonomics, industrial hygiene, and work environment policy. This technical report was produced with the supported of a grant from the National Institute for Occupational Safety and Health (grant #U02/CCU308771) through the Center to Protect Workers' Rights (CPWR, grant #ROI OHI 3060), the health and safety arm of the Building Trades Department of the AFL/CIO. The contents of this report are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH or CPWR.

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Ergonomic Exposure Assessment

The purpose of this ergonomic job assessment (EJA) of reinforcement ironwork using a “Dowel By Substitution” (DBS) is to:

1. Identify the generic ergonomic risk factors (e.g., forceful exertions, awkward postures, localized contact stresses, vibrations, temperature extremes, repeated motions or prolonged activities) that rebar ironworkers are exposed to during the tasks associated with inserting rebar into DBS systems;
2. Identify which aspects of the tasks associated with DBS systems cause or contribute to worker exposure; and
3. Recommend controls to reduce or eliminate identified ergonomic risk factors.

PATH

Included in this EJA, using the PATH methodology, is a quantified estimate of postural risk factors. The purpose of this quantitative exposure analysis of is to:

1. Provide estimates of the frequencies ironworkers spend in various trunk, leg, and arm postures, as well as time spent doing manual material handling (MMH) activities; and
2. Quantify which activities of the DBS tasks cause or contribute to high ergonomic exposures for the ironworker.

Comments or requests for more information
If you would like further information or would like to send written comments on this Technical Report, please use the address shown below:

Construction Occupational Health Program
Department of Work Environment
University of Massachusetts Lowell
1 University Avenue
Lowell MA 01854
Attention: Scott Fulmer, Director

Or you can visit the COHP’s web site at:
http://www.uml.edu/Dept/WE/COHP

For an immediate response, we can be reaching using the following telephone numbers:
(978) 934-3329 (Admin. Assistant Therese O'Donnell)
(978) 452-5711 (fax)
Therese_ODonnell@uml.edu
METHODS

The data for this report includes both descriptive ergonomic observations and the analysis of direct observations of the PATH methodology. Site observations were made on a major highway project in Boston that included the construction of an underground tunnel connecting two interstate highways. Observations were made by two trained ergonomists, but a single trained observer made the PATH observations. A total of 300 PATH observations were made. The PATH observations were made on 14 different individuals on several different occasions between May 2001, and November 2002. The same company, a subcontractor on the construction site, employed each of the individuals. The subcontractor specialized in Ironwork, and the crew included members of various Locals (including 7, 37, 57) of the International Association of Structural, Ornamental, and Reinforcing Ironworkers.

The environmental conditions ranged from sunny and hot on some days to damp and cold under a tunnel roof on other days. Rain preempted work unless the DBS work was under the tunnel roof. During the winter, work continued regardless of cold temperatures.

The observer used an Aero1500 handheld computer by Compaq to record PATH data. The handheld computer ran a program called Inspect-Write by PenFact®. The data collected on the handheld computer was then uploaded onto a laptop computer, and the Inspect-Write program then exported the data in a text file to be analyzed by EpiInfo.
ANALYSIS

Operation: Concrete reinforcement

Task: Insert threaded rebar into Dowel By Substitute (DBS) imbedded in slurry wall.

Work Objectives: To insert rebar dowels into threaded holes anchoring into slurry wall. Once inserted, the anchored rebar dowels would later be tied to the rebar mats that reinforced large roof and invert slabs of the cut and cover tunnel structure.

Workers Ironworkers

Description Inserting rebar – rigging, MMH, screwing in bars
  a) Prepare work – unload bar, set bars near holes
  b) Insert bars – one or two people hold bar, find thread, screw

On this job, three levels of threaded holes had been embedded into slurry wall. The lowest level was 3”-6” off the ground; the middle level was 30”; the upper level was 50” to as many as 80”.

Work Schedule Typical construction hours – 7 – 3:30.
The Ironworkers usually did not work on this task for an entire day.

Work Pace Rate of complete dowel insert varies with success of finding usable thread – 2 to 10 minutes, if successful;

Tools and Equipment Rebar dowel – 7’ to 14’ lengths of #11 rebar (5.3lbs/ft., 1.401” diameter)
Pipe wrench – adjustable, less than 10 lbs.
Dummy dowel – 12” threaded, #11 rebar (5.3lbs.)
WD40 – spray can
Wire cutter – pliers, less than 10 lbs.
**Work Methods**

<table>
<thead>
<tr>
<th>Task</th>
<th>Activity</th>
<th>Tools</th>
<th>Body area</th>
<th>Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare</td>
<td>Unload rebar</td>
<td>Wire cutter</td>
<td>Hand/wrist</td>
<td>Awkward posture</td>
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<tr>
<td>Set rebar near holes</td>
<td></td>
<td></td>
<td>Back</td>
<td>Forceful exertion, trunk flexion</td>
</tr>
<tr>
<td>Insert bars</td>
<td>Pick up and carry bar</td>
<td></td>
<td></td>
<td>Forceful exertion, trunk flexion</td>
</tr>
<tr>
<td></td>
<td>Line up bar into threaded hole</td>
<td>Dummy dowel, WD40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Screw in bar</td>
<td>wrench</td>
<td>Wrists, Shoulders, Back</td>
<td>Forceful exertion, severe forward flexion, overhead work, repetition</td>
</tr>
</tbody>
</table>

**Summary of Ergonomic Exposures**

The primary ergonomic exposures of concern with this task are forceful exertion, awkward posture, and repetition. Rebar weighs 5.3 lbs./ft., so the dowels being inserted ranged from 37.5lbs. to 75lbs., according to it’s length. When the dowels need to be screwed in to a high level, the heavy weight and the repetitive flexion must be done with the elbows over shoulder height (about 5% of the time). The trunk must be in severe forward flexion (36% of the time) when the dowels are screwed into the lowest level, only a few inches above the floor.

**Controls**

One control to consider is the use of an impact wrench and a coupler that fits the wrench and the dowel. The dowel would be driven in by the power of the impact wrench, thus saving exposure to repetitive wrist motion, and reducing the amount of time screwing in the dowels. As is the case with any power tool, the necessary precautions should be taken. The torque of the impact wrench could be substantial and act against the wrist. Also, care should be taken to insure the grip of the impact wrench does not put the wrist in awkward posture. On the highest row of inserts, some sort of elevated work surface should be used to reduce the amount of overhead work.
1) Prep work: Ironworkers laying out rebar in DBS area. The rows of holes in the background are imbedded in the slurry wall. The short bars will be inserted and the longer bars will be attached to the shorter ones.

2) A crew of Ironworkers inserting rebar dowels into DBS system.
3) After the crew has inserted the rebar into the lowest level of DBS holes, then the short dowels are ready to attach to the longer dowels, creating a mat at that level.

4) The finished work of the Ironworkers: the DBS is inserted into the wall, and the mats are connected to the DBS dowels. Here, Laborers are standing on a finished mat while pouring into a finished form next to the open one they are standing on.
5) Some rows of DBS holes are much higher than the average.