Asian-Pacific Newsletter on Occupational Health and Safety

Volume 11, number 1, March 2004
Construction

Published by the
Finnish Institute of Occupational Health
Topeliuksenkatu 41 a A
FIN-00250 Helsinki, Finland

Guest Editor-in-Chief
Suvi Lehtinen

Guest Editor
Inkeri Haataja

Linguistic Editor
Sheryl Hinkkanen

Layout of the cover pages
Tuula Solasaari-Pekki

The Editorial Board is listed (as of 10 March 2004) on the back page.

The electronic version of the Asian-Pacific Newsletter on Occupational Health and Safety on the Internet can be accessed at the following address: http://www.occuphealth.fi/Asian-PacificNewsletter

The issue 2/2004 of the Asian-Pacific Newsletter deals with youth and work.

Photograph on the cover page:
Chaichan Sreepoh

Printed publication:
ISSN 1237-0843
On-line publication:
ISSN 1458-5944

Contents

Health and safety in construction work

Although the development of technology is rapid in most sectors of working life the world over, construction work is still labour-intensive. In the developing world, most construction workers perform high-risk work in return for low income. The hazards associated with this work include accident hazards, physical hazards, chemical hazards, biological hazards, poor ergonomics, and psychosocial problems.

During the period of fast economic growth in Thailand (1993–1997), there was much construction of high-rise buildings, tunnels and highways. Many reports of serious occupational accidents came from construction sites. The number of workers who died in falls from high places rose to more than 700 in the year 1996. Also reported were very high numbers of cuts and injuries caused by sharp instruments, musculoskeletal problems, exposure to noise and vibration, chemical-induced dermatitis, insects bites, etc.

Food sanitation and housing problems are challenging issues at most construction sites. Outbreaks of food poisoning are a particular concern. Stress and family problems caused by shift work are another concern among construction workers. Some parents need to bring their children with them from place to place, thereby preventing the children from getting a school education. Poor access to health care is another constraint that worsens the situation.

Employers, supervisors, engineers, ergonomists, occupational health physicians, hygienists and other health and safety professionals should work together to improve the design of jobs and work stations that have unsafe qualities or have caused injury. Appropriate initial training in the components of an effective system should be organized, and basic ergonomic methodologies should be provided.

Enforcement of the law should be taken into account when worksites neglecting good health and safety practices are inspected. Back-up support from political decision-makers is still needed in order to achieve a good system of sanitation, education and health care that would improve construction workers' quality of life.

Construction workers build the houses, schools, offices, hospitals, and roads – as well as a lot more – that mean better lives for the people of the world. Let us learn to do more for them in return.

Wilawan Juengprasert, M.D., M.Sc.
Senior Medical Supervisor
Office of Health Inspector General
Ministry of Public Health
Nonthaburi, Thailand 11000
E-mail: wilawan@health3.moph.go.th

Safety and health in construction work

Alberto López-Valcárcel, ILO

The size of the problem

The construction industry has traditionally been considered as a hazardous occupation, due to the high incidence of occupational accidents and, above all, of fatal injuries, as is shown in the following examples of data from some countries with statistics on the issue.

In the United States (US), in 2001, the construction sector employed 7.1% (9,581,000 workers) of the country work force. Nevertheless, it accounts for 9.7% of all occupational injuries and 20.7% of the fatalities (1,2).

In France, in 2000, construction employed 5.6% (1,215,000 workers) of the total paid employment, but it accounted for 19% of all occupational injuries and 26% of the fatalities (2,3).

In Spain, in 2001, the construction sector employed 11.6% (1,850,200 workers) of the total work force. However it accounted for 26.4% of all work-related injuries and 26.1% of the fatalities (2,4).

In Japan, in 2000, construction employed 10% (5,690,000 workers) of the total work force, but it accounted for 25.1% of all occupational accidents and 38.7% of the fatalities (2,5).

In analysing the above data it is easy to see the significant contribution of the construction industry to employment creation. Another common feature is the high proportion of the work-related accidents of a particular country that occurs in the construction sector, which makes construction safety a compelling issue. However, the most striking aspect of the above data is the enormous proportion of the occupational fatalities of a particular country that occurs in the construction sector, which makes construction safety one of the highest priorities for national policies and programmes in the field of occupational safety and health (see Figure 1).

Figure 2 shows the fatality rates in the construction industry in a number of countries[1]. When reading this information we should bear in mind the difficulties of comparing construction accident data[2], and the limitations of this kind of benchmarking.

In any case, these statistical data show that, after decades of continuous decline, the rate of fatal accidents in the construction industry, in most of the industrialized countries, is now stabilized at below 20 fatalities for every 100,000 workers.

The case of developing countries is different. Their situation is far from being uniform. Some developing countries have already brought down their fatality rates in the sector below the level

[1] Panama and South Korea (1998); France and Japan (1999); Argentina and Brazil (2000); and US (2001)

[2] First, because of the different ways statistical date are collected (countries in which it is compulsory to report accidents at work in order to qualify for treatment under worker's compensation schemes record almost all accidents; but in most countries that is not the case). Second, because definitions of occupational accidents (even fatalities) differ from country to country. And, third, because construction accident rates tend to rise during boom conditions, and to decline when the industry goes into recession.

of 40 (per 100,000). Yet, in most of the developing countries these rates are believed to be still well above this level.

The number of fatal occupational accidents in construction all over the world is not easy to quantify, as information on this issue is not available for most countries. Nevertheless, the ILO estimates that at least 60,000 fatalities[3] occur at construction sites, around the world, every year. This means that one fatal accident occurs every ten minutes, in the sector. That also means that around 17% of all fatalities at work (1 in every 6) are construction fatalities (see Figure 3).

Figure 4 shows the trend in occupational fatalities, in the construction industry, for a number of countries. As we can see in the case of Japan and in the European Union (EU), the number of fatalities has decreased; while in the case of the US, there was a slight increase in the construction workforce. While in Japan, the sharp fall in the number of fatalities corresponds this number. In the US, this slight increase in the number of fatalities corresponds with just a slight decrease in the number of construction workers.

There are also other trends, like the case of Spain, where employment in the construction industry has increased steadily over the past six years while, at the same time, the construction fatality rates have fallen sharply.

Statistical data also reveal that the likelihood of a construction worker suffering a fatal injury at work is still several times higher than that of an average worker, all economic sectors considered[4]. As we can also see, this difference is even more acute in the case of the most industrialized countries. Therefore, it is not surprising that, for many of these countries, the driving force behind construction safety is in fact the ambition to convert the construction industry into an activity which is not more dangerous than any other.

[3] In 2003 we have updated our estimates to 60,000 fatalities, from the previous estimate of 55,000 (2001).

[4] In fact, it is 2.6 times higher in Argentina, 2.8 times higher in Spain, 3 times higher in South Korea, 3.4 times higher in France, 3.5 times higher in the US and 3.8 times higher in Japan.

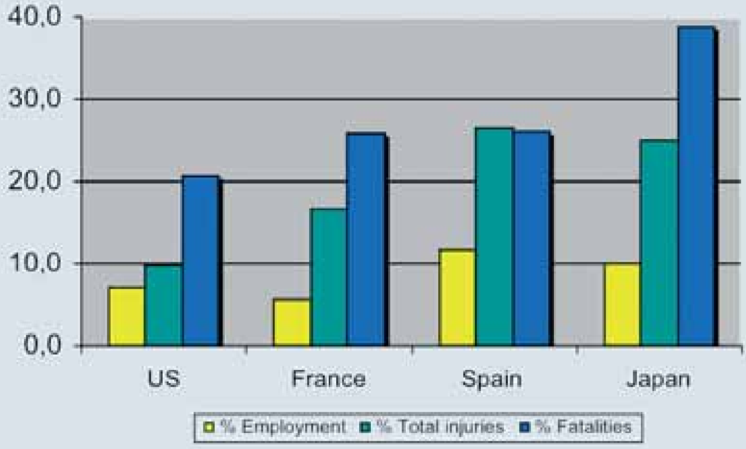


Figure 1. Employment and occupational accidents in construction as a percentage of all economic activities.

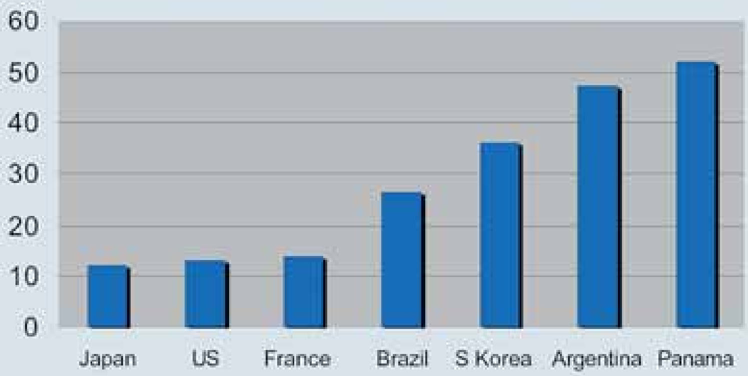


Figure 2. Fatality rates in construction industry. Different countries. Number of fatalities per 100,000 workers.

Figure 3. Global ILO estimates of fatal occupational injuries, 2003.

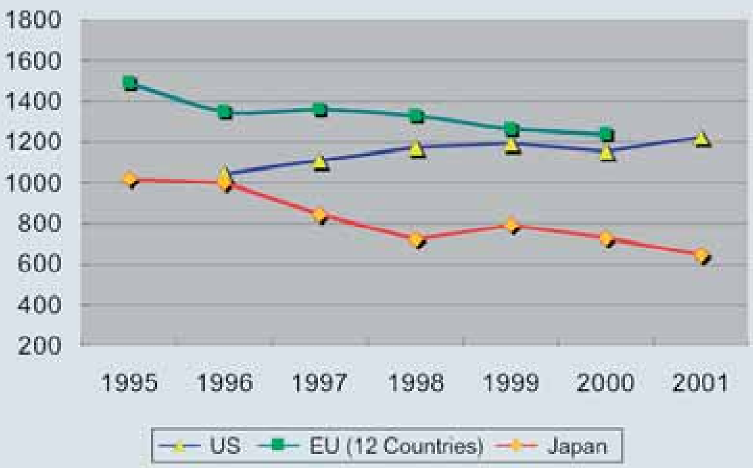


Figure 4. Construction industry. Different countries. Trends in number of fatal injuries.

Historically, occupational safety and health programmes in construction have been focussed on the area of safety, i.e. on the prevention of accidents. This is not surprising because of the immediate visibility of the effects of accidents (injuries and material damages) as compared to diseases whose consequences appear only after a period of time. The problem lies in that the health of workers may be affected many years after being exposed to a certain agent or contaminant at the workplace. Thus, reliable statistical data on occupational diseases, especially in the case of a workforce as mobile and sporadic as construction, are difficult to obtain.

Nevertheless, the true dimension of work-related diseases is starting to become clearer. For instance, in the United Kingdom it is estimated that about 1 in 20 workers currently or recently working in construction has suffered from a work-related musculoskeletal disorder. Moreover, construction workers in the United Kingdom are twice as likely to suffer from work-related diseases than workers in other industries (6).

In France, on the other hand, 20% of diseases recognised by the workers' compensation system as work-related diseases occur in the construction sector (7).

Planning and co-ordination: two imperatives for construction safety

The risks construction workers face are largely the result of poor planning. Thus a well-organized construction site is generally a safe site and, in a broader sense, a well-managed site (well planned, organized, supervised and controlled) is also a safe site.

Organizing construction work always requires planning. Each of the construction work units (excavation, structure, roof, etc.), each operation (storage and supply of materials, dumping rubble, etc.), and so on, should be planned ahead of time. In addition, the worker's safety and productivity and the quality of the work can only be guaranteed if there are sufficient skilled workers, and appropriate tools and equipment, at a given time.

There are many factors that interfere with proper planning in the construction industry: the diversity of tasks, the variety of construction projects, insufficient time between bidding and initiating the work, ill-defined projects or changes in the projects, or unforeseen changes in the weather. Even so, basic safety planning can always be done, thus eliminating the causes of many potential accidents.

One of the best ways to approach planning for construction safety is to write down the measures for risk prevention that have been decided for a particular site. That is the purpose of the safety project.

The safety project establishes, defines, quantifies and budgets for the preventive measures (collective protection, signalling, personal protective equipment, training, first aid), and the welfare facilities (drinking water, sanitary facilities, washing facilities, changing rooms), that are planned for a particular construction site.

The co-ordination of prevention among different enterprises that participate in a construction project is another fundamental aspect of health and safety in this industry. It is common to find several enterprises carrying out their work at the same time at the same site, in such a way that workers from one of these enterprises are exposed to risks generated by the others. At the same time, prevention and protection measures adopted by one enterprise could affect workers from other enterprises at the same construction site. Sometimes problems also arise when none of the enterprises takes the responsibility for controlling the risks that another contractor may have left behind on leaving the site.

The need for a specific approach

Construction work involves a series of occupational risks, such as work at heights (use of scaffolding, gangways and ladders; work on roofs); excavation work (use of explosives, earthmoving machines); lifting of materials (use of cranes, hoists), and so on, which are specific to the sector.

A specific approach to occupational safety and health in the construction industry is also required as a result of the temporary character of its workplaces. A temporary workplace implies temporary welfare facilities, temporary site utilities (lighting, electricity), temporary collective protection (fencing, shoring, guards-rails, scaffolding, safety nets), and so on. Continuous change of work sites also calls for a specific approach to occupational safety and health management (OSH) at the construction site, where planning, co-ordination and budgeting become extremely important.

Some countries already implement policies and programmes on OSH directed at and specifically designed for the construction sector. This particular treatment of OSH in construction generally includes specific regulations, technical standards, advisory and inspection services, publications and information services for the construction sector. However, this is not the case in most countries, where action at the national level on OSH matters hardly differs by economic sector and where specific programmes on OSH often do not exist for the construction industry.

ILO criteria

The ILO has always recognized the need for specific treatment of the occupational safety and health issue in the construction industry and, in 1937, adopted the Convention No. 62, Safety Provisions for the Building Industry, which was the second ILO convention on occupational safety and health, specifically addressed to a particular sector of economic activity.

At present, Convention No. 62 has 30 ratifications.

In 1988, the ILO adopted a new standard on this subject, Convention No. 167, Safety and Health in Construction after considering that the former Convention No. 62 was no longer appropriate for regulating risks in this important sector of economic activity (8).

One of the new issues Convention No. 167 included is the need for planning and co-ordination of safety and health at the sites, specifying that when several companies undertake activities simultaneously at one construction site: (a) the principal contractor shall be responsible for co-ordinating safety and health measures and for ensuring compliance with such measures and, (b) each employer remains responsible for the application of the prescribed measures in respect to the workers placed under his authority. Convention No.

167, furthermore, establishes that those concerned with the design and planning of a construction project shall take into account the safety and health of the construction workers.

To date, Convention No. 167 has been ratified by 19 countries.

In 1992, a new ILO Code of Practice, Safety and Health in Construction was approved. Again, in this code, reference is made to the planning and co-ordination issue and furthermore, some additional responsibilities of designers and clients are also pointed out, among which the following are worth highlighting (9):

In the absence of a principal contractor, a competent person or body should be nominated at the site with the authority and means necessary to ensure co-ordination and compliance with safety and health measures.

Those concerned with the design and planning of a construction project should integrate the safety and health of the construction workers into the design and planning process. They should also take into account the safety problems related to subsequent maintenance when it involves special hazards.

The clients should: (a) co-ordinate or nominate a competent person to co-ordinate all safety and health activities during the construction projects; (b) inform all contractors on the project of special risks to safety and health that the clients are or should be aware of; and (c) require those submitting tenders to make provision for the cost of safety and health measures during the construction process.

The growing interest in management systems. The ILO/OSH 2001

Management in the construction industry involved in fact two different kinds of management: the management of the project or site, and the management of the company or organization.

During the past decade, we have seen how the centre of attention in the management of OSH in the construction industry has moved from the project level to the company level; and towards a more dynamic and systematic approach, in line with quality and environment standards.

The basic idea behind this new approach, the Occupational Safety and Health Management Systems (OSH-MS), is that of the continuous improvement in OSH performance. In this sense, OSH management in the construction company should not only be considered as a means for the observation of relevant legal obligations, but it should also aim at achieving the best OSH performance.

It was in this context, that the ILO recently adopted its ILO Guidelines on occupational safety and health management systems (ILO/OSH 2001), at a tripartite meeting of experts that took place in Geneva in April 2001 (10).

These new ILO Guidelines provide an international model, compatible with other management system standards and guides. They are not legally binding and are not intended to replace national laws, regulations and accepted standards. They reflect ILO values, such as tripartism and also the relevant ILO international Conventions on occupational safety and health. Their application does not require certification, but it does not exclude certification as a means of recognition of good practice if this is the wish of the country implementing the Guidelines.

One important aspect of the ILO Guidelines is the requirement for a national framework for OSH Management System. In particular, it calls for the establishment of a national policy on OSH Management Systems and the development of National Guidelines and Tailored Guidelines (to address specific conditions and needs of the companies or groups of companies) as well as the mechanisms for supporting the implementation of OSH-MS. This is one of the unique features of the ILO Guidelines, which makes it distinct from the ISO type of approach, such as OHSAS 18000.

A final remark

Although occupational safety and health should be, above all, considered as a worker's right, it should not overshadow the fact that prevention of occupational accidents is also a means for construction companies to become more competitive.

The decisive step towards the inclusion of safety and health in the construction work will only be taken when all the parties involved in the process (workers, employers, designers, clients) become aware that the imperatives of occupational safety and health on the one hand, and of economic efficiency on the other, are not only non-contradictory but convergent.

Bibliography

1. BLS (Bureau of Labour Statistics) Workplace Injury, Illness and Fatality Statistics 2001, USA http://www.osha.gov/oshstats/work.html
2. LABORSTA. ILO on-line database on labour statistics http://laborsta.ilo.org/
3. CNAMTS (Caisse National de l'Assurance maladie des Travailleurs Salariés).Statistiques nationales 2000 des accidents du travail, France (Travail & Securité, July – August 2002, No. 620)
4. INSHT (Instituto Nacional de Seguridad y Salud en el Trabajo). Estadísticas de Accidentes de Trabajo 2001: http://www.mtas.es/insht/statistics/mtas.htm
5. JCSHA (Japan Construction Safety and Health Association). Visual Statistics of Industrial Accidents in Construction Industry 2001: http://www.jicosh.gr.jp/english/statistics/jcsha/2001/2001.pdf
6. Caldwell S. 1999. Taking Construction Health & safety into a New Millennium. http://www.ice.org
7. Pelé A. 1996. 1,512 maladies professionnelles indemnisées en 1994 (Cahiers des Comités de Prévention du BTP, No. 5/96)
8. ILO, 1988. Convention 167 Safety and Health in Construction (ILO, Geneva) http://www.ilo.org/ilolex/english/convdisp1.htm
9. ILO, 1992. ILO Code of Practice Safety and Health in Construction. (ILO, Geneva) http://www.ilo.org/public/english/protection/safework/cops/english/download/e920894.pdf
10. ILO. 2001. ILO Guidelines on Occupational Safety and Health Management Systems (ILO/OSH 2001) http://www.ilo.org/public/english/protection/safework/managmnt/guide.htm
11. López-Valcárcel A., 2001. Occupational safety and health in the construction work (Afr Newsletter on Occup Health and Safety 2001;11:4–7) http://www.occuphealth.fi/e/info/anl/african101.pdf
12. López-Valcárcel A. Opening speech at ISSA Construction Section XXVI Symposium (CRAMIF, Paris) http://www.cramif.fr/utilitaires/aiss/discours_ang1_2.asp

Alberto López-Valcárcel
Senior Occupational Safety Specialist
International Labour Office
4, route des Morillons
1211 Geneva 22
Switzerland
lopezv@ilo.org

Challenges and strategies of occupational health and safety in the construction industry in China

Zhao-lin XIA, Guo-liang LU, You-xin LIANG, P.R. China

Construction site in Jiangsu Province, P.R. China. (Photo by Seppo Olkkonen)

The construction industry has been identified as one of the most hazardous industries in both industrialized and industrializing countries. There is little doubt that China has seen a dramatic increase in output and employment in the construction industry in the past 30 years. In the year 2002, the output of the construction industry was around USD 100 billion. Numerous studies have shown that construction output is growing particularly rapidly, often exceeding the overall economic growth rate. The industry employed more than 36 million people, more than doubling its share of the total workforce from 2.3 per cent to 5.2 per cent. The construction industry plays a major role in combating the high levels of unemployment and in absorbing surplus labour from the rural areas.

The main occupational health problems

Construction workers move through various stages and operations, during which the operations and the process steps change continuously. The challenge to the occupational health professional in characterizing exposures in this ever-changing environment is enormous, requiring consistent data collection methods on numerous sites under a variety of environmental conditions.

It has been found that construction workers are exposed to many harmful substances, such as unpleasant dust, fumes from burning processes, gases from combustion processes and geological formations, and large numbers of toxic chemicals. There are also biological and physical hazards, particularly from noise but also from heat, vibration, inflammable materials, and compressed air. These are real hazards, but much of the excess morbidity is thought to be work-related rather than directly occupational and must be exacerbated by the stresses inherent in site work: low pay, long hours, poor hygienic conditions, poor quality of food and water, and the abuses that an all-male workforce living away from home seems to indulge in, such as heavy smoking, alcohol consumption, and sexual-psychological issues, including even sexually-transmitted diseases.

Many studies have shown that exposure to high levels of noise is widespread in the construction industry. The extensive use of heavy equipment and hand tools within small, sometimes enclosed, areas produces personal exposure to noise. The enclosed nature of tunnels and cut and cover areas increases the problem, because sound reverberates off the concrete walls and ceilings. Hearing loss due to noise exposure is a prevalent occupational disease in China.

Particulates at the worksite are generally viewed as a "nuisance" in spite of the fact that particulates at construction sites often contain concrete and therefore crystalline silica. The levels of respirable crystalline silica found in numerous studies illustrate that the potential for significant exposure still exists.

Much of the construction work is done during the summer months. This means that most workers experience exposure to heat, inducing perspiration.

Lifting and handling heavy objects are very common in the construction industry. In some surveys, 30% and 37% of construction sites affirmed that their daily workshifts included repeated lifting and handling by muscle force alone. Moreover, repetitive hand/arm movements have become even more common, owing to the constant expansion of various tasks. Postures causing pain or fatigue are indicated by many employees. The occurrence of this type of complaint has increased since the late 1980s, probably due to improper application of ergonomic principles and organization of work. These factors have caused musculoskeletal disorders among construction workers.

In some stages, workers in the construction industry may be exposed to several important occupational carcinogens, including radon gas, chromium (VI) compounds, and hardwood dust particles.

Occupational injuries and accidents

The construction industry has been identified as one of the most hazardous industries in China, and occupational accidents involving falls have been identified as the most common cause of fatal injury in the industry. The construction industry consistently ranks as one of the leading industries with regard to the occurrence of occupational fatalities. In the year 2002, construction work had the highest number of fatal work injuries to date, with over 1,948 accidents leading to 2,042 deaths. Compared with the figures for the year 2001, these represented increases of 16.4% and 24%. In all, 80% of all fatal occupational injuries are attributable to six causes: motor vehicle incidents, machine-related incidents, being struck by falling objects, collapse of structures, falls, and electrocution. Of these accident types, falls (47.2%), collapse of structures (19%), being struck by falling objects (8.8%), electrocutions (9%), and machine-related incidents (6%) were found to be the leading causes of death. Injuries resulting from falling are usually classified as occurring from an elevated work surface (e.g. ladders, scaffolds, roofs, buildings, stairs, vehicles, etc.) or from the same level. The magnitude of these fatal occupational injuries resulting from falling is a major public health concern.

Reasons

The reasons for the high accident rate in construction work are not difficult to ascertain. The industry is splintered, and this can daunt the most experienced of managers, including health and safety managers. Construction is labour-intensive, and the workforce tends to be itinerant, unskilled, foreign, and, above all, subcontracted. In addition, their work environment changes frequently. Construction site workers operate moving machinery and vehicles, work underground or at elevated levels, and use sharp tools and heavy equipment.

There are also technical reasons why construction is dangerous. The work inevitably leads to the break-up of new groups; there is much movement horizontally and vertically. Because of the short duration of most projects, the learning curve is steep or, more commonly, non-existent.

Many of the construction workers come from outside urban areas. Their educational level is relatively low and their notions of health and safety are less than adequate. Furthermore, most of them usually receive little training before beginning on the job, especially in some small companies. This is also a major cause of the high accident rate in the local construction field.

Yet another main reason is that the existing legislation does not address all of the problems. The legislation does not provide a sufficient prescriptive umbrella that defines accountabilities, supplemented by succinct regulations and industry-led codes of practice or guidelines.

The last important reason is inadequate management and organization. For example, even though this country has some safety and health legislation, compliance and enforcement are sometimes lacking or minimal. This situation needs to be rectified.

Strategies

To improve construction workers' occupational health and safety, many things need to be done. First, although China has its Construction Act, clearer, more complete, and more practicable safety standards, regulations, and legislation should be formulated for the construction industry in different regions. Workers' pre-employment and periodical safety education should be guaranteed. In addition, the implementation and enforcement should be underlined and enhanced in the whole industry.

The prevention of occupational injuries in the construction industry is feasible given a commitment by both employers and employees to the implementation of site-specific preventive strategies. The strategies need to be adapted over time because the physical environment of a construction project changes rapidly. During all stages of a construction project – from excavation of the site, through structural steel work, to final site cleanup – each job presents physical hazards that can be contained. In the planning phases, contractors can be required to have safety programmes, including a safety supervisor who is on site at all times and who has access to prior injury data on similar sites, job hazard analyses, and potential approaches to hazard control. Expenditures for such items as additional training for new employees or perimeter guarding could be included in the overall cost estimation of the project.

The second major area is occupational health promotion. It is necessary to reduce exposures and hazards, and to educate workers with regard to the health hazards of these agents. In addition, an active, preplanning hazard assessment and intervention programme for a multi-employer construction environment needs to be developed. Further education for management and workers, helping them to fulfill their responsibilities concerning health, is also important. The numerous benefits of occupational health promotion initiatives include economic benefits to the employer, reduced staff turnover, improved productivity, reduced absenteeism, and an improved corporate image.

Third is to promote the use of personal protective equipment in construction work. The literature indicates that most occupational injuries could be prevented, or at least their severity would have been reduced, through the use of proper personal protective equipment, such as helmets, lifelines and lanyards, employee training to prevent falls, and the implementation and enforcement by management of measures to prevent falls and apply other preventive measures at the worksite.

Last, in connection with the consultation approach, it is important to develop and promote a good, blame-free monitoring or surveillance system that includes the reporting of accidents, so as to provide information to be used for improvements.

References

1. Wu HJ, Zhang Q. Safety situation in construction industry in China and its reasons and strategies at present. Construction Safety 2003;9:5–7.
2. Crown-cyr A. Construction hazards and fatalities remain high. Job Safety and Health Quarterly 1999;10(4):16–23.
3. Syed M Ahmed. Site Safety Management in Hong Kong. Journal of Management in Engineering 2000;10:34–42.
4. Neitzel RL, Noah S. A review of crane safety in the construction industry. Applied Occupational and Environmental Hygiene 2001;16(12):1106–17.
5. Pritchard C, McCarthy A. Promoting health in the construction industry. JOEM 2002;44(6):540–5.
6. Xia ZL, Sorock GS, Zhu JL, Courtney TK, Fu H, Liang YX, Christiani DC. Fatal occupational injuries in the construction industry of a new development area in East China, 1991 to 1997. AIHAJ 2000;61:733–7.

Dr. Zhao-lin XIA (Professor)
Dr. Guo-liang LU
Dr. You-xin LIANG (Professor)
Department of Occupational Health, School of Public Health
Fudan University
Shanghai, 200032, P.R. China
E-mail: zlxia@shmu.edu.cn

Asbestos-related diseases among construction workers in Japan

Yuji Natori, Toshio Hirano, Mari Shimazu, Naoki Toyama, Japan

Construction industry in Japan

The construction industry in Japan accounts for over 20% of work-related deaths and injuries requiring an absence of 4 days or more. The number of occupational fatalities in the construction industry amounted to 607 in 2002, 36.6% of total deaths resulting from occupational accidents. Of new cases compensated for due to occupational diseases, the industry accounts for 15% of the total reported cases. Thus the construction industry requires special efforts to prevent occupational accidents and diseases, while, as in many other countries, its worksites are regarded as comprising many demanding jobs known as 3-D (dirty, dangerous and difficult) jobs.

Photos by Naoki Toyama

Construction works generating dust.

The high incidence of occupational accidents and diseases in the construction industry is attributed not only to hazardous conditions of work but also to difficulties in organizing effective preventive programmes. Increasing attention is drawn to changing hazardous operations dealing with heavy materials, elevated workplaces and a variety of chemicals. The Ministry of Health, Labour and Welfare is promoting preventive programmes focusing on hazardous jobs in the construction industry, and control measures of accidents have improved especially in large construction companies in Japan. Special efforts have been made for the prevention of accidents, in particular for spreading construction methods of setting up safe scaffolds prior to building. This has led to significant reduction of accidents involving falls. The Ministry of Health, Labour and Welfare established in 1996 the guidelines on safer construction methods and has provided subsidies to small construction enterprises. The construction industry groups and trade unions have accepted the guidelines and have contributed to the dissemination of the improved scaffolding methods. However, falling accidents accounted for 41.8% of work-related fatalities in the construction industry in 2001. The prevention of falling accidents is still important, especially in small enterprises.

In the aspects of preventing work-related diseases, the situation is more serious. Construction workers were exposed to high concentrations of dust, including asbestos dust, during the period of rapid economic growth in Japan, particularly in the 1960s and 1970s. The numbers of pneumoconiosis, lung cancer and mesothelioma victims have since increased and are expected to continue to rise. This has necessitated increased attention to such diseases in the construction industry.

The next target should be intensified actions for micro enterprises and small enterprises, including the self-employed workers, and for the prevention of occupational diseases.

The high rates of small enterprises and self-employed workers are another important feature of the construction industry. In the construction industry in Japan, 70% of workers are employed in micro enterprises and small enterprises, while about 12% of workers are self-employed (1). The workforce structure in the construction industry is unique; as shown in Fig. 1, the majority work in enterprises employing less than 30 workers. It should be noted that larger enterprises employing 100 or more workers, and accounting for 0.5% of total construction businesses, also rely heavily on contracted micro enterprises and small businesses. Since the Industrial Safety and Health Law does not cover employers, including those self-employed, a notable proportion of construction workers falls outside the scope of strict regulations, such as regulations for 47 organic solvents requiring a local exhaust system and periodic health examinations, definitions of 23 kinds of dusty work, etc. The self-employed workers are outside the scope of workmen's compensation schemes and are covered merely through a voluntary insurance scheme for the self-employed workers and small businesses.

It is therefore important to obtain a clearer picture of the often underreported occupational accidents and diseases in the construction industry, and to discuss types of preventive programmes that can address problems in micro enterprises and small enterprises and among the self-employed workers.

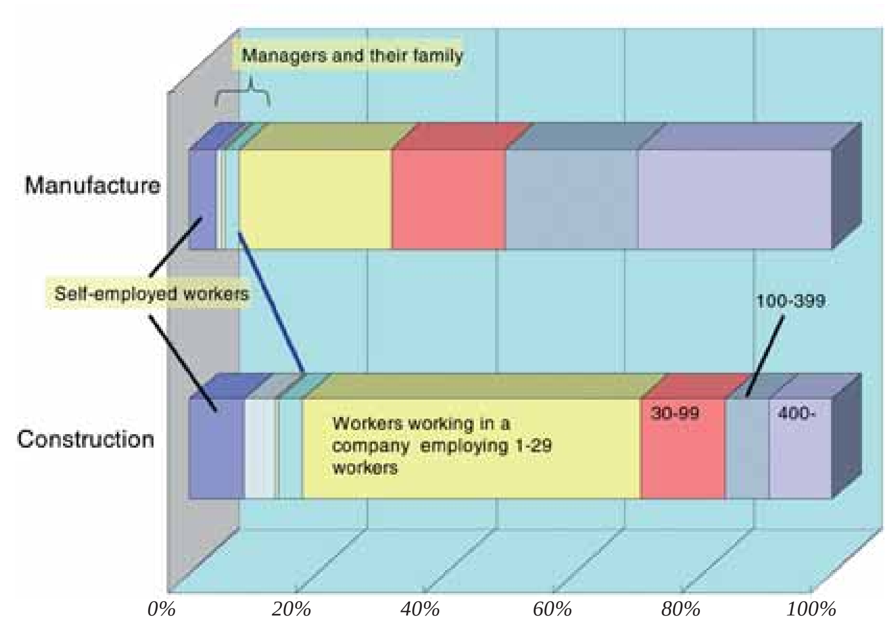


Figure 1. Structure of the workforce in manufacturing and construction in Japan.

Asbestos-related diseases and the construction industry

Of about 8,000 new cases of occupational diseases yearly reported in Japan, the construction industry accounts for 15%. Among 1,157 cases reported from the industry as requiring an absence of 4 days or more in 2001, 638 were diseases due to occupational injuries, 115 due to physical agents, 27 due to work forms, 4 due to hypoxia, 47 due to chemical substances, and 313 were due to pneumoconiosis and complications. Cases due to injuries included 450 cases of lower back pain. Most cases caused by physical agents were due to abnormal temperatures. While these figures related to cases with an absence of 4 days or more and that were compensated for, respiratory diseases and lower back pain were clearly the two prominent occupational diseases among construction workers. Construction workers have further suffered from many occupational injuries, including spinal injuries, finger cuts, and fractures, as well as from vibration disorders, hearing loss, cardiovascular diseases, organic solvent poisoning and others. As for occupational respiratory diseases, dust and asbestos have been the leading causes.

In the use of asbestos in industry, the current phase is recognized as a decelerating period that started around 1990 at about 300,000 metric tons/year and in recent years has retreated to below 100,000 metric tons/year. Noteworthy events during this phase were the prohibition of crocidolite and amosite in 1995, the amendment of the Prevention of Air Pollution Law in 1997 to prohibit scattering of asbestos during abolition, and the inclusion of asbestos in 2000 in the designated list of Pollutant Release and Transfer Register (PRTR). This drastic decrease is expected to continue under pressures toward a total ban. The government has announced a ban in principle on the use of asbestos as construction material after October 2004. It is essential now to strengthen the monitoring of exposure to asbestos in various construction sites and to improve detection of and care for people with asbestos exposure.

The implications of asbestos exposure among construction workers in Japan are yet to be studied. Concerns are growing that the past and still continuing exposures to asbestos among these workers must be addressed by comprehensive programmes. A breakdown of special medical examinations in 2001 revealed that of 21,184 workers who underwent special health examinations due to asbestos at 2,155 establishments, 186 or 0.9% were found to require medical advice. In comparison, the number of workers with positive findings through such examinations in 1991–2000 amounted to 2,652 or 1.0% among a total of 258,451 workers examined.

As shown in Table 1, a recent study on the prevalence of mesothelioma in Japan during the period 1995–2001 identified a steady increase in deaths among males, reaching 50% and a 60% increase in deaths due to mesothelioma of the pleura (2). Thus the public was struck by the predicted number of deaths among males during 2000–2029, which range from 28,700 to 58,000. These findings contrast with a noteworthy increase in the compensation status since the early 1990s in lung cancer and mesothelioma caused by exposure to asbestos, as shown in Table 2. Since 1992, people who have contracted lung cancer and mesothelioma due to asbestos have been compensated at a rate of approximately 20 to 40 cases per year.

The cumulative use of asbestos in buildings has been widespread. In addition to construction workers already exposed to asbestos during construction work, workers engaged in maintenance, renovation and demolition of buildings will be at an increasing risk in the years to come. It is clear that, even after the total ban of asbestos, prevention of both exposure to and diseases caused by asbestos will continue to be a high priority in the society as a whole.

Table 1. Deaths due to mesothelioma in Japan since 1995 (Takahashi et al., 2002).

Year	Total		Pleura		Peritoneum		Others		Total
	Men	Women	Men	Women	Men	Women	Men	Women	
1995	356	144	201	74	35	16	120	54	500
1996	420	156	283	75	23	22	114	59	576
1997	451	146	281	74	31	17	139	55	597
1998	429	141	283	78	39	23	107	40	570
1999	489	158	319	85	27	21	143	52	647
2000	537	173	367	89	30	24	140	60	710
2001	574	198	414	116	35	26	125	56	772

Table 2. Compensation status of occupational cancer caused by exposure to asbestos.

Year	Lung cancer	Mesothelioma	Year	Lung cancer	Mesothelioma
1975	8	0	1989	9	10
1976	2	0	1990	10	6
1977	0	0	1991	10	8
1978	3	1	1992	9	14
1979	5	0	1993	11	10
1980	1	0	1994	9	12
1981	2	0	1995	10	13
1982	7	0	1996	15	12
1983	4	0	1997	12	10
1984	3	4	1998	23	19
1985	7	4	1999	17	25
1986	5	9	(2000)	(18)	(34)
1987	8	2	(2001)	(21)	(33)
1988	7	3	(2002)	(22)	(55)

Table 3. The results of pneumoconiosis screening in 2000–2002.

Year	Total	0/1	Rate of 0/1	1/0	Rate of 1/0
2000	6514	859	13.2	33	0.5
2001	6763	916	13.5	60	0.9
2002	7138	954	13.4	53	0.7

Table 4. Effects of education on recognition and practices among workers at dusty worksites.

Question	Yes				No	Other	Total
			Education (−)	Education (+)			
Can you recognize the difference between sprayed asbestos and rockwool?	1,194	57%	44%	62%	736	169	2099
Do you know that lung cancer should be compensated?	336	16%	10%	24%	1575	188	2099
Do you know that malignant mesothelioma should be compensated?	232	11%	7%	16%	1684	183	2099
Do you clean your workplaces everyday to reduce re-generating dust?	809	39%	20%	50%	26	1264	2099
Do you use a proper dust respirator at dusty worksites?	897	43%	24%	56%	332	870	2099

Activities of local occupational health teams

A trend is growing in Japan to establish local occupational health teams to provide occupational health services for small and medium-sized enterprises. The services include technical advice about the planning and implementation of occupational health programmes, assessment of exposures to various occupational risks, health surveillance and counselling for workers, and education and training. It has generally been difficult to address occupational health issues of construction workers, primarily because of the lack of both local resources and initiative. The increasing awareness of work-related risks and the recent progress in guidance to smaller enterprises about voluntary safety and health management systems have led to various attempts by such local teams, which usually cover the construction industry as part of their services.

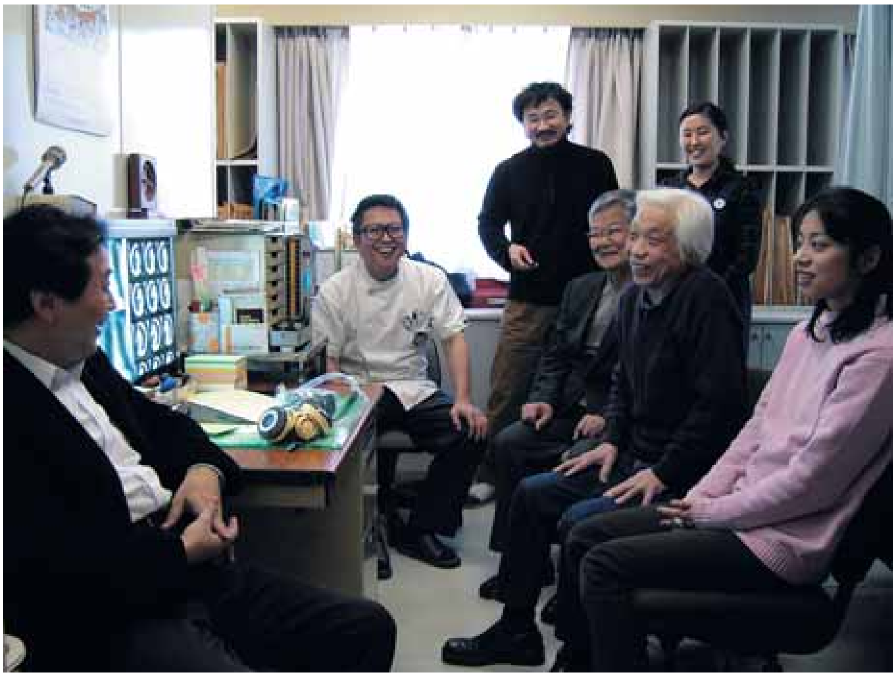
Recent models include construction industry programmes of such teams, in cooperation with employers' and workers' organizations. An example is our cooperation with the Tokyo Joint Association of General Federation of Construction Workers' Union, which is an organization of 150,000 construction workers in Tokyo. This trade union mainly organizes self-employed workers and small businesses working at small construction sites for wooden buildings or at large construction sites as subcontractors. A comprehensive occupational safety and health programme has been launched with the objectives of preventing occupational accidents and diseases, early detection of relevant diseases, assistance in compensation claims by victims, and training in preventive measures, in particular for the self-employed workers and small businesses. The trade union, the Construction National Health Insurance Association affiliated with the trade union, the Himawari Clinic and the Tokyo Occupational Safety and Health Center started a joint programme in 1996.

Initial activities included joint surveys of construction sites and health surveillance of construction workers. For example, to detect occupational respiratory diseases, we have annually checked about 6,000 chest X-ray films of construction workers against the Japanese Standard Pneumoconiosis Films by the Ministry of Health, Labour and Welfare. As a result, we found that workers with 0/1 small opacities and pleural plaques accounted for 13%, and those with 1/0 small opacities accounted for 0.6% (Table 3).

In 2000, we started educational programmes about the prevention of occupational respiratory diseases. For members with abnormal chest X-ray findings, we conducted workshops about the prevention of occupational respiratory diseases and the improvement of working conditions. The workshops were held 20 times per year from 2002. We used newly designed teaching materials comprising photographs and video clips of various jobs, as well as instructions about the measurement of total dust and asbestos concentrations.

The workshops have proven effective for construction workers in enhancing the recognition of risk due to dust and asbestos, and in changing work practices at dusty job sites. A prominent example is shown in Table 4. Workers adopted a local exhaust system and personal protection in cutting a dry wall, and a drastic reduction in dust concentrations during work resulted (Fig. 2).

Photo by Naoki Toyama



Occupational health team members.

Cooperation with the health insurance association

These activities have led to compensation by the Workers' Accident Compensation Insurance Law. Compensation claims were presented from 1998 for pneumoconiosis cases with X-ray findings corresponding to 1/0 profusion or above according to the Pneumoconiosis Law. Workers with Category I findings accounted for 14, those with Category II findings 36, and those with Category III findings 10, with one worker with Category IV findings. Nineteen workers were treated for secondary bronchitis.

In the meantime, the Construction National Health Insurance Association nominated two of the authors as advisory physicians and another as an advisory public health nurse. From 2000, we examined the medical fees documents from various hospitals of patients with malignant mesothelioma and lung cancer or lung fibrosis and interstitial pneumonia with a view to identifying cases of occupational disease. Then the public health nurse and the person in charge of the branch of the Construction National Health Insurance Association visited the victims' homes to assist them and learn about their past jobs. If necessary, we visited the physicians of the hospitals for operated and autopsied lung specimens and examined asbestos bodies of their lungs (3). As a result of these activities, one case of malignant mesothelioma and seven patients with lung cancer were accorded compensation for occupational diseases. These activities also led to the establishment of a society for asbestos victims in construction (4).

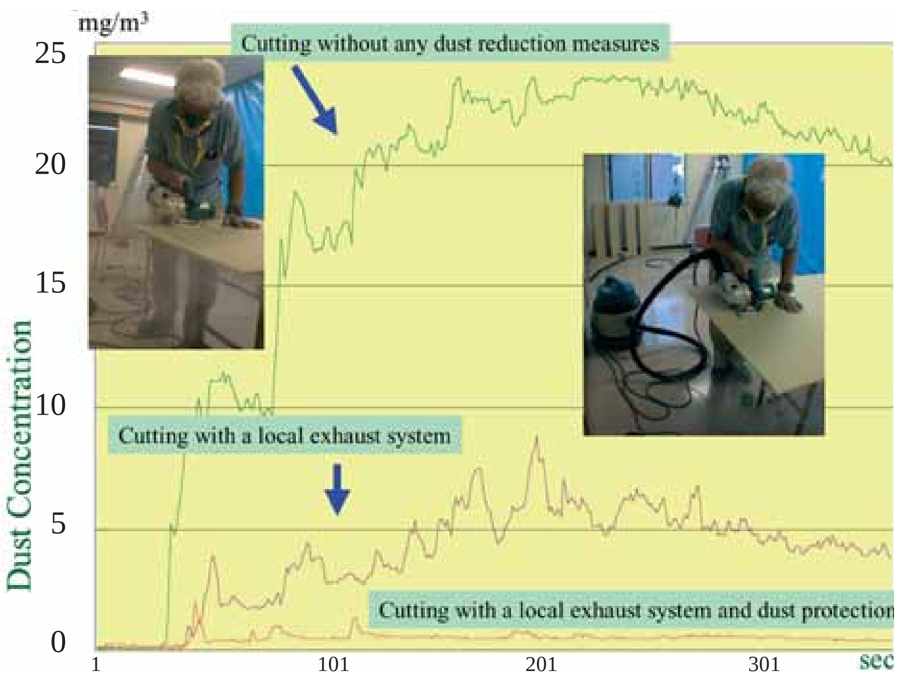


Figure 2. Different exposure levels with/without preventive measures in dry wall cutting.

Photo by Naoki Toyama

Group activities to identify improvement measures.

Workplace improvement activities

The next phase of cooperation among the trade union, the clinic and the centre evolved in the form of participatory activities involving workers and managers. We took account of the guidelines for occupational safety and health management systems in the construction industry established by the Japan Construction Safety and Health Association (JCSHA). We realized that the occupational safety and health management systems had not been spread to small businesses yet. In view of the urgent need to prevent asbestos-related risks, we have been trying to strengthen grass-roots action that is implemented by workers and managers of small businesses (5). We referred to the local experiences in applying the Work Improvement in Small Enterprises (WISE) methodology developed by the ILO as well as the training materials for Participation-Oriented Safety Improvement by Trade-union Initiative (known as POSITIVE), developed by the Japan International Labour Foundation and used in Japan and other Asian countries (6, 7). We thus tried to apply the WISE methodology to micro enterprises and small enterprises in the construction industry. The methodology comprises group inspection by means of a specially designed checklist, workshops to learn ergonomic principles through local good examples, and group work for implementing low-cost improvements. The aims of this activity were: a) to improve the workplace environment, safety, health and productivity in actual construction sites; b) to support the voluntary practices of workers, self-employed persons and small businesses, and c) to spread the training through the trade union network. We started the activity in April 2002.

Firstly, we formed a committee for workplace improvement under the trade union's executive committee. The members of the committee were skilled workers, including carpenters and painters. Most of them, who work in actual construction sites, were either from small businesses or were self-employed. The committee held training courses that had the simultaneous aims of identifying local good examples at the workplaces visited, collecting photographs of these good examples, and producing training materials. In 2002, we held six training courses. The committee members took part in the visits to construction sites, and in the discussion on how to control risks – such as those involved in materials handling and dust exposure – and how to improve actual conditions. The results of the group discussion, fed back to the visited workplaces, encouraged the workers and managers concerned and greatly helped promote improvement action. We confirmed that one important factor facilitating immediate improvements was pointing out good examples and solutions.

In 2003, the committee established a training package, named "The toolbox for improving workplaces", that included an action checklist, collected good examples, and devised presentation materials for a basic training course. The improvement activity is now spreading to 30 affiliated trade unions.

Conclusions

The prevention of asbestos-related diseases among construction workers requires collaborative, well-informed action of construction workers and managers. Our experiences show the importance of voluntary programmes through local teamwork that combines awareness raising, health surveillance and participatory action training. On the basis of these experiences, we can confirm that: a) construction workers and their trade unions can establish voluntary preventive activities while playing a key role in programme activities; b) medical clinics and non-governmental organizations can support the activities; and c) a comprehensive approach focusing on local achievements is essential.

References

1. Labor Force Survey, Bureau of Statistics, Ministry of Public Management, Home and Telecommunications 2001: http://www.stat.go.jp/english/data/roudou/index.htm.
2. Takahashi K, Furuya S, Murayama T, Natori Y, Kurumatani N. Asbestos in Japan: country report. J Univ Occup Environ Health 2002:24(Suppl 2):58–64.
3. Natori Y, Ishiwata H, Akabane H, Miura Y, Kimura Y, Kurumatani N. The relationship between shipyard work, asbestos-associated pathological findings and the number of asbestos bodies in autopsy lungs. Advances in the Prevention of Occupational Respiratory Diseases. Amsterdam: Elsevier Science, 1998:832–7.
4. Consensus report. Asbestos, Asbestosis, and Cancer: The Helsinki Criteria for Diagnosis and Attribution. Scand J Work Environ Health 1997:23: 311–6.
5. Furuya S, Natori Y, Ikeda R. Asbestos in Japan. Int J Occup Environ Health 2003:9(3);260–5.
6. Kawakami T, Khai TT. Participatory application of ILO-OSH 2001 to small enterprises. Asian-Pacific Newslett Occup Health and Safety 2003:10(1):4–6.
7. Kogi K. Work improvement and occupational safety and health management systems: common features and research needs. Ind Health 2002:40:121–33.

Yuji Natori
Hirano Kameido-Himawari Clinic
1-10-7 Kameido, Koutou-ku
Tokyo 136-0071, Japan
E-mail: natori@himawari-clinic.jp

Reducing physiological strain in construction work in Thailand

– AN ERGONOMIC METHOD

Pongjan Yoopat, Thailand

Introduction

The decline in construction volumes subsequent to the South East Asian economic crisis of 1997 is now under control in Thailand, creating an increasing number of jobs in the country. In 1999 there were 13,612 construction establishments all over Thailand (64% of these with less than 200 employees) employing 522,402 officially registered construction workers, of whom about 24.5% were women. The gender distribution was roughly the same for unskilled labour (22% female), whereas only 16% of skilled workers were women (1).

Besides these official employment figures, women and children work many hours in small-house construction, although no precise figures on these are available. The family follows the construction workers (skilled or unskilled) around the country, living temporarily in modest to poor conditions on the construction site and moving to another site when the job is finished. Their salary is much lower than the official salaries and they have no social security status. The working conditions are difficult to keep under control, and any accidents or diseases that occur are not registered.

In combination with the adverse tropical climate, the social conditions and the physical work may create serious health risks varying from general physical fatigue to, for example, cardiac failure, dehydration, sodium chloride deficiency, heat cramps, heat exhaustion, heat syncope and even sudden unexpected nocturnal death syndrome (SUNDS) (2,3). The results of other studies on workload and heat stress, conducted in India, Indonesia, Malaysia and in Thailand (4–7), confirm the seriousness of these risks. Here it must be remembered that there is a fundamental difference between Thai and Western workers as concerns cardiac load (5). Several standards and thresholds, such as the commonly used Wet Bulb Globe Temperature (WBGT) Thermal Index (8), cannot be used to predict reactions to physical strain. The stress-strain model as described by Rutenfranz (9) has been used to evaluate the interrelations between job demands (stressors) such as task, organization and environment, and exposed individuals' physiological response (strain). Furthermore, the model can be used to solve the problem of interindividual and intraindividual differences, which is thought to be very important (10,11).

This study was carried out as a part of the research project "Ergonomics Study of Strenuous Tasks under Tropical Working Conditions" for the Social Security Office of the Thai Ministry of Labor and Welfare (12). The objectives of this study were to assess physiological strain in construction work and to consider priorities for preventive interventions.

Material and methods

Subjects

Forty-three construction workers (Table 1), both men and women, participated in the study and were observed during their habitual daily activities.

Worksites and work activities

The selected worksite was situated at the Rangsit University campus and concerned a 10-floor building involving the classic construction methods of foundation piling, iron binding, carpentry, scaffolding, bricklaying, concrete mixing, materials fetching, preparations and transport of materials. The workstations and subjects were randomly selected at the construction site, in mutual agreement between the management and researchers. The working hours during June and July were about 8 to 10 hours a day, starting early in the morning to avoid the hottest periods of the day, with a one-hour lunch break in the middle of the period. The average air temperature varied from 32.0º C to 38.4º C, the peaks appearing during the

Table 1. Characteristics of the participants

	Men (N = 21)	Women (N = 20)
Age (y)	33 ± 4	30 ± 4
Height (cm)	162 ± 6	153 ± 6
Weight (kg)	59 ± 8	56 ± 9
VO2max (l/min)	2.68 ± 0.55	1.57 ± 0.35
VO2max (ml/kg)	45.4 ± 6.10	28.0 ± 5.00

afternoon. The relative humidity was about 60–75% and the radiant temperature sometimes exceeded 45º C, resulting in WBGTs ranging from 29.2º C up to 33.3º C, which requires alternating work-rest periods during the shift (ISO 7243). The rest periods took place in a cooler, shaded area and there was a permanent supply of drinking water.

The tasks performed were registered with a chronometer in order to have a clear picture of the type of work and the duration of tasks. The results were expressed as the percentage of the total observation time, which was, on the average 95 min in the workshift, varying from 56 min up to 179 min. The total observation time was used in the calculation of intensity-duration aspects of tasks.

Physiological responses

Heart rate (HR) was recorded by means of a data-logging system (BHL2000, Bauman & Haldi) counting every 8 beats and calculated as values per minute. Changes in activities were recorded during the observation and timing. The absolute heart rate values were transformed into relative values expressing the work intensity in between the rest level and the maximal work intensity allowable level for 8 hours. The resting value was obtained after 5 minutes of sitting at rest. From these values the percentage of cardiovascular load (% CVL) was calculated as follows: 100 [(HRwork-HRrest) / (HRmax (8hr) - HRrest)]. (13). Body temperature increase and weight loss during the registered period were measured with Ellab device (CTD thermometer, Denmark, 1985) and weight balance with an accuracy of 100 grams. The Subjective Workload Index (SWI) questionnaire, developed by Cergo International, (13), includes in total eight parameters, six of which express load (problems involving fatigue, concentration, risk assessment, complexity, work rhythm and responsibility) and two of which serve as compensating factors (interest in the job and the level of autonomy). For each factor, the subjects placed him/herself on an 11-point scale (0–10). Values of less than 2 do not call for particular measures, while values of 3 and up require interventions for improvement. The higher the value, the shorter the time to implementation of the intervention.

Table 2. Physiological strain among construction workers

	N	CVL (%)	Increase Body temp (° C)	Weight loss (%)	SWI
Carpenters	10	45.1 ± 16.7	0.44 ± 0.32	1.38 ± 0.97	3.1 ± 0.6
Bricklayers, male	4	54.9 ± 21.6	0.53 ± 0.30	1.42 ± 0.50	3.5 ± 0.9
Bricklayers female	2	64.7 ± 19.6	0.25 ± 0.13	0.80 ± 0.54	2.7 ± 2.3
Materials fetchers, male	5	41.9 ± 17.9	0.53 ± 0.72	1.66 ± 0.50	2.4 ± 0.7
Materials fetchers, female	18	42.9 ± 19.0	0.42 ± 0.25	1.52 ± 0.13	3.0 ± 0.7
Piler, operators, male	4	77.7 ± 24.9	0.45 ± 0.04	3.00 ± 2.05	3.2 ± 0.1
Total	43	50.3± 20.9	0.44 ± 0.37	1.60 ± 1.18	3.0 ± 0.8

CVL = Cardiovascular load
SWI = Subjective Workload Index

Table 3. Cardiovascular response per worker category for each operation

N	Carpenters 10		Bricklayers 4		2		Materials fetchers 5		18		Pilers 4		Total 43	
	men		men		women		men		women		men			
	CVLi)	ID-CVLii)	CVL	ID-CVL	CVL	ID-CVL	CVL	ID-CVL	CVL	ID-CVL	CVL	D-CVL	CVL	ID-CVL
Digging	-	-	80.1	6.0	-	-	67.9	19.5	58.0	5.3	-	-	64.2	5.3
Piling	-	-	-	-	-	-	-	-	-	-	96.2	32.3	96.2	1.9
Woodwork	47.9	29.9	76.0	0.1	-	-	40.9	0.1	-	-	-	-	47.8	7.4
Assembling	55.0	7.8	61.6	1.5	-	-	40.4	3.3	-	-	-	-	52.3	2.4
Iron binding	-	-	-	-	-	-	-	-	28.7	2.5	-	-	28.7	1.1
Cement work	-	-	50.8	7.5	76.6	11.5	34.0	1.3	-	-	-	-	54.4	1.5
Materials handling	55.8	1.7	69.7	15.5	77.7	15.5	63.3	9.6	62.9	22.2	90.2	23.6	64.9	14.5
Crane driving	-	-	-	-	-	-	19.6	3.4	-	-	-	-	19.6	4.1
Not observable	-	-	22.1	0.6	-	-	-	-	26.2	0.2	-	-	24.1	0.2
Productive time (*)	52.9	13.1	60.0	6.3	77.2	1.4	44.4	6.2	43.9	7.5	93.2	27.9	53.6	10.1
Walking	46.7	4.1	51.2	8.7	79.0	7.3	46.3	4.7	47.1	5.4	75.9	16.6	50.8	8.4
Standing/waiting	35.4	2.6	56.8	12.6	51.4	16.5	44.7	4.3	47.9	6.2	71.7	11.6	46.6	6.7
Sitting	29.7	1.2	25.1	2.6	38.9	8.9	20.0	1.0	29.8	6.4	54.8	2.9	32.1	1.6
Non-prod. time (*)	37.3	2.6	44.3	7.9	56.4	10.9	37.0	3.4	41.6	6.0	67.4	10.3	47.1	6.9
TOTAL	45.1	7.8	54.9	7.1	64.7	6.2	41.9	4.8	42.9	6.8	77.7	19.1	50.3	8.5

i) CVL = cardiovascular load, ii) ID-CVL = intensity duration–cardiovascular load

(*) Productive operations are those which are directly linked to the realization of the construction. Non-productive are operations which are indirectly involved, including transports without materials, standing and sitting at rest (waiting for materials or new orders).

Results

General results are presented in Table 2). The results for general workload, expressed by the CVL, are important and indicate that the level calling for attention is reached or exceeded (e.g. among pilers). Body temperature and weight loss seem to be under control, with the work done by pilers presenting the risk of weight loss. Most of the observations are confirmed by the subjective ratings, which call for measures in the medium and long term.

Critical jobs

From the general results, it can be stated that all of the jobs studied reach some critical levels. The list by priorities is: 1) piling workers (machine operators and assistants) – the CVL and fluid loss through sweat call for interventions in the short term; 2) bricklayers, both women and men, mainly because of CVL, and, for men, also the fluid loss through sweat and the body temperature are higher than the average values; 3) materials fetchers, of both genders, because of fluid loss althrough sweat though their CVL is lower; and finally 4) carpenters.

Critical operations

The CVL (%) for each operation is multiplied by 0.01 of the percentage of total time and indicated as the ID-CVL, or the ratio of the intensity duration to the cadiovascular load. This is summarized in Table 3.

The critical CVL levels are: > 90% CVL for piling and materials handling during piling; > 80% CVL for digging bricklayers; > 75% CVL for cement work, materials handling and walking among female bricklayers, woodwork among male bricklayers, and walking among pilers; and > 70% while standing and waiting for pilers. All of these high levels call for improvement measures in the short term, irrespective of the duration of the operations in questions.

Discussion

It is obvious that the ID-CVL is the highest for pilers (piling and materials handling), and improvement measures are required in the short term. Woodwork is stressful work for carpenters (29.9) because of its duration. In general, materials handling is a problem for all occupational groups except carpenters (1.7), who have almost all materials on the spot, and if not, they are brought by female materials fetchers (22.1). Furthermore, comparison of the productive and non-productive times indicated that the difference between production and recovery is poor among male bricklayers (9.3%) and materials fetchers of both genders (6.0% and 5.5% for male and female materials fetchers, respectively). The carpenters reach about 39% recovery and the pilers 38.3%; these are not sufficient but are more acceptable, although for pilers, the level of CVL is much too high.

An interpretation of the WBGT (Wet Bulb Globe Temperature), ISO 7432, is possible when classifying work intensity (light, moderate and heavy). When comparing the CVL values, light work can be characterized by CVL values below 30%, moderate by values of 30–60% and heavy by values above 70%). All categories of the participants' jobs were found to need reduction of working time (alternating work-rest schedules):

- 50–50%	for carpenters	WBGT = 32.5° C, CVL = 45.1
- 25–75%	for male bricklayers	WBGT = 31.8° C, CVL = 56.8
	for female bricklayers	WBGT = 30.9° C, CVL = 60.3
	for female materials fetchers	WBGT = 31.5° C, CVL = 46.7
- not allowed	for male materials fetchers	WBGT = 33.3° C, CVL = 48.0
	for pilers	WBGT = 33.1° C, CVL = 82.0

Photo by Chaichan Sreepoh

Many tasks in construction cause physiological strain.

Development of preventive measures

With regard to the participants' physical capacity, which was moderate for male workers and rather poor for female workers, the cardiovascular load is too high to allow them to continue working full-time under the given tropical conditions.

Several possibilities are available to reduce load:

1. Better work organization of work for:
   - materials handling (a critical operation for almost all involved)
   - the non-productive times: walking distances, waiting times (standing or sitting) and the periods of exposure to the sun
2. Shelters to protect against the sun and electrical fans can increase the cooling effect of evaporation, and beverages can help the body keep its water balance.
3. For piling work, another type of economic management is advised. Subcontracting where the work is paid per pile incites the operators to go beyond their maximal capacity.

Conclusions

The method used in this project makes it possible to arrive at concrete proposals for improvement of the workload. The reactions of individuals are more likely to be used than rigid rules and directives, such as an increase of body temperature or a given environmental temperature limit. The reactions reflect the real strain of the exposed workers and are in concordance with the subjective ratings. It may be expected that when the workers' experiences are enhanced by health criteria, the operators and managers will be more willing to accept improvement measures. However, ongoing and sustaining qualified research is needed for formulating evidence-based quidelines.

Acknowledgement

The author is grateful to the Social Security Office of the Ministry of Labor and Welfare, for the financial support provided for this project. She also expresses her thanks to the contributing construction company, the management and the workers, without whom this pilot study never could have led to this article. Appreciation is extended to the Rangsit University and Cergo International, for their support and scientific advice.

References

1. Report of the 1999 Construction Survey. National Statistical Office Thailand.
2. Gogh KT. Sudden unexplained death syndrome among Thai workers in Singapore. National Epidemiological Seminar. Bangkok, Thailand, 1990.
3. Yoopat P, Glinsukon T, Vanwonterghem K, Louhevaara V, Vanoeteren J. Heat stress and physical workload. In: Proceedings of The first International Workshop on Health and Working conditions in South East Asia. (Commision of the European Union, DGXII-STC. Developing countries, EU-ERBICI; p. 14–144), Patumthani, Thailand: Rangsit university, Ergonomics Unit; 1999.
4. Vanwonterghem K. Assessment of physical work capacity of Indian coal-miner workers. Report ILO-expertise; Dhanbad, India; 1988.
5. Vanwonterghem K, Intaranont K. Report – Study of the exposure limits in constraining climatic conditions for strenuous tasks: an ergonomic approach. Brussels: Commission of the European Communities. RTD-INCO-CI1-0519-M; 1993.
6. Vanwonterghem K, Manuaba A. 1997 Report Improvement of Quality of Life: determination of exposure limits for physical strenuous work under tropical conditions. Brussels: Commission of the European Communities. RTD-INCO,-CT900519; 1997
7. Yoopat P, Vanwonterghem K, Intaranont K. An assessment of workload in the Thai steel industry. Applied Ergonomics 1998;29:267–71.
8. ISO 7243. Hot environments. Estimation of heat stress on working man based on the WBGT-Index. Geneva: International Labor Office; 1982.
9. Rutenfranz J. Aspects of work physiology in occupational stress problems (in German). In: J.R. Nitsch, editor. Stress: Theorien, Untersuchungen, Massnahmen. Bonn: H. Huber Verlag; 1981.
10. Simonson EM. Physiology of work capacity and fatigue. Springfield, Illinois: Charles C. Thomas; 1971.
11. Vanwonterghem K. An experimental study of heat strain and tolerance limits in rescuers in hot-humid conditions. (in French). Doctoral Thesis. Paris: Pantheon-Sorbonne University; 1982.
12. Yoopat P, Glinsukon T, Toicharoen P, Boontong S, Vanwonterghem K. Ergonomics study of strenuous tasks under tropical working conditions. Final report, research project of Social Security Office, Ministry of Labor and Welfare. Nonthaburi, Thailand; 1998:103–26.
13. Yoopat P, Pornkamon T, Glinsukon T, Vanwonterghem K, Louhevaara V. Ergonomics in practice: Physical workload and heat stress in Thailand. International Journal of Occupational Safety and Ergonomics (JOSE) 2002;8:1,83–93.

Pongjan Yoopat, PhD
Division of Sport Science and Ergonomics, Faculty of Science
Rangsit University
Paholyotin Rd, Pathumtani 12000
Thailand
E-mail: pongjan@rangsit.rsu.ac.th

Kim Jin-geal
Republic of Korea

Harmfulness

Background and purpose

The Harmfulness and Hazard Prevention Plan required by law is a risk assessment that acknowledges the dangers intrinsic to construction sites and involves the formulation of technical countermeasures. It was introduced with the amendment of the Occupational Safety and Health Act enacted on 13 January 1990. Its main objective is to devise concrete measures in order to constrain dangerous factors and to secure workers' safety and health. For this purpose, design drawings are examined and safety measures, for instance, to prevent accidents, collapse of structures, electric shock, etc. are analysed.

Procedure, scope and history of the Plan

The procedure required for the Harmfulness and Hazard Prevention Plan is as follows:

The construction company submits its Harmfulness and Hazard Prevention Plan to the Korea Occupational Safety and Health Agency (KOSHA) before work at a building site begins. KOSHA must examine the plan within 15 days and must periodically conduct safety inspections based on the plan submitted by the contractors. The following five construction project types are required to submit a Harmfulness and Hazard Plan:

- Buildings or structures with a height from the ground exceeding 31 m, buildings with more than 30,000 m^2 in total area, or culture or meeting facilities (excluding exhibit halls, zoos and botanical gardens), sales or business facilities, general hospitals, lodging facilities, and the construction, rebuilding and wrecking work (hereinafter construction) of an underground shopping centre
- The construction of bridges with a maximum span of 50 m
- Tunnel construction work
- The construction of multipurpose dams, power generation dams, reservoir dams of 20 million tons, or local water supply dams; and
- Excavation works more than 10 m in depth.

The Harmfulness and Hazard Prevention Plan introduced in 1990 was changed in 1996 in accordance with the environmental changes that took place in the construction industry and the improvement of construction safety technology. In line with this change, the contractor turns in a plan after having consulted with a qualified occupational safety professional. In 1997, self-regulatory safety management was put into place in order to stimulate safety awareness at construction sites. A construction company where the accident rate fell under a specified rate became entitled to conduct self-regulatory safety management, which means the company itself examines and inspects the safety management.

The system was amended in 2003 so that if a fatal accident occurred at a construction site, the company's self-regulatory safety management was suspended and KOSHA conducted an inspection. Moreover, to keep abreast of the boom in construction of large buildings, the obligation to submit a Harmfulness and Hazard Prevention Plan was extended to include large construction sites exceeding a specified total area and public buildings. The government continues to make every effort to develop the system and to generate positive results.

Achievements and effects

As was mentioned above, the Harmfulness and Hazard Prevention Plan involves examinations and inspections. The performance of examinations and inspections depends on the governmental deregulation policy or the economic trend in the construction industry, but the numbers performed have been increasing since the year 2000. (Figure 1)

Although the construction sites submitting a Harmfulness and Hazard Pre-

s and Hazard Prevention Plan

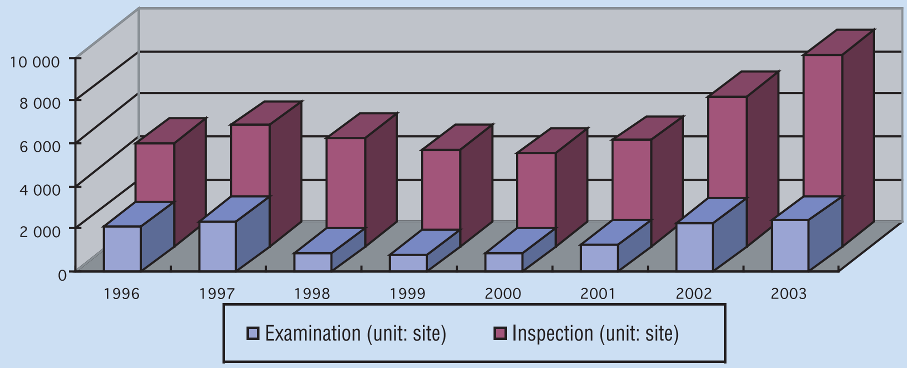


Figure 1. Examinations and inspections

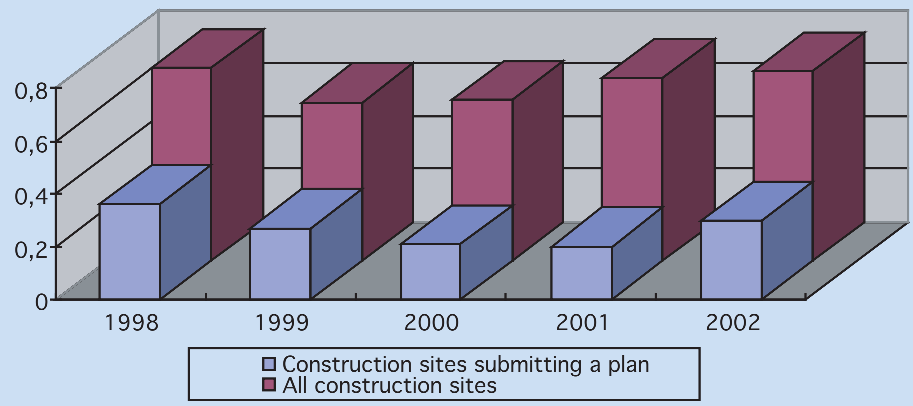


Figure 2. Accident rate

vention Plan account for only 2–3% of all construction sites, most of the dangerous construction sites and large construction sites are covered. This means that a substantial share of construction sites are examined and inspected.

The Harmfulness and Hazard Prevention Plan has played a leading role in improving the capacity of self-regulatory safety management and in developing safety technology. As a result, the accident rate at the sites submitting a plan is 0.3%; this is about 42% of the corresponding rate for the entire construction industry, which is 0.72%. Therefore, it can clearly be demonstrated that the plan leads to positive results and is effective. (Figure 2)

The system not only contributes to the improvement of self-regulatory safety management at large construction sites, but it also stimulates effectiveness in securing safety management through a preliminary examination at all stages of the construction work, thereby reducing and eliminating the dangerous factors in new and in small or medium-sized construction sites. Therefore, the Harmfulness and Hazard Plan itself has many effects on the motivation of safety management.

In the actual building process, the plan provides the people concerned with motivation for safe construction sites even though the site lasts for only a short time. Also, learning from the work done by inspectors helps construction workers understand the overall safety management at the site.

Future perspectives

For effective accident prevention at construction sites, a systematic safety management mechanism needs to be established for each stage of planning, design, construction, maintenance and management. Especially the formulation of the plan and its examination and inspection must be subjected to a thorough safety assessment during the planning stage. In addition, the characteristics of the building work and the large numbers of people involved call for substantial and effective safety management.

Even if the Harmfulness and Hazard Prevention Plan is evaluated as carrying out the important tasks accorded to it, safety awareness and the right atmosphere are necessary to ensure safety. (The Plan has had some positive effects, but more concrete results are needed, as is a direct impact on safety management.) In particular, the government has to develop an operating system to help institutions and construction companies create an atmosphere where both employers and employees are willing to participate in safety management. To this end, KOSHA intends to procure advanced technology and to strengthen its position as the organization specialized in accident prevention. This will be done by intensifying the key technical capacity of inspectors, by reinforcing safety management through R&D, by the application of examination and inspection technology, and by promoting positive participation at sites through company-oriented technical assistance.

Kim Jin-geal
Director of the Construction Safety Department
Korea Occupational Safety and Health Agency (KOSHA)
34-4 Gusan-dong Bupyeong-gu, Incheon, 403-711, Korea
E-mail: desert@kosha.net

Women using traditional cooking fuels in developing countries:

Problems and alternatives

H. Venkatakrishna-Bhatt, India

Civilization has been seen as development and the consumption of energy – so much so that, until recently, per capita consumption of a nation was taken as an index of its technological advancement (1). Theoretically, with the present rate of economic development and population growth in less developed countries (LDCs), the total world energy consumption would go by >200 billion thermo coupled activation (TCA).

Table 1 shows that currently industrialized countries (including Eastern Europe and Russia) use 74% of the global energy consumption while they support only 28% of the world's population. Out of the total energy utilization on Earth, non-commercial fuels (traditional fuels: woods, crop residue and cattle dung) catering for the principal needs of 2.5 billion people account for only 6.38% (Table 1). But among LDCs, the traditional fuels account for almost 25% of their total energy requirements, being predominantly utilized as the principal cooking fuel by 73% of the population. The rural population of LDCs (>70%) is completely dependent on traditional fuels for their domestic cooking. This is because LDCs are inevitably agriculture-based and therefore can manage on less energy than urbanized societies of industrialized developed countries. In other words, almost 52% of the world's population still eat food cooked on wood fuel, crop residues or dung cakes (Table 2). Further, there are compelling reasons to assume that people's dependence on traditional fuels may continue to increase over the next decade, owing to population growth, the non-availability of alternative energy sources that are economically viable, and the timeframe required for social adaptation.

The use of traditional fuels in LDCs, however, presents certain problems and requires steps for integrated fuel policies. The major problems caused by traditional fuel combustion are:

a) ecological imbalance (2)
b) increased atmospheric pollution load (3); and
c) housewives' exposures (4, 5).

Ecological imbalance

Among traditional fuels (wood, crop residue and cattle dung (6)), wood alone accounts for 64% and caters for 4.6% of the total global energy requirement (Table 1). Alongside other land clearing requirements for agriculture, industry and urban expansion, large-scale deforestation – mainly to acquire fuel wood to burn for energy – can result in indirect ecological imbalance. In the next decade, population growth alone would result in a 19% increase in Asia's fuel requirements, thereby concomitantly increasing deforestation and resulting in a 20% decrease (should

Table 1. Global energy consumption and percentage distribution

Commercial fuels	Developing countries (%)	Industrialized countries (%)	Global energy consumption (Million TCA)
MODERN FUELS			
Petroleum	8.77	33.09	4,270
Coal	8.57	23.53	3,275
Natural gas	1.67	14.71	1,670
Hydro and nuclear	0.59	2.21	285
SUB-TOTAL	19.60	73.54	9,500
TRADITIONAL FUELS			
Wood	4.17	0.44	470
Crop residue	1.47	0.05	155
Cattle dung	0.74	-	75
SUB-TOTAL	6.38	0.49	7,00
GRAND TOTAL	25.98	74.03	10,200

TCA = thermo coupled activation

Table 2. Percentage distribution of population relying principally for cooking needs

	Commercial fuels (%)	Wood (%)	Dung and crop residue (%)	Total population (Million)
India	10	48	43	610
Total urban				
Urban non-poor	67	33	low	60
Urban poor	low	57	43	70
Rural	4	48	48	480
Developing countries	26	45	28	2,800
Industrialized countries	100	low	low	1,105
World	47	32	20	3,905

Table 3. Pollutant concentrations in domestic smoke given off by different fuels being used in Ahmedabad

Type of fuel	Benz (o) pyrine µg/1000m^3	Total suspended particles (TSP) µg/m^3	Total suspended particles B (a) P µg/g TSP	NO_x µg/m^3	SO_2 µg/m^3
Wood	1,270 (763–1,682)	7203 (4,711–11,460)	188 (147.0–19.0)	318 (20–1,827)	169 (23–791)
Cattle dung	8,248 (4,171–13,580)	15966 (9,590–20,036)	560 (208.0–743.0)	144 (12 1,350)	242 (29–1,142)
Cattle dung + wood	9,317 (833–25,653)	21,163 (9,968–58,577)	534 (705.0–668.0)	326 (14–2,033)	269 (20–1,340)
Coal	4,207 (4,089–10,820)	26147 (4,119–48,174)	273 (224.6–321.4)	220 (100–393)	427 (88–1,358)

there be no reforestation) in the sustainable yield per capita, while in contrast, there may be a 25% reduction in fuel wood use in industrialized countries. Legislation should set limits in order to protect ecosystems against over-exploitation while also prescribing future options for continued use of forests – which incidentally are among LCDs' major assets.

Some "energy plantation" experiments conducted in India have enabled feasibility analysis concerning the cultivation of plants for their fuel value. The results suggest that casuarinas, which as an energy crop have a cyclic time of 4 years, can yield about 14 X 10^3 TCA per sq. km. In semi-arid regions, plants with a high water efficiency, such as "tumble weeds" could be cultivated on a similar energy crop cycle. Such energy plantations may be rejected as inadequate eco-disturbances, because forestry should always preserve the customary fauna and flora of the region as seen in virgin forests. Therefore, energy plantations are out of the question as a solution to the problem of eco-conservation, although cultivation of an energy crop may be an economically viable solution for fuel wood.

Household exposure

Cost-benefit analysis of the long-term or short-term productivity of natural resources, even at the risk of eco-disturbances, forms only a part of the story of fuel use. Another major consideration is the community health problem. Traditional fuel burning has exposed about 4.26 million housewives (with a world population of 3,905 million and an average family unit of 5 persons) to excessive smoke conditions since 1976.

Extensive work done in the air pollution unit of the National Institute of Occupational Health, Ahmedabad, India (7) enabled projection of this interesting problem, as seen in Table 3. It is clearly shown here that women working in the kitchen and using traditional fuels – wood, cattle dung cakes or even poor-quality fuels such as coal – are exposed to dense concentrations of sulphur dioxide, suspended particulate matter, benzo-a-pyrines, oxides of nitrogen and carbon-monoxide exceeding acceptable international norms. This study revealed a gradual increase in morbidity among women in relation to age. More than 18.1% of women using these cooking fuels suffered from respiratory complaints; the corresponding figure for women using kerosene was only 6%.

As presented in Table 4, Delhi (8) hospital records show the trend of severe congestive cardiac failure, with enlarged hearts and more pulmonary disturbances among women. It was also concluded from these data that the cause of chronic *cor pulmonale* in women was damage to the lungs induced by exposure to smoke from cooking fuel from an early age onwards, together with frequent chest infections. Some data pertaining to African hut dwellers have revealed similar conditions.

A noteworthy feature is that while priority is given to finding solution for various occupational hazards (9), no

Table 4. Development of cor pulmonale *among men and women at Delhi (8)*

Age (Years)	Men	Women	Total
<20	-	2 (0.4%)	2 (0.2%)
21–30	10 (4%)	87 (17%)	97 (13%)
31–40	44 (18%)	168 (32%)	212 (27%)
41–50	108 (45%)	144 (27%)	252 (32%)
51–60	52 (22%)	87 (17%)	139 (18%)
>60	25 (10%)	39 (7%)	64 (8%)

attention has been paid to the female population, who form the largest single group with similar exposure and who have been suffering since the beginning of civilization. Although the problems of, e.g. malnutrition, general hygiene, clean water supply and primary health care have been appreciated, the inhalation of smoke, aggravating overall ill health effects, warrants equal attention (10).

Atmospheric pollution

Besides women's household exposure, the environmental impact of traditional fuel burning is another important problem. Even conservative estimates indicate that the use of traditional fuels in LDCs may amount to as much as 3/4th of coal utilization. Comparison of the emission factors for the combustion of coal with that for fuel wood indicates that, as to pollution from organic matter, wood is more dangerous than coal and contributes in the same proportion towards the total atmospheric pollution load (11). Whereas traditional fuels may not pose a critical problem in the global perspective, their contribution is not insignificant for large urban complexes (12). In India, where 69% of the urban population in general still depends upon wood and cattle dung for their cooking needs, the use of such fuels can alter the air pollution pattern of a large urban complex (13).

Energy alternatives

All the above problems collectively project the need for appropriate energy alternatives in LDCs. Such energy alternatives are not governed only by technological strains but also by societal acceptance and political decisions. The question now is: What energy options are available for replacing traditional fuels in LDCs?

The options can be classified into non-renewable and renewable energy categories. It is apparent that in LDCs, by the end of the next decade, there may be a shortage of easily accessible non-renewable fossil fuels which can be recovered economically. Besides early depletion of non-renewable energy sources, their replacement of traditional fuels in rural areas of LDCs involves many major drawbacks. They require an extensive transport network, and as costs accelerate such energy sources become less accessible.

Nevertheless, the use of commercial energy sources in domestic kitchens does not solve the problems of women's household exposure and environmental impacts unless fuel storage and their usage patterns of fuel use are entirely changed. There are neither major advantages nor great prospects for large-scale utilization of non-renewable energy sources in rural areas of LDCs, which has stirred an increasing interest in renewable energy alternatives; e.g. hydroelectric, solar, geothermal, tidal, wind, biomass, and biogas energy.

The foremost renewable energy resource is hydroelectric power. It has the potential to meet the energy demand of 3.95 X 10^9 metric TCA in LDCs. But it is unlikely that the full potential of this source (8.33 X 10^8 metric TCA in LDCs) can be harnessed, owing to various technical problems associated with hydropower sites. Applications of fuel use in rural India are a remote possibility, at least in the near future. The disadvantages of biomass energy have been determined earlier. The most promising renewable energy resource alternatives for wider applications in rural areas are solar energy and biogas (1).

Solar energy options

As regards solar energy, it is easy to make a case for tropical countries such as India, where most areas receive 2,500–3,500 hours of bright sunshine a year. In India, total solar energy annually reaching the surface is on the order of 3 X 10^{15} kWh. But it would simply be misleading to conclude that the total energy requirement of a large country like India can be met by tapping solar energy incident on a 25 sq. km area. The biggest snag with large-scale utilization of solar energy is the large land and material requirement; however, the relative economic competitiveness of this renewable source vis-à-vis fossil fuels and uranium is changing rapidly. Some optimistic estimations presented by economists indicate that the cost of electricity generation by photovoltaic cells may drop 20 to 25-fold in the next decade, while the price of oil or natural gas may double during the same period.

Small-scale solar powered appliances – for example, kitchen stoves and hot water heaters – have been proved to be economically viable options. At present in India, more than 40 national organizations are engaged in research and development programmes on this renewable energy source, and Rs 400 million have been allocated for research and development. In some Indian rural areas, many solar voltaic pumps and lighting systems have been installed on an experimental basis.

Indian government estimates indicate that use of solar-powered water heaters in industries and hotels alone would save 20 million tons of coal, 2.5 million tons of oil and 5.4 kWh of electricity consumption. Recently, many public sector organizations have been instructed to use such solar-powered hot water appliances as a result of feasibility trials.

India is also marketing box-type, solar-powered domestic cookers, in the price range of Rs 400 each, and in many cities their use has proved popular. In Gujarat State, the Gujarat Energy Development Agency (GEDA) estimates that if even half of the food consumed by a family of five to six people is cooked on solar-powered cookers, the saving would be 520 kg of coal per year. With a million rural families using traditional fuel in Gujarat State alone, the annual saving could be a million TCA. Encouraged by such estimates, GEDA have decided to opt for large-scale manufacturing of solar-powered cookers.

Solar appliances are undoubtedly pollution-free and do not pose any health problems to domestic users. Extensive use of solar-thermal electric converters or photovoltaic and solar-thermal hydrogen systems, however, could lead to heat imbalance of the ecosystem. But as such effects are not certain, the economic viability of even large solar-powered systems should be explored if LDCs are to be able to survive hikes in fuel prices (Gujarat Energy Development Authority. Personal Communication; 2002).

Biogas pits

Another promising energy source, particularly in rural areas of LDCs, is biogas pits. Indian experiments done in the last five years have adequately proved the economic and technological viability of biogas pits in a tropical climate. India's first community biogas plant was established in Andhra Pradesh in 1976, and now more than 270,000 biogas pits have been commissioned. Such plants provide gas for cooking and lighting as well as for running engines and pump sets and for generating electricity. For the next five years, the Indian government has provided Rs 500 million for subsidies and supporting facilities to enable the establishment of family biogas plants in villages. If such expansive experiments prove successful, we can anticipate that at least half of the Indian rural population shall cook their food on such biogas stoves.

Many more LDCs besides India should follow in the footsteps of China with regard to application of this renewable energy source. In China, pits producing biogas fulfil 69.5% of the total estimated rural energy requirement of 320 million TCA. The balance consists of coal (18.2%) and electricity (7.8%). There are already more than six million such pits in the whole of China, producing about 700 million cubic metres of biogas (14).

To sum up, in this article I have attempted to identify the problems associated with the use of traditional fuels for domestic cooking in LDCs and to present energy resource alternatives. The total global consumption of traditional fuels is only 6.9%, yet more than 70% of the female population in developing countries are at serious health risk due to excessive exposure to smoke from domestic stoves that begins in their childhood or adolescence. If substantial commitment towards emancipation of women is made in LDCs, then solar energy and biogas are economically and technologically viable alternatives of renewable energy sources. The experience and expertise gained in India and China are noteworthy landmarks to combatting the energy crisis.

Acknowledgements

The author wishes to thank the Director of the National Institute of Occupational Health, Ahmedabad, for his support, facilities and encouragement.

References

1. World Resources Institute: UNEP, UNDP, World Bank: World Resources: A Guide to the Global Environment. Oxford: Oxford University Press; 1998–99.
2. Verma Y, Venkatakrishna-Bhatt H, Syed SM. New dimensions of ecotoxicology and a case study of aquatic ecosystem. Advances in Biosciences 1991;10(1):61–6.
3. Patel TS. Air Pollution: Problems and Perspectives. Indian Council of Medical Research Bulletin 1997;27(6):51–9.
4. Gopalan HNB, Saxena S. Domestic environment and health of women and children. In: Biofuels: Tata Energy Research Institute, New Delhi.
5. Bahera D, Jindal SK, Malhotra HS. Ventilatory function in non-smoking rural Indian women using different cooking fuels. Respiration 1994;61:89–92.
6. Bahera D. Health effects of indoor airpollution due to domestic cooking fuels. Indian Journal of Chest Diseases and Allied Sciences 1995;37(4):237–8.
7. National Institute of Occupational Health (NIOH). Domestic source of air pollution and its effects on respiratory system of house wives in Ahmedabad. NIOH Annual Report 1982. p. 32–42.
8. Padmavati S, Joshi B. Incidence and etiology of chronic cor pulmonale in Delhi: a necropsy study. Diseases of the chest 1964;46:457–63.
9. Venkatakrishna-Bhatt H. Source and sink of health risk sustained in a hotel environment by workers. Silver Jubilee Proceedings of Andhra Pradesh Hotels Association 1996;25:75–6.
10. Venkatakrishna-Bhatt H. Occupational health impairment in the catering section of hotel business. Journal of Kurnool Hotelliers Association:VASS 1988;1:43–6.
11. Aggarwal AL, Raiyani CV, Patel TS et al. Assessment of exposure to Benz (o) pyrene in air of various population groups in Ahmedabad. Atmosphere and Environment 1982;16:867–70.
12. Saiyed HN, Patel TS, Gokani VN. Indoor air pollution in India – A major environmental and public health concern. Indian Council of Medical Research Bulletin 2001;31(5):61–9.
13. Nigel B, Rogelio P, Rachel A. Indoor air pollution in developing countries: a major environmental and public health challenge. Bulletin of the World Health Organization 2000;78:1078–92.
14. Smith K.R. Indoor air pollution implicated in alarming health problems. Indoor Air Pollution – Energy and Health for the Poor (Newsletter published by World Bank) September 2000:1–5.

Dr. H. Venkatakrishna-Bhatt
Ex-Senior Grade Deputy Director
Head, Department of
Neurobehavioral Toxicology
National Institute of Occupational
Health
Meghani Nagar
Ahmedabad 380016, India

Mailing address:
Dr. H. Venkatakrishna-Bhatt
Flat No. 13, Block No. 2
Suramya Apartments
Sola Road, Opposite to Mirambika
Street, Near Naranpura Telephone
Exchange
Ahmedabad 380063
Gujarat, India
E-mail: hvkbhatt@yahoo.co.in

Editorial Board

as of 10 March 2004

Price of the Asian-Pacific Newsletter USD 6