Reinforcing bar installation: Case study of a training center for the steel trades

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Abstract: Work activities, organization, environment and equipment are all sources of occupational health and safety (OHS) risks for rebar installers. The case study of a training center for the steel trades in Quebec improves our understanding of the OHS status of rebar installation.
Keywords: rebar installer, OHS risk, musculoskeletal disorders, ergonomics.

1. Introduction

Manufacturing steel reinforcement rebar assembly for concrete structures. and installing them in formwork involve numerous challenges relating to technique, time, cost and quality. To begin with, the work environment is subject to discontinuity and hence uncertainty (Ditrichstein 2005). The reinforcing structures are generally large and cumbersome, thus adding complexity to work organization and the supply of materials at the construction site.

Steel concrete reinforcing bars are produced in straight lengths or coils. Coils are assembled at the shop in meshes. Steel bars are moved, cut, stacked and assembled into reinforcement sub-assemblies (AFCAB 2008) according to standards as catalogued items or according to drawings on a custom-order basis. These lattices may be handled as such at the construction site or welded in the shop for delivery to the site as large completed assemblies. The steel reinforcement assembly, along with various composite materials, is then installed in the formwork before pouring the concrete (Ditrichstein 2005). Typical processes are summarized in Table 1.

Called ‘rebar installers’ in the trade, installers of steel assemblies for reinforced concrete must pick up and carry corrugated rods measuring up to 18 m in length and with diameters ranging from 11.3 mm to 25.2 mm (7/16 inch to 1 inch, linear mass ranging from 0.785 kg/m to 3.925 kg/m) as well as 10-15-meter rolls of steel wire, corrugated steel wire or welded steel screening of various weight and mesh size (Ditrichstein 2005).

The work activities of these steel trade workers require them to assume onerous postures involving 1) prolonged arm and body bending during the tying of the rods of horizontal structures such as beams, floor slabs or bridge decks (NIOSH, 2005); 2) sitting positions in harnesses, elevated, with legs extended, during the tying of the rods of vertical structures such as walls, bridge pillars and columns.

The activities, organization, environment and equipment involved in the work of rebar installers are all sources of occupational health and safety (OHS) risks. In a review by Manolache et al. (2010), it was concluded that tying is their most physically demanding task (positions of extreme biomechanical stress, repetitive efforts, long hours), that their work environment is highly variable (weather, construction site, etc.) and that the weight and handling of the steel portions are also very demanding.

Table 1: *Rebar manufacturing, assembly and placement processes*

		Type of reinforcing steel			
		Coil (flexible)	**Bar or rod (rigid)**		
Where to work is performed	**Shop**	Cut, assembled, welded	Cut, bent, pre-assembled	Cut, bent	Cut, bent
	Construction site – on the ground			Pre-assembled	
	Construction site- in formwork	Installed as delivered	Final tying	Final assembly and tied	Assembled and tied
	Final product	Wire mesh in slab	Small columns, small to medium walls, stairs	Small columns, small to medium walls, stairs,	Floors, slabs, decks, large walls, large columns

The aim of the present study was to complete the portrait of the work activities and OHS risk exposure of this category of employee in the steel trades, using a training center as a case study.

2. Methods

The aim of the research project was to study and analyze the case of the learning activities that prepare individuals for employment as rebar installers. Thirty pupils and two instructors at the Centre de Formation des Métiers de l'Acier (CFMA) participated in a study divided into three portions: 1) consultation of CFMA documents and information systems; 2) direct observation of actual work in the shop; 3) semi-directed interviews lasting one hour each. Analysis of CFMA documents and information systems allowed us specifically to produce a portrait of the types of OHS intervention in place (structure of the approach to accident prevention, policy, administrative procedures, worker training) and of the work activities of the novice rebar installers. Direct observation of work situations allowed us to gather information on the difficulties and facilitators of work (tasks, postures, environment, equipment, materials, work tools). Semi-directed interviews (of pupils and instructors) allowed us to document difficulties, accidents, incidents and perceived work-related risks, as well as the organization of the simulated construction site, worker experience, prior training and knowledge of the workplace and the work management mode (task rotation, task preference, production imperatives, personal strategies, work pace, breaks).

3. Results

In Québec, training for the trade known as 'rebar installer' involves 735 hours of instruction followed by 150 hours of apprenticeship at a construction site. Training is followed with 2,000 hours of construction site work in order to qualify for journeyman certification. The Commission de la Construction du Québec (CCQ) recognizes a single training center, namely the Centre de Formation des Métiers de l'Acier (CCQ

2009) as authorized to provide this training. Spanning a period of six months, the training includes learning to read plans, introduction to the various components of a reinforcing structure and several hours of building of each of the various types of structure. Pupils are required to have between 10 and 40 months of prior manual work experience in some other trade and to have completed at least grade nine.

The shop is divided according to type of reinforcing structure. Cohorts of 22 pupils supervised by an instructor carry out the assembly of various vertical or horizontal structures in simulations of what would be done at a construction site. The simulations are similar to real ones with the exception they are inside.

Work is done daily in a single shift from 07:00 to 14:30. The pupils get two 15-minute breaks plus 30 minutes for their meal. They rotate through the tasks in order to acquire experience on each structure. There are two or three group meetings per week on occupational health and safety.

The shop consists of several work areas for the structures to be built and storage spaces for the materials. The floor is kept clean and unencumbered. The carrying distances from the storage spaces to the work areas range from 2 to 30 meters. These distances reflect the dimensions and shape of the reinforcing structures to be built and installed. The modes of storage of the materials are defined clearly: stacking in rows or on fixed hooks. A pupil raises and carries, often over his shoulder, about 750 kg of steel per day.

The work activities of rebar installers involve assuming awkward or onerous positions, often unsymmetrical, repeated during extended work periods, indeed throughout the entire work day: 1) arms above the shoulders during tying of column and wall supports; 2) bending of the torso, crouching or kneeling to tie the rebars of slabs or beams; 3) bending sideways coupled with twisting of the torso during tying of column and wall supports.

The pupils view the carrying, handling and tying of steel rods as the most difficult tasks involved in the work activity. Back pains are preponderant in several tasks, but upper limb pains (shoulders, arms, forearms, elbow, wrists and hands) and pains in the upper spinal (cervical) region are also prevalent. Pains in the lower limbs result from the crouching or kneeling positions typically involved in work on horizontal structures.

The majority of the pupils have developed personal work strategies in order to minimize the movement required, to organize their work (repeated reading of plans) and to facilitate the handling and carrying of steel rods (the use of hooks). The majority of them also claim to engage in regular physical exercise outside of classroom hours or in stretching exercises before the beginning of classes.

The perceived causes of incidents or accidents are inadequate organization of the work, unexpected events, the unstable nature of certain body positions, the raising and carrying of steel and the instability of certain poorly assembled structures.

4. Discussion and/or Conclusions

The work activities of rebar installers are complex and physically demanding. The risks of musculoskeletal disorders are significant and associated essentially with carrying, handling and tying of steel rods. The risk seems greatest overall for the back, which is corroborated in the literature. Nevertheless, our study shows that both the upper and lower limbs are solicited heavily for certain tasks, which is cause for concern. The risk of falls and near falls is limited thanks to proper management of the

overall tidiness of the storage areas and the use of personal protective equipment (harnesses). The distances covered are also significant. The weight, dimensions and volumes of materials to be stored are considerable. The risks of cuts and puncture wounds by the cut edges of materials are also significant.

The work pace at the CFMA is slower than at a real construction site. Interference from vehicles is also more limited. The amount of steel handled by a worker at a real construction site is around 1,000 kg per day while it is 750 kg per day during training.

This case study improves our understanding of OHS risks to rebar installers. Analysis of construction sites is now necessary in order to document more thoroughly the impact of ever-changing environments and to validate the results obtained from this study of the steel-trades training center. Preventative measures, based on a complete OHS risk portrait, will then be proposed for this industrial sector.

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