

# Masonry Construction

## Recognizing & Controlling Ergonomic Hazards

By Robert G. Batson



### IN BRIEF

- Ergonomics is a scientific approach to identifying and controlling work-related musculoskeletal disorder (WMSD) injuries or illnesses of the muscles, tendons, joints and nerves that are caused or aggravated by work.
- A body of knowledge exists on ways to control (avoid, abate or prevent) many ergonomic hazards experienced by masons and mason tenders.
- Masonry contractors, both large and small, need SH&E professional assistance to translate research findings into new practices that may consist of different masonry materials, equipment and work methods than are currently in use.

tion Sector Council (2008), ergonomics applied to the workplace is a scientific approach to identifying and controlling work-related musculoskeletal disorder (WMSD) injuries or illnesses of the muscles, tendons, joints and nerves that are caused or aggravated by work. "Examples of WMSDs are:

**E**rgonomics is the study of the body's movements and postures in relation to the performance of certain tasks. Risk factors emerge in the task environment (conditions such as loads and pace; equipment controls and tools that are manipulated manually, especially repetitively) and the individual worker (proper conditioning and warm-up). Risk factors may trigger acute injury such as back pain or chronic illnesses such as carpal tunnel syndrome.

According to the National Occupational Research Agenda (NORA) Construction

injured tendons or joints, elbow muscles and tendon inflammation, herniated disc, rotator cuff syndrome, carpal tunnel syndrome, and back and neck strain" (NORA Construction Sector Council, 2008). The report continues, "workers in all construction sectors and occupations are exposed to multiple physical risk factors associated with WMSDs:

- high physical exertions;
- prolonged static physical exertions;
- repetitive physical exertions;
- awkward working postures;
- working in cold conditions;
- whole-body or segmental vibration" (NORA Construction Sector Council, 2008).

Based on the first four factors, construction workers subject to WMSDs include those trades with significant material handling tasks that are naturally part of their work, such as carpenters who install framing and drywall, and masons and their helpers. In fact, "manual material handling is the largest single cause of lost workday injuries in construction. One out of every four injuries happens because someone lifted, carried, pushed or pulled something the wrong way, or beyond his or her capacity" (CNA Loss Control Services, 1999). Further investigation reveals that masons and mason tenders are at extremely high risk for WMSDs. For example, "58% of all lost-time injuries among masons could be directly attributed to installation and manual materials handling activities" and "in 2005, the masonry industry had the highest rate of back injuries and illnesses (75.4 per 10,000 workers) out of all construction trades" (Hess, Kincl, Amasay, et al., 2010).

OSHA 29 CFR 1926, Subpart Q, Concrete and Masonry, contains no guidance on ergonomics.

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Subpart H, Material Handling, does not actually address the physical handling of materials, but with its emphasis on mechanical aids in material handling the implication is to use equipment instead of muscle power whenever possible. Masonry construction remains a craft in which most of the work movements must be performed manually. A NIOSH publication (Albers & Estill, 2007) offers some guidance for masonry workers, but is certainly not comprehensive.

Ergonomic-related injuries result from a mason's movements and postures in performing work. Examples include motions that put strain on the arms and back, such as squatting, twisting with load in one hand, bending at the waist, reaching with load in one or both hands, awkward posture, often working within a constrained envelope, and working with hands and shoulders above the head. Through improper training or neglect, individuals may adopt work motions and create an injury or chronic illness; for example, "masons may hold the trowel too tightly" (Kreh, 2009).

How can this situation be improved? Part of the problem is that the number of masonry contractors is quite large (hundreds in each U.S. state), but they vary in size. Some masonry contractors are units of large construction companies; many are small businesses. Another part of the problem is that much research has been completed in the past decade on how to control ergonomic hazards for masons and mason tenders, but it is not widely disseminated. Clearly, a program of targeted ergonomic training developed by SH&E professionals for masonry supervisors and workers is needed.

#### **Hazard Recognition & Control**

Two hazards encountered with some masons have been identified: 1) Some masons (because they may have a trowel in one hand) use a single-handed pinching grip to lift and place the block. This grip is a well-known risk factor for hand and wrist injuries that should be discouraged. 2) Some masons are required to regularly lift and maneuver heavy building materials, such as concrete masonry unit (CMU) block, with their arms above their shoulders when laying higher courses or when lifting over vertical rebar or electrical or plumbing conduits (Hess, Kincl, Amasay, et al., 2010). Seven risk factors for back and shoulder injuries for all masons are identified by Hess, et al.:

- block weight;
- lifting frequency;
- height from which block and mortar are lifted;
- height at which the block is placed;
- buttering activity (applying and smoothing mortar using a trowel);
- distance of the workface from the mason;
- high expected production rates (200 blocks or 600 bricks per shift is common).

Three other back and shoulder risk factors for all masons:

- height of the mortar stand or pan (Hess, Weinstein & Welch, 2010);
- degree and frequency of twisting involved (Hess, et al., 2010);
- forward bending motions, perhaps more than 1,000 per shift (Marks, 1999).

It seems fair to say that these 10 hazards are encountered by all masons, but what of their helpers? Mason tenders are involved in handling blocks,



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mortar and materials to mix the mortar, as well as assembling, adjusting and disassembling/moving scaffolding, which generally consists of steel tube frames and heavy planking for walking surfaces. "Frame and mason's scaffolding have always been prominent fixtures in the industry. They're an essential component of most masonry projects" (Martin, 2006). Mason tenders, therefore, have a distinct list of five ergonomic risk factors (Mirka, Bernold & Lorenc, 1994):

- distribution of block/brick throughout the worksite from delivered piles (using a wheelbarrow);
- redistribution of block/brick from temporary piles (by hand or bucket);
- erecting and modifying scaffolding—lifting/positioning metal framework, lifting/placing plank flooring of the scaffold;
- lifting bricks and mortar to masons on the scaffolding;
- lifting heavy bags of masonry mortar up to the mixer and shoveling.

A body of knowledge exists from researchers in the U.S. and other countries on ways to control (avoid, abate or prevent) many of these ergonomic hazards. The following examples are provided to illustrate controls that are recommended by researchers. These examples confirm that solutions to control ergonomic hazards in the masonry trade are available, but need to be disseminated.

The best U.S.-published reference known to the author is a 46-page document on ergonomic best practices in the masonry industries prepared by the Washington State Department of Labor and Industries (L&I) in conjunction with the Washington State Conference of Mason Contractors (Davis, 2001). It was developed to help employers comply with the Washington State Ergonomics Rule and the Masonry Industry (L&I WAC 296-62-051). However, it is both comprehensive in coverage and practical in its control options, so that any masonry contractor—large or small—can access it and determine, at least initially, ergonomic hazards and exposure levels for masons in the employer's particular masonry trade groups and tasks.

*Practical controls* refers to options such as limiting the weight of items that one individual attempts to lift, use of appropriate equipment to limit ergonomic hazard exposures or use of job rotation. Davis (2001) states, "tasks commonly performed by block, brick and tile workers in the masonry industry were reviewed, and those tasks with potential WMSD hazard exposures as described by the ergonomics rule [were identified]. Hazard control examples for reducing these risk factor exposures were identified."

Seven specific working groups (masonry trades) are addressed by Davis (2001): bricklayers, for both block and brick; hodcarriers or tenders, for both block and brick; finishers (tile); tile setters; and retaining wall constructors (dry stack only). Text and tables for each group are organized into summary hazard exposures, details of each exposure, then task-by-task hazardous activity and control options.

To summarize, this document may be used to educate owners, supervisors and SH&E professionals about hazards and controls, and to select and implement specific controls applicable to the work, but is not for use in awareness training of workers. Davis notes that "further refinement and work may be needed to implement interventions, in some cases. Development and testing of more innovative ideas may also be necessary before feasibility can be assumed." These sound like jobs for the SH&E professional, either working within a larger masonry firm or consulting with a smaller firm.

According to Faber, Kingma, Kuijer, et al. (2009), field observations in the Netherlands found "masons on average spend about 2.5 hours/day handling block, and about half the blocks were handled with one hand." Other important findings in the Netherlands study, which match the more detailed recommendations in the Washington State best practices document, are:

- Masons are frequently subjected to back and shoulder loads in excess of current health limits.
- Increasing lifting height appeared to be the most effective way to reduce lower back loading.
- Working with the hands much higher than iliac crest (hip) height should be avoided because it leads to high shoulder loading.
- Organize masonry work so that blocks are handled with the hands at about iliac crest (hip) height as much as possible.
- One-handed block handling at other locations than at near floor level resulted in relatively high shoulder loads and, therefore, should be avoided in these conditions.

Concerning block handling, Karwowski (2006) states that "block holding time increased with wall height, and wall height of 80 to 100 cm (32 to 40 in.) is optimal for all factors."

Marks (1999) recorded specific results of a Canadian study:

- Develop information and training on trade-specific ergonomic practices, including effective work pacing.
- Identify best practices to reduce injuries and increase efficiency (e.g., mast-climbing work platforms).
- Implement a prejob exercise program and improve work/rest cycles.
- Plan and organize sites to facilitate access, reduce unnecessary materials handling and avoid work in constricted spaces.
- Use height-adjustable mortar boards.
- Keep platforms for stacking brick and block no lower than knee height.
- Educate workers to use a trowel suited to their individual size and strength (e.g., 12 in. may be too large).
- Work with manufacturers and architects/designers to develop and specify more ergonomically favorable bricks and blocks.

Next, let's discuss the practicality of implementing these findings. Concerning work pacing, Kreh (2009) observes:

Masonry work is very repetitive and . . . repetitive motions are hidden hazards. The best way to cut down on these types of repetitive-stress injuries is for the mason to become more aware of what causes them and how to change the movements involved.

Concerning work practices that may increase efficiency while reducing injury risk, several papers and a video are available that promote two-person lift teams for laying CMU. Citing an International Masonry Institute study, Moraski and Watters (2009) report, “Researchers found that using a lift team has the potential to reduce back injuries among bricklayers. Not only does a lift team reduce low back muscle force, but also bricklayers do not have to bend forward as much as when lifting alone.” Also, Moraski and Watters say, “It is likely that lift teams reduce worker fatigue over the course of the day.”

Citing a study at the University of Texas, Karowski (2006) reports “a 20% increase in productivity by using adjustable scaffolding and that bilevel scaffolding can be used to present the brick and mortar just below waist level” of the mason.

Concerning prejob exercise programs, Hecker, Gibbons, Rosecrance, et al. (2000), discuss the effectiveness of a 2-hour ergonomics and body conditioning training module presented to construction workers as part of a program to prevent musculoskeletal disorders.

Concerning masonry materials, Davis, Kotowski, Albers, et al. (2010), evaluate as a risk mediator for mason tenders half-weight mortar bags (47.5 vs. 95 lb) for biomechanical, physiological and perceived differences. Their conclusion was that half-weight bags were “worth it” for the contractor. As for block size, Hess, Kincl, Amasay, et al. (2010), report an investigation of alternative blocks:

- lightweight (26 lb) concrete blocks;
- autoclave aerated concrete solid precast blocks, popular in Europe for more than 70 years, which are longer than CMU (24 vs. 16 in.), but 33% lighter per volume and offer the following advantages:
  - mason builds more wall per each block laid;
  - no need for drywall;
  - environmentally friendly to manufacture;
  - excellent thermal and acoustic insulation;
  - excellent fire and termite resistance;
- and disadvantages:
  - larger size makes them more awkward to handle;
  - no hole in block so must be handled with two hands.

Based on a national survey of U.S. masonry contractors, Hess, Weinstein and Welch (2010) found that “half-weight cement bags and autoclave aerated concrete were rarely used anywhere, while lightweight block and mortar silos appear to be diffusing across the country.”

### How Masons Learn the Trade & Safe Work Practices

To understand how the available information on preventing WMSDs in masonry workers could

be disseminated, one must identify how masons learn the trade, and develop insight and habits of safe work practices. Some masonry training begins as early as high-school vocational courses; it also may begin with two to four semesters in a vocational/technical college. These courses are considered preapprenticeship, and provide technical industry knowledge as well as some hands-on training in simulated settings. Safety is part of most courses and is guided by the instructor’s interest in protecting the student while under his/her supervision.

To become a journeyman mason, one must enroll in a formal apprenticeship program through a training center, union program or mason contractor. Apprenticeship programs combine classroom instruction with on-the-job training and may last 3 to 4 years. Apprentices begin work at a contractor as mason tenders, then transition to performing actual masonry work under the guidance of an experienced mason. Safety is covered in classroom instruction, but the student will likely work safely and avoid unsafe acts to the extent that these practices are emphasized by his/her mentor, and by the mason foreman or supervisor. The apprentice will therefore benefit from safety training (e.g., OSHA 10-hour construction industry course and periodic safety meetings with coworkers), but the question remains: will the worker obtain training in WMSDs specific to their craft and tasks?

Probably the best situation for such an apprentice would be to work for a contractor certified by Mason Contractors Association of America (MCAA). To obtain such a certification, the owner must first earn 100 hours of course credits applicable to the masonry contractor business, pass an exam and pay a fee. Safety is included in the required curriculum, so even in a small firm, the seed has been planted, and safety training should follow. Certification renewal requires owners and supervisors to participate in continuing education courses throughout the 3-year certification period. Again, if ergonomics is included in the safety courses within the curriculum, the seed is planted to convey that information downward to the masonry workforce.

Of course, this assumes that masonry contractor owners and supervisors value protecting the safety and health of their human resources. Specific training for masonry workers in recognizing and avoiding ergonomic hazards in their work will have to come in the form of materials (e.g., booklets, online courses, in-person courses) that cover more than the typical OSHA 10-hour construction safety course. Several approaches are available, even for contractors with limited resources.

### Countermeasure Implementation & Training

This author’s position is that dissemination must occur through the supervisors of the masonry contractor, preceded by SH&E professional assistance.



**Buttering—applying and smoothing mortar using a trowel—is one of seven risk factors for back and shoulder injuries for all masons.**

Possibly the largest barrier to adequate training in ergonomic hazards and controls for masonry construction is the character of the industry itself.

Other researchers have observed, "More effective dissemination of information on best practices can lead to greater utilization . . . and reduced WMSDs" (Hess, Weinstein & Welch, 2010). Masons and mason tenders have chosen a craft that requires great physical exertion. "An average day's work for a mason is to handle 200 CMUs, each weighing 38 lb or more." So, the mason handles about 7,600 lb of block during an 8-hour workday (Walter, 2010). Aside from moving and positioning blocks, mason tenders must regularly handle "typical bags of masonry cement weighing 42.7 kg (95 lb)" (Davis, et al., 2010). As stated by Jerry Painter, president of Painter Masonry Inc., Gainesville, FL, referring to both masonry materials and scaffolding, "the hardest part of the whole thing is to get all employees to buy into being safe and being observant."

Training materials must, at a minimum, highlight the 10 ergonomic hazards for masons and five ergonomic hazards for mason tenders identified earlier. Once masons and mason tenders are aware of these hazards, the supervisor must be prepared to tell them what safe practices are to be followed, with management support. The SH&E professional's role is to understand the specific controls researchers have identified for each hazard, and develop the countermeasure practices that are feasible and cost-effective for each masonry contractor.

Experts including masonry contractors, occupational safety and health specialists, contractor association representatives, ergonomics consultants and representatives of workers' compensation programs who met at a 2004 NIOSH meeting to identify best practices to reducing the risk of WMSDs were in general agreement on appropriate countermeasures. "The top best practices identified included the use of mortar silos; grout delivery systems; mechanical scaffolding; half-weight cement bags; H-Block and A-Block; lightweight block; autoclaved aerated concrete; half-size pallets; and two-person lift teams," (Walter, 2010). According to Hess (as cited by Walter, 2010), barriers to adopting best practices include building codes and regional work norms.

Where these practices are new to the contractor, resistance to change and additional costs must be overcome. For example, consider the case of mechanical scaffolding. Albers and Estill (2007) recognize conventional frame scaffolding as a barrier to improved ergonomics; they say the solution is widespread use of adjustable scaffolding: "This allows a brick or block mason to stoop less because the materials and work surface are both kept near the mason's waist height, which is more comfortable and stresses your body less." Mason tenders also would benefit because "adjustable scaffolding reduces their heavy physical labor in repeatedly changing the height of a frame scaffold."

For the small contractor, the controls identified by the NIOSH meeting (Walter, 2010) may be infeasible; either they do not match the contractor's work tasks, materials or equipment, or the controls are simply cost-prohibitive. In that case, recall the

many practical options suggested by Davis (2001) in the Washington State document. Assistance in sorting through these options and finding appropriate matches among them, or other more creative approaches, could be obtained from the contractor's state OSHA consultation office. In Alabama, for example, University of Alabama is the host site for Safe State, a program that provides free safety consulting services to small businesses.

Another training option is for either OSHA (through a Susan Harwood training materials development grant) or MCAA to sponsor the development of web-based training in masonry construction hazard identification and controls. Such a course could easily be developed in both English and Spanish versions, and made available online to small masonry contractors. The owner and supervisor(s) would be trained using the online materials, with instruction either by an online tutor or the state's OSHA consultation office. Then, after selecting countermeasures deemed appropriate, the owner and supervisor(s) would, in turn, train the workforce using the same website. Thus, slides and video clips they choose would illustrate their ergonomic safety expectations and motivate group discussions with workers about the particular ergonomic guidelines and practices they want the workforce to follow.

If OSHA and MCAA decline to fund such an endeavor, an alternative approach to developing training material is for one or more large masonry contractors with SH&E professionals on staff to develop masonry ergonomic training materials for their own use, and to make them available free of charge to small contractors via national or local industry groups. Finally, a state agency with construction safety within its mission could take the lead in converting available research results into training materials.

Possibly the largest barrier to adequate training in ergonomic hazards and controls for masonry construction is the character of the industry itself.

Researchers working with industry stakeholders found that while products, equipment and work practices already are in use by masonry contractors to reduce the rate of musculoskeletal disorders among masonry workers, the decentralized nature of the industry and prevalence of small contractors has led to regional differences in their use and barriers to widespread adoption. (Walter, 2010)

A barrier between management/supervisor and workers may exist in a large contractor's union environment. For example, "although use of lift teams is often written into union contracts, investigators found they are not necessarily used in the field" (Moraski & Watters, 2009). A different barrier may exist between management and worker in the more typical small subcontractor. The businessperson who operates the firm is an entrepreneur; to be a mason, one must enjoy physically demanding, repetitive work. Both individuals are independent



and do not welcome change in their work patterns. One reason to include owners/supervisors in the group needing training is expressed by Marks (1999): "Getting both management and labor to recognize that risk factors exist [is the first step]. The next step is to work toward controlling or eliminating those factors."

## Conclusion

This article describes the numerous ergonomic hazards encountered daily by masons and mason tenders. It surveyed recent research and development activities in the U.S. and other countries to demonstrate that a wide variety of engineering, work practice and administrative controls are available as countermeasures to masonry ergonomic hazards.

As noted, barriers to dissemination of research findings and implementation of appropriate controls, include:

- 1) lack of awareness of the severity of the problem and availability of multiple control options;
- 2) lack of training materials from any source—government agencies, industry groups, larger contractors, universities or colleges;
- 3) the decentralized nature of the industry and prevalence of numerous, small business contractors in each state;
- 4) small businessperson skepticism that the ergonomics problem affects his/her workers, hence the very existence of his/her firm, and that inexpensive training and control practices are available.

This article addresses barrier 1, and suggests several alternative approaches to resolve barrier 2. It is suggested that each state's OSHA consultation service and/or each state's masonry contractor industry group could address dissemination/implementation problems listed as barriers 3 and 4. The SH&E professional interested in becoming involved in his/her state's solution is welcome to use the content of this article to make a presentation at an annual meeting of his/her state's masonry contractor group.

Masonry contractors, both large and small, need SH&E professional assistance primarily to translate research findings into new practices, which may include different masonry materials, equipment and work methods than are currently in use at that contractor. Workers would need to be retrained around these new practices and understand that adoption of these practices is not designed to complicate their work, but to protect them from work-related injury and illness. The training must involve both the owner and supervisors to convince masonry workers that certain ingrained habits and practices are no longer acceptable, and to adopt the safer practice identified in the training. **PS**

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