World at work: Bricklayers and bricklayers' assistants

H F van der Molen, S J Veenstra, J K Sluiter,
M H W Frings-Dresen

Spotlight on the construction industry

For ages people have been building shelters and houses using bricks and blocks bound together by mortar. As a result, the trade of bricklayer gradually evolved into what it is today. However, working methods, materials, tools, equipment, and workplaces may vary between workers, construction projects,¹ and countries, leading to differences in health and safety risks.

In the Netherlands, codes of practice are developed for various professions in the construction industry aimed at reducing health and safety risks. These codes are based on consensus between health and safety experts, employers, and employee organisations. Recently, such a code of practice was developed for bricklayers.² The facts presented here are based on that document or other sources as research studies, expert opinions, questionnaires, and interviews conducted with employers and employees. The risk assessments are compared with international standards and scientific literature. The aim of this paper is to give an overview of the tasks, health and safety risks, and control measures to reduce or eliminate hazards of the job and in the workplaces of bricklayers and their assistants.

TASKS OF THE JOB

Bricklayers are engaged in building and renovating houses, offices, and industrial complexes using bricks, blocks, and mortar. Each day the Dutch bricklayer handles some 800–1100 bricks or an average of 165–220 blocks.^{3–4} The bricks and blocks are delivered to the construction sites by truck, in packages or in bulk. The bricklayers' assistant is responsible for the preparation and the transportation of materials and equipment to the actual workplaces. The bricklayer builds the walls by adding mortar and placing the bricks (one handed) or blocks (two handed) in their correct position. In general, one assistant works for two to five bricklayers. Over the years, bricklaying, transporting materials and equipment, and block laying have developed into three specialised professions, but combinations of

them frequently occur. Table 1 shows the time spent on these different tasks by bricklaying teams working in the traditional way, handling bricks of 1.6–2.2 kg.

HAZARDS OF THE JOB AND IN THE WORKPLACE

Physical work demands and workload

At the work site, the most demanding task for the assistant in terms of physical work is the manual transportation of bricks, blocks, and mortar (the manual lifting and carrying of materials and pushing/pulling wheelbarrows for more than four hours every working day). For the bricklayers the most demanding task in terms of physical work is one handed repetitive lifting of bricks (1–6 kg with bended lower back for more than four hours per day) or two handed lifting of blocks (6 to >48 kg). Jäger and colleagues⁷ reported that an increase of the brick/block mass leads to an increase in the moment and compression curves of 20 Nm or 1 kN per 5 kg. Latza and colleagues⁸ found an increased risk of low back pain (PR = 2.6) for workers laying large sandstones (7–10 kg) for at least two hours a shift compared with workers laying no such sandstones, while Sturmer and colleagues⁹ found that more than 10 years working as bricklayer increased the chance of low back disorders by 2.3 times (95% CI 1.2 to 4.5) compared with other construction workers.

Verstraten and colleagues¹⁰ reported an energetic workload index ($\dot{V}O_2/\dot{V}O_2 \text{ max} \times 100\%$) of 35% for younger bricklayers (between 25 and 35 years of age) and 41% for older bricklayers (above 45 years of age). Internationally, a physiological limit for an eight hour working day varies, but generally 30–40% of $\dot{V}O_2 \text{ max}$ is thought to be acceptable.¹¹

Worldwide, bricklayers and bricklayers' assistants experience musculoskeletal symptoms in one or more body regions more often than other construction workers.^{12–13} Table 2 shows the 12

month prevalences of musculoskeletal complaints among Dutch bricklayers and bricklayers' assistants. The 12 month prevalence of sustained or regular lower back complaints is 45%, while shoulder and knee complaints are reported as second highest by 26%.¹⁴ The 12 month prevalences of any back and shoulder complaints in the Netherlands are consistent with the data reported in Sweden^{15–16} and the USA.¹⁷

Toxic substances

Bricklayers are exposed to dust when sawing bricks/blocks or when mixing cement/glue. This dust may contain quartz. The highest dust concentrations will occur when working indoors. Short term exposures may exceed the Dutch threshold limit value for "inert" dust (10 mg/m³ for inhalable particles and 5 mg/m³ for respirable dust). The Dutch threshold limit value for respirable quartz dust (0.075 mg/m³) can be exceeded, especially when sawing blocks containing quartz indoors. In the Netherlands quartz dust concentrations of up to 0.2 mg/m³ have been measured when preparing and handling blocks.¹⁸ In the USA bricklayers are exposed to median concentrations of respirable dust and respirable quartz dust of 2.13 and 0.32 mg/m³ respectively.¹⁹ Long term exposure to high concentrations of quartz dust may result in silicosis. Moreover, quartz dust is considered to cause lung cancer in humans.²⁰ In the Nordic countries an increased standardised incidence ratio of lung cancer (119; 95% CI 112 to 127) was found in bricklayers compared with a reference population of 53 occupational groups.²¹ The dust generated when handling insulation materials contains mineral fibres. In general, the applicable threshold limit value for the mineral fibres is not exceeded.

Mortar contains cement. Cement is alkaline and regular prolonged skin contact can result in skin complaints. Allergens that are present in the cement can cause allergic contact eczema. The prevalence of self reported skin complaints in Dutch bricklayers is estimated at 10.3%.²² In Finnish bricklayers an incidence rate of 3.44 per 10 000 working years was found for allergic contact dermatitis from chromium.²³

Noise

Bricklayers are exposed to noise caused by the equipment present in their environment, to impulse noise when positioning bricks and when chipping bricks to size, to noise caused by cutting bricks/blocks, and by work involving power tools (drilling, sawing, grinding). The European action limit of 80 dB(A)²⁴

Table 1 Mean time (in minutes) and standard deviation (SD) of tasks performed by Dutch traditional working bricklayers (n = 10) and bricklayers' assistants (n = 10) and as a percentage of total working time over a standardised observation period of 4.5 hours^{5,6}

Tasks	Bricklayer			Bricklayers' assistant		
	Mean (min)	(SD)	%	Mean (min)	(SD)	%
Bricklaying	135.0	(13.2)	50	0.4	(1.0)	0.1
Preparation	49.6	(12.3)	18.4	40.0	(47.4)	14.8
Removing mortar	24.4	(9.3)	9.0	7.7	(17.2)	2.9
Consultation	2.6	(2.1)	1.0	11.6	(9.8)	4.3
Cleaning	2.5	(2.8)	0.9	7.7	(13.9)	2.9
Breaks	35.9	(4.9)	13.3	38.7	(7.3)	14.3
Intermediate task	1.1	(2.1)	0.4	1.8	(2.7)	0.6
Micro pauses	12.3	(11.5)	4.6	19.9	(12.3)	7.4
Transportation of materials	4.6	(4.1)	1.7	141.4	(60.1)	52.4
Other, undefined tasks	2.0	(1.5)	0.7	0.8	(1.1)	0.3
Total	270		100	270		100

may be regularly exceeded, which can result in hearing loss if no hearing protection or insufficient hearing protection is used. Full shift personal exposure levels in Dutch bricklayers (n = 17) were measured as varying from <80 to 93 dB(A), with an average exposure level of 87 dB(A) (Veenstra, 1982, unpublished results). In Canada an average exposure level among bricklayers (n = 14) was reported of 90.8 dB(A).²⁵

Vibration

People who work with grinders, drills, saws, or chisel hammers are exposed to hand/arm vibrations. Long term exposure to high levels of hand/arm vibration may result in "white finger syndrome" or damage to the wrists or other parts of the body. For most teams of Dutch bricklayers, average exposure levels are expected to be below the EU vibration guideline, in which the action limit for hand/arm vibration is 2.5 ms^{-2} .²⁶ In the United Kingdom, however, Palmer and colleagues²⁷ reported high estimated doses ($A(8) > 5 \text{ ms}^{-2}$) in bricklayers and masons based on self reported exposures. This difference in exposure level may be due to different tasks performed by bricklayers in the two countries (for

example, the use of a grinder or air hammer when cutting joints between bricks).

Climate

The work is conducted outdoors and partly indoors. Working outdoors involves exposure to cold or heat, wind, and rain. Indoors, exposure to cold and draughts may occur if the rooms are not fully glazed yet. This may lead to musculoskeletal complaints²⁸ and colds. During the summer, and during sunny weather in particular, there is exposure to ultraviolet radiation, which may result in sunburn or eye irritation. Years of exposure may lead to skin cancer later in life.

Safety

Construction workers are at high risk of occupational accident.²⁹⁻³¹ Various scenarios may result in accidents, such as bumping into something, tripping or slipping, being trapped by a swinging load, being hit by falling material or equipment or by a load falling from a crane, being hit by falling or collapsing scaffolding, or being trapped by a falling pile of stones or a toppling wheelbarrow. There is the risk of falling from floors or scaffolding, caused by missing railings or floor jams not being closed up or

sealed off, or as a result of slipping off a ladder. There is also the risk of being injured when handling stones or blocks or when using power tools. Inadequate lighting hampers work and increases the chance of accidents.

In 2002 a total of 2380 work related accidents affected the 31 500 Dutch bricklayers. An estimated 59% of these occurred at the work site.³² Most accidents involving construction workers were caused by falling, sprains and strains, or hits by falling materials. Of all work related accidents, almost two thirds of those caused (temporal) disability for work.

Psychosocial work demands

Economic factors like recession, piece-work payment, scheduling, and production demands may tend to increase the pressure of work on construction workers.³³ Time pressure (34%), insufficient involvement in work planning (17%), and poor day to day management (16%) are the main psychosocial demands perceived by Dutch bricklayers,²² and may therefore, represent a risk for health complaints or increase the chance of injuries.

MEASURES TO PROTECT WORKERS

Many consensus based recommendations have been reported in the literature to reduce or eliminate health and safety risks. However, the effects of these recommendations often remain unclear and controlled studies on intervention measures are scarce, particularly those on combinations of work demands and workload. Moreover, the knowledge about the effects of implementation strategies for the adoption of preventive measures at the workplaces is even scarcer. Both knowledge about effective measures and implementation strategies, might be conditional to reduce the health and safety risks at

Table 2 Occurrence and 12 month prevalences (frequency and duration) of musculoskeletal complaints per body region among Dutch bricklayers and bricklayers' assistants (n = 791)¹⁴

	No, never (%)	Yes, once (%)	Yes, regular (%)	Yes, sustained (%)
Neck	56	25	13	6
Shoulders	43	31	18	8
Lower back	21	34	35	10
Upper back	61	21	13	5
Elbows	63	18	12	7
Wrists/hands	61	22	11	6
Hips/thighs	68	17	11	4
Knees	46	28	17	9
Ankles/feet	72	16	8	4

Figure 1 Mechanical transportation of bricks.

the workplaces of bricklayers and their assistants.

Measures to reduce the physical work demands and workload

Lifting devices tailored for the workplaces of bricklayers, block layers, and their assistants are recommended for adjusting working height, mechanising block laying, and mechanising transportation of materials.^{4 7 34-37}

For advanced mechanical transportation of bricks (see fig 1), it is necessary to deliver bricks in subdivided packages. Devices can be used to supply bricks and mortar in an elevated position (see fig 2) to reduce bending by the bricklayer. To ensure that the predicted lumbar load

Table 3 Ergonomic measures (consensus based) to reduce the physical work demands

Transportation of bricks with electric wheelbarrow
Mechanical transportation of bricks on scaffold/device (e.g. crane)
Supply of mortar/cement in silo
Filling cement tubs with concrete hopper
Filling cement tubs by pumping mortar
Delivering subdivided packages of bricks ready to be transported mechanically
Bricks positioned on elevation
Cement tubs positioned on elevation
Using mechanical height adjustable scaffolds
Mechanical transportation of blocks
Mechanical positioning of blocks in wall
Use of lighter bricks/blocks (≤ 14 kg)
Mechanical (glue) mortar preparation
Transporting glue by pumping
Mechanical horizontal transportation of scaffold (elements)
Mechanical vertical transportation of scaffold (elements)

during bricklaying remains below computed strength values, Jäger and colleagues⁷ advise that the brick supply be stacked higher than 50 cm. Meijer and colleagues³⁸ found that greater working heights (30 and 50 cm) for picking up the bricks and mortar significantly reduced oxygen uptake up to 20% from the twelfth layer (± 75 cm height of bricklaying) compared with a situation in which there was no adaptation in the storage height of bricks and mortar.

To stay below the NIOSH recommended weight limit,³⁹ the weight of blocks lifted manually should be no more than 6 kg.³ However, De Looze and colleagues⁴⁰ reported that peak compression was found to increase at

higher brick/block weights but that no differences in time integrated spinal compression force were observed in four of five combinations of weight and frequency.

Table 3 lists all technical measures aimed at reducing the physical work demands of bricklayers. Most Dutch bricklayers are well aware of these measures, but the degree of use varies considerably throughout the Netherlands. Some measures are not widely used, such as an elevation for bricks and mortar tubs (26%), the electric wheelbarrow (15%), mechanical transportation of mortar (11%), and mechanical height adjustable scaffolding (4%), while mechanical transportation and mechanical positioning of blocks (see fig 3) are reported to occur frequently or always by 58% and 47% respectively.

Measures to reduce exposure to toxic substances

A combination of three measures—using gloves, good hygiene, and skin care—reduces the risk of skin damage caused by cement. To prevent allergic eczema through chromium in cement/mortar, EU legislation sets a limit of 0.0002% soluble chromium in cement.⁴¹ Skin contact with insulation material can be reduced by the use of mineral wool wrapped in foil and by avoiding the cutting and trimming of insulation material. Close fitting clothing prevents the skin being exposed to the material.

Dust exposure caused by manual mixing of mortar/glue can be largely avoided by mechanical feeding and mixing of mortar or glue components. When carrying out work at eye level or above head level, facial exposure to mortar and glue can be avoided by wearing a cap and a face shield. Exposure to quartz can be reduced in various ways: use of materials containing little or no quartz, limiting the amount of sawing work by having the blocks supplied already cut to size, or using tools with water supply or local exhaust ventilation. When these measures are insufficient the use of respiratory protection may be necessary.

Measures to reduce exposure to noise and hand/arm vibrations

Noise levels can be reduced by replacing old and noisy machines by new more silent equipment. However, in the case of handheld tools such as drills and saws, the amount of reduction is limited. It is even more difficult to reduce impulse noises caused by handling or hitting bricks. Therefore, the action limit for harmful noise (80 dB(A) for an eight hour working day) may be exceeded and hearing protection should be worn.

Figure 2 Adjusting working height.

Figure 3 Mechanical lifting of blocks.

To prevent health complaints such as “white finger syndrome” or joint problems resulting from exposure to hand/arm vibrations, working with drills/mixers, saws, pneumatic hammers, or grinders should be reduced to 0.5–1 hour per day. Job rotation can be used to reduce the exposure time.

Measures to protect against climate

Measures to protect against the adverse influence of the weather include personal protection (for example, adequate working clothes, hats/helmets, gloves, shoes, sun creams), work planning and organisation (for example, starting in the shadow, working-rest schedules, clearing snow and ice from ladders and scaffoldings), covering or screening workplaces (for example, placing windows or roofing with plastic materials), and equipment and facilities (for example, temporary heating or cooling, drying places for clothes). However, a

survey among painters working behind screening showed more complaints about the climate than in a reference population of all painters. Moreover, lighting, views and ventilation could be improved.⁴²

Measures to increase safety

To prevent unsafe work situations, a safety plan and prescriptions are thought to be conditional. Table 4 lists the measures, technical and otherwise, for improving safety at the work site. These measures should be part of the safety plan adopted by the bricklaying companies. On a national scale, these measures are best promoted industry-wide, for instance, through labour-management organisations.²⁹ Schneider and colleagues³³ argued in favour of supplementary legislation in this respect. Labour inspectorate (USA) or covenants (the Netherlands) are examples of supplementary legislation to

Table 4 Safety measures (consensus based) to prevent accidents

Use approved scaffolding, ladders, lifts, and cranes
Use above mentioned equipment in accordance with instructions and avoid overloading
Secure floor jambs and edges
Adopt safe working practices
Use the required protective equipment (i.e. head, feet, skin, ear, facial, and respiratory protection)
Avoid situations in which people can trip over rubbish and equipment
Ensure that the workplace is tidied up
Use the prescribed signals when hoisting
Ensure that the crane driver has a hoisting certificate and is well trained and highly experienced
Ensure that silos are set up on a stable, sound base so that they cannot tip over
Ensure that the electrical equipment complies with all requirements and is well maintained
Work carefully
Ensure that there is good lighting
Ensure that work instruction and training is given, especially if equipment is being used

assure widespread adoption of safer and less risky work practices.

Measures to reduce psychosocial work demands

Certain trends and developments in the construction industry (for example, improved logistics, multifunctional teams, educational programmes, and certification⁴³) may help to reduce time pressure and to improve the perceived or actual involvement of bricklayers and their assistants in work planning.

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Authors' affiliations

H F van der Molen, J K Sluiter, M H W Frings-Dresen, Coronal Institute for Occupational and Environmental Health, AmCOGG Amsterdam Center for Health and Health Care Research, Academic Medical Center/University of Amsterdam; Arbouw Meibergdreef 9, 1105 AZ Amsterdam, Netherlands

S J Veenstra, Occupational Hygiene Consultancy Veenstra, Hippolytushoef, Netherlands

Correspondence to: H F van der Molen, Coronal Institute for Occupational and Environmental Health, AmCOGG Amsterdam Center for Health and Health Care Research, Academic Medical Center/University of Amsterdam, Meibergdreef 9, 1105 AZ Amsterdam, Netherlands; h.f.vandermolen@amc.uva.nl

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