II. REVIEW OF LITERATURE

The literature pertaining to the study on “Ergonomic Analysis of Unorganized Women Construction Labourers in their Occupational Settings” is reviewed under the following broad headings:

A. History and Etymology of Ergonomics
B. Ethos of Ergonomics
C. Construction Industry in India – A Promising Scenario
D. Studies Conducted on Women Construction Workers
E. Work Environment and Work Related Hazards in Construction Sites
F. Occupational Safety and Health

A. History and Etymology of Ergonomics

Ergonomics is a work of selection, environment and inventions of the tools. Christensen way back in 1987 had projected that the importance of a “good fit” between humans and tools was probably realized early in the development of species. Australopithecus Prometheus selected pebble tools and made scoops from antelope bones in a clear display of selecting/creating objects to make tasks easier to accomplish. In the work environment, the selection and creation of tools, machines, and work processes continued. Over centuries, the effectiveness of hammers, axes and plough improved. With the Industrial revolution, machines such as the spinning jenny (a machine that produced yarn to make cloth) and rolling mills (a method of flattening iron ore into flat sheets) were developed to improve work processes. This is the same motivation behind much of ergonomics today (http://www.ergoweb.com/resources/reference/history.cfm). However, much of the thinking behind ergonomics remained something etched at the back of designers for a long time.

The foundations of the science of ergonomics appear to have been laid within the context of the culture of ancient Greece. A good deal of evidence indicates that Hellenic civilization in the 5th century BC used ergonomic principles in the design of their tools, jobs, and workplaces. One outstanding
example of this can be found in the description Hippocrates gave of how a surgeon's workplace should be designed and how the tools he uses should be arranged (Marmaras et al., 1999). Archaeological records of the early Egyptian dynasties who made tools and household equipment, among others that illustrated ergonomic principles are also true. It is therefore questionable whether the claim by Marmaras et al., (1999) regarding the origin of ergonomics, is justified doubts, Okorji (2009).

It was not until the 16th century, when Bernardino Ramazinni an Italian physician, who lived from 1633 to 1714, named the father of occupational medicine wrote a medical journal about complaints from his patients, where he described the various injuries they had and how they were related to their occupations and work environments (http://www.ergonomics-info.com/history-of-ergonomics.html&sa).

The term ‘ergonomics’ did not arise until 1857. The notion was first used and defined by a Pole, Wojciech Jastrzebowski in 1857, when he created and used the term in a narrative he wrote about the science of nature. But there was still more that was needed for the importance of ergonomics to catch on with the greater industrial and manufacturing sectors (http://www.harrisworksystems.com/Articles.asp?ID=255). The production of industry was still largely dependent on human power/motion and ergonomic concepts were developing to improve worker productivity. With the popularity of scientific management, a method that improved worker efficiency by improving the job process (http://www.ergoweb.com/resources/reference/history.Cfm & sa), in the early 1900’s, large industries became aware of greater productivity when they were placed in certain positions (Feedme, 2010). It was introduced in the 19th century by Frederick Winslow Taylor, a pioneer of this approach and evaluated jobs to determine the “One Best Way” they could be performed. His ideas led to reduced work injuries and an increase in production levels - an indication of the use of basic ergonomic concepts at that time.


- Bernardino Ramazinni’s medical journal titled ‘De Morbis Artificum (Diseases of Workers)’ in 16th century this laid the foundations for a better understanding of ergonomics (http://www.ergonomics-info.com/history-of-ergonomics.html&sa).

- Frederick Winslow Taylor’s ‘Principles of Scientific Management’, first published in 1911, is a classic in industrial psychology (Encyclopedia of Social Sciences, 2001).

- In the US, several popular textbooks written by scientists like Woodson, McCormick and Sanders were published since the 1950s. In 1963 the first edition of a masterpiece by Grandjean, “Fitting the Task to the Man,” was published. In 1996, the IEA and the ILO jointly launched “Ergonomics Checkpoints” with easy-to-understand illustrations for the improvement of workplaces and working conditions (http://www.ergonomics.jp/e_index/e_outline/e_ergono-history.html&sa).

A fundamental contribution in the field of Ergonomics was made by the works of the following ergonomists:

- Practical applications of ergonomics - Zbichorski and Pawlikowska, (1962); Oginski and Krasucki (1972) and Cwirko (1986).
In the 1900s Frank and Lillian Gilbreth further expanded Taylor’s methods and came up with the ‘Time and Motion Studies’. The Gilbreths looked at the different techniques that would help reduce the amount of unnecessary motions required to perform a task (http://www.ergonomics-info.com/history-of-ergonomics.html&sa). If the Gilbreths gave ‘ergonomics’ exposure then World War II placed it firmly on the world map. During War in 1943, it became clear that aircrafts in good condition and which were flown by the best of pilots still saw numerous crashes. An army officer, Alphonse Chapanis came up with a way of greatly reducing the “pilot errors” by replacing confusing designs in airplane cockpits with more logical controls (http://www.harrisworksystems.com/Articles.asp?ID=255). However, much of the basic concepts of ergonomics were not understood. Yet, men were beginning to see some connection between a man’s health and the work he did each day. After World War II, the focus of concern expanded to include worker safety as well as productivity (Feedme, 2010). Research focused thrust thus on a variety of areas such as muscle force required to perform manual tasks, compressive low back disk force when lifting cardiovascular response when performing heavy labor, perceived maximum load that can be carried, pushed or pulled.

In the decades since the war, ergonomics has continued to flourish and diversify. The Space Age created new human factors issues such as weightlessness and extreme g-forces. How far could environments in space be tolerated, and what effects would they have on the mind and body? The dawn of the Information Age has resulted in the new ergonomics field of human-computer interaction (HCI). Likewise, the growing demand for and competition among consumer goods and electronics has resulted in more companies including human factors in product design. The coining of the term Ergonomics, however, is now widely attributed to British psychologist Hywel Murrell, at the 1949 meeting at UK, which led to the foundation of the Institute of Ergonomics and Human Factors. He used it to encompass the studies in which he had been engaged during and after the II World War (http://en.wikipedia.org/wiki/Ergonomics). The Ergonomics Research Society was established in the UK in 1949. A crucial moment for Polish ergonomics
was in 1979 when the 7th IEA Congress, organized by Jan Rosner, was held in Warsaw.

Ergonomics has grown over the years. People are uniquely different, often with different shapes and sizes, different limitations and abilities in strength, skills, speed and judgment. So, an ergonomist usually considers factors of this line in order to bring about a solution that works. In Ergonomics, in order to solve problems effectively, one needs to be sound in psychology and physiology and make his or her result perfect with an engineering approach. That is the beauty of this science! (http://momsclubofcarmichael.org/about_us.php copyright 2010). Thus the relation between workers, work and work environment was more or less defined. By virtue of these factors ergonomics is hence forth categorized under three approaches (http://www.ergoweb.com/resources/reference/history.cfm&sa).

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<td>encompass areas of knowledge that involve human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity such as</td>
<td>considers areas of knowledge that involve human behavior and attributes such as</td>
<td>includes areas of knowledge that involve physical aspects of the workplace and human abilities such as</td>
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<td>a. Working postures</td>
<td>a. Decision making process</td>
<td>a. Force required to lift</td>
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<td>b. Materials handling</td>
<td>b. Organization design</td>
<td>b. Vibration and reaches</td>
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<td>c. Repetitive movements</td>
<td>c. Human perception relative to design</td>
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<td>d. Work related musculoskeletal disorders</td>
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<td>e. Workplace layout</td>
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<td>f. Safety and health</td>
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The human resources that constitute knowledge and aid those who are concerned with ergonomics in workplace are presented under Figure 1 and 2.
The concept of Ergonomics:
A science and practice that deals with the interaction of Human and Machine

Professionals who use Ergonomics/Human Factors:
- Industrial Engineers
- Occupational Hygienists
- Occupational Medicine Physicians
- Safety Engineers
- Architects
- Occupational therapists
- Physical therapist
- Occupational medicine / nurses
- Insurance loss control

Figure 1: The Ergonomic Groups

Figure 2: Concept of Ergonomics
B. Ethos of Ergonomics

The term “Ergonomics” means different things in different context today and is concerned with the design of systems in which people carry out work. The term ergonomics originates from the Greek words ‘Ergon’ means work while ‘nomos’ means natural law - thus, when the two words are combined, ergonomics means 'how to work according to nature' as opposed to working in contradiction to the 'laws of nature.' According to Macleod (2006), the term nomos means rules. So the literal meaning is “rules of work.” For Bridger, (1995) and Gibb et al., (1999), Ergonomics aims to ensure that human needs for safe and efficient working are met in the design of work systems. Unsafe, unhealthy, uncomfortable or inefficient situations at work can be avoided by taking account of the physical and psychological capabilities of humans, opine Gibb et al., (1999).

Usability is the central concept of ergonomics. It is an umbrella term for all those factors, which influence the efficiency of any human activity done by technical tools (http://www.erg.bme.hu/oktatas/tleir/ergpsy/conc_erg).

Chronological Understanding of Ergonomics

According to Grandjean (1980), the object of ergonomics is to observe the relationship of man at work with his spatial environment. The most important principle is fitting the task to the man. Ergonomics is interdisciplinary: it bases its theories on physiology, psychology, anthropometry, and various aspects of engineering.

For Meister (1989), it is the study of how humans accomplish work-related tasks in the context of human-machine system operation and how behavioural and non-behavioural variables affect that accomplishment. The practice of learning about human characteristics and then using that understanding to improve people’s interactions with the things they use and with the environments in which they do so connote to ‘Ergonomics’, state Wilson and Corlett (1995).
Definition of Ergonomics: Dictionary/Encyclopedia and in the Occupational milieu

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<tr>
<th>Author</th>
<th>Year</th>
<th>Meaning of Ergonomics</th>
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<tr>
<td>Longman New Generation Dictionary</td>
<td>1982</td>
<td>The study of the conditions in which people work most effectively with machines.</td>
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<tr>
<td>Tayyari and Smith</td>
<td>1997</td>
<td>The study of work laws.</td>
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<tr>
<td>New Penguin English Dictionary</td>
<td>2000</td>
<td>It is a science concerned with the relationship between human beings, the machines and equipment they use and the working environment</td>
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<tr>
<td>Encyclopedia of Social science</td>
<td>2001</td>
<td>The “science of work”, it is also known as “human factors engineering”, “human engineering” and “engineering psychology”. It is the field that considers human capabilities and limitations in the design of machines and objects that people use in carrying on purposeful activity.</td>
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<tr>
<td>Park</td>
<td>2007</td>
<td>Fitting the job to the worker.</td>
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<th>Dictionary</th>
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<th>Application oriented Definition</th>
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<td>Barron’s insurance</td>
<td>2000</td>
<td>The control device used to minimize accidents and injuries to employees resulting from an unsafe working environment. For example, potential cumulative trauma disorders losses may be lowered by using office furniture that reduces the physical and mental stress resulting from repetitive motions, such as constantly reading a computer screen.</td>
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<tr>
<td>Gale Encyclopedia of Public Health</td>
<td>2002</td>
<td>The science of fitting the demands of work to the physical capacities of the worker.</td>
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<tr>
<td>Gale Encyclopedia of small business</td>
<td>2002</td>
<td>The process of changing the work environment (equipment, furniture, pace of work, etc.) to fit the physical requirements and limitations of employees, rather than forcing workers to adapt to jobs that can, over time, have a debilitating effect on their physical well-being.</td>
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<tr>
<td>Culture Literacy Health</td>
<td>2002</td>
<td>The technology concerned with the design, manufacture, and arrangement of products and environments to be safe, healthy, and comfortable for human beings. The term is most often encountered in discussions of the design of furniture, tools, and other things built to be used by human references.</td>
</tr>
<tr>
<td>Mosby’s Dental</td>
<td>2004</td>
<td>The field of science including all aspects pertaining to a comparison of the mental and physical exhaustion produced to the quantity and quality of the deliverable care.</td>
</tr>
<tr>
<td>Oxford Dictionary of Science and Medicine</td>
<td>2005</td>
<td>The study of relationship between workers and their environment with particular emphasis on engineering aspects. In sport, ergonomics includes the study of designs that produce the most efficient racing cycles, canoes, and other sports equipment.</td>
</tr>
<tr>
<td>McGraw - Hill Dictionary of Aviation</td>
<td>2005</td>
<td>The activity or science of designing, building, or equipping mechanical devices or artificial environments to the anthropometric, physiological, or psychological requirements of the men and women who will use them.</td>
</tr>
<tr>
<td>Oxford Dictionary of Architecture and Landscaping</td>
<td>2006</td>
<td>Study of the relationships between working humans e.g. tools, machinery, and instrument panels to ensure the efficiency and usability of designs.</td>
</tr>
<tr>
<td>Columbia Encyclopedia</td>
<td>2010</td>
<td>The engineering science concerned with the physical and psychological relationship between machines and the people who use them.</td>
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Chapanis (1996) defined human-factors engineering as the application of human factors information to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable and effective human use. For Hancock (1997), ergonomics is that branch of science which seeks to turn human-machine antagonism into human-machine synergy.

In the words of Tayyari and Smith (1997), Ergonomics is defined as that branch of science that is concerned with the achievement of optimal relationships between workers and their work environment. It deals with the assessment of the human capabilities and limitations (biomechanics and anthropometry), work and environment stresses (work physiology and industrial psychology), static and dynamic forces on the human body structure (bio-mechanics), vigilance (industrial psychology) fatigue (work physiology and industrial psychology), design stimulation and tools anthropometry and engineering. Therefore ergonomics draws heavily from many areas of science and engineering, and its goal is to fit (adapt) work to the individuals, as opposed to fitting workers to the work, through developing knowledge that results in efficient adaptation of work methods to the individuals physiological and psychological characteristics.

According to Wilson (2000), Ergonomics is the theoretical and fundamental understanding of human behavior and performance in purposeful, interacting, socio technical systems and the application of that understanding to design of interactions in the context of real systems. It is the design and engineering of human-machine systems for the purpose of enhancing human performance (Dempsey et al., 2000). International Ergonomics Association, (2000) describes it as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

According to Lee (2005), Ergonomics is concerned with promoting compatibility between humans and systems. The science is pursued to enhance the effectiveness and efficiency with which work and other activities are carried out and to enhance certain desirable human values. These goals, he states, require increasing convenience of use, reduction of errors and increasing productivity.
Ergonomics is thus a unique and independent discipline that focuses on the nature of human-artifact interactions, viewed from the unified perspective of the science, engineering, design, technology and management of human-compatible systems, including a variety of natural and artificial products, processes, and living environments, reports Karwowski (2006). Macleod (2006), adds that it seeks to design tools, equipments and tasks to optimize the interface between human and systems. This interface can be as simple as that between a human and a chair (such as the back rest, the cushioning or the height) or a much more complex interrelationship between an employee and an entire production line.

Ergonomics is employed to fulfill the two goals of health and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines (IEA, 2007). Thus from simple working with nature concept to designing heavy tools to suit human factors, concept of ergonomics has undergone phenomenal developments, by which its purpose becomes quite distinct. The prime purpose therefore, is to take care of human needs in the work environment. In Park’s (2007) viewpoint the object of ergonomics is to achieve the best mutual adjustment of man and his work for the improvement of human efficiency and well being. Khan (2010) concludes stating the purpose of Ergonomics as to:

- **Fit the demands of work to the capability of a person (to reduce stress).**
- **Design the task to enable one to accomplish efficiently, accurately and safely.**
- **Design workplace proportions to ensure correct body-posture.**
- **Adapt lighting, indoor climate and noise, to suit a person’s physical requirements.**

These factors reiterate the relationship of the worker, work and work environment trilogy and the need for maintenance of a flawless interface among the three concepts. It is in the worker’s hands to fulfill them.

Ergonomics more often refers to physical ergonomics as it relates to the workplace. In the workplace, it has to do largely with the safety of employees, both long and short-term, as it can help reduce costs by improving safety (http://en.wikipedia.org/wiki/Outline_of_ergonomics). **Macleod (2006),** had put forth the following ten basic principles that summarize the field of physical ergonomics where the workers more or less have a very large role to play to ensure achievement of the goals of ergonomics, safety (health), comfort and efficiency in the work done in a given work environment (Exhibit 2).
Exhibit 2: Macleod’s (2006) Ten Principles of Ergonomics

- **Working in neutral posture**: Working in awkward, controlled postures increase fatigue and physical stress on the body, reduces strength and dexterity, thereby making it more difficult to do a task. The workers should therefore maintain the natural curve of the spine, keeping the neck aligned, keeping the elbows in and shoulders relaxed and wrists in neutral positions. The best positions in which to work are those that keep the body **“in neutral”**.

- **Reducing excessive force**: Excessive force can overload the muscles, creating fatigue and potential for injury. It can slow down and one’s ability to perform the task well. Contrarily, almost anything that can do to minimize the exertion required for the task will make it easier and more efficient.

- **Keeping everything in easy reach**: An easy way to make work more user-friendly is to keep products, parts and tools that are frequently needed within reach. Long reaches often demand twisting, bending and straining, which makes work more difficult and time consuming. In many ways, this principle is redundant with posture, but it helps to evaluate a task from this specific perspective.

- **Working at proper heights**: A common workplace problem is a mismatch in heights between employees and the work they were doing. This leads to awkward postures and related fatigue, discomfort and potential damage to soft tissue. Working at the right height is also a way to make things easier.

- **Reducing excessive motions**: The number motions required to do a task can have a profound impact on both efficiency and wear and tear on the body. Excessive motions can create injury to sensitive tissue and joints as well as cause waste of time. Whenever feasible, it is necessary to reduce unnecessary motions.

- **Minimizing fatigue and static load**: Overloading physical and mental capabilities can lead to lost production, poor quality, accidents and wear and tear injuries. Fatigued muscles slow down pace of work, but adds proneness to injury. Holding the same position for a period of time is known as static load. It creates fatigue and discomfort and can interfere with work.

- **Minimizing pressure points**: Direct pressure or contact stress is a common issue in many workstations. In addition to being uncomfortable, it can inhibit nerve function and blood flow.

- **Providing clearance**: It is important to have both adequate workplace and easy access to everything that is needed with no barriers in the way. Lack of clearance can create bumping hazards or force one to work in contorted postures. It can increase long reaches, especially if there is inadequate space for knees or feet.

- **Moving, Exercising and Stretching**: The human body needs to exercise and stretch. To be healthy the human body needs activity. One needs to stretch to the full range of motions for each of one’s joints occasionally throughout the day, heart rates need to rise for a period of time everyday and muscles need to be loaded occasionally. Unfortunately, most jobs don’t promote these activities. And where there is movement or exertion, it’s often too much of the wrong kind that has to be avoided.

- **Maintaining a comfortable environment**: Human beings often do not perform well in less-than-ideal environments. Excessive heat and humidity slows down one’s performance, while excessive cold hinders effective work. Toxic chemicals can damage one’s health and vibration can injure sensitive tissue. Improper lighting not only affects performance but also lead to workplace injuries and accidents.
All these principles address physical issues, those items that people have to adopt in day to day life wherever they are and whatever they do.

C. Construction Industry in India – A Promising Scenario

Construction Industry is one of the most booming industries in the whole world (Economy Watch, 2010). It is an integral part of infrastructure development which gives a tremendous boost to economic growth. Narayanan (2010), opines that in recent years, the industry has registered enormous growth worldwide. Although the development of technology is rapid in most of the sectors, construction work is still labour intensive. It is often compared to a travelling circus (Koningsveld, 1997).

In developing countries construction work provides a traditional point of entry to the labour market for migrant workers from the countryside. A job in construction is often the only alternative to farm labour for those who do not have much education or skill. It has special importance for the landless. Safeguarding such employment opportunities must be high on the social agenda of poor countries with surplus labour. Responsible employers will guard against premature mechanization of tasks that can be undertaken by labourers (Lopez-Valcarcel, 2001).

Construction sector is the world’s largest industrial employer with seven per cent of total world employment and 28 per cent of industrial employment (Improving Working and Living Conditions in Construction, 2004). In India this sector is the largest employer of unorganized labour next to agricultural sector report Laskar and Murty, (2004). It is next to agriculture in terms of employment and income contribution to the Indian economy (Pandey, 2009). The contribution of this sector to India’s GDP (Gross Domestic Product) at factor cost in 2006–07 was ₹1,965,550 million, registering an increase of 10.7 per cent from the previous year. Similarly the share of construction in GDP has increased from 6.1 per cent in 2002–03 to 6.9 per cent in 2006–07 (Government of India, 2008b). The industry in India is an important indicator of development as it creates investment opportunities across various related sectors. The industry has contributed an estimated ₹3,84,282 crore to the national GDP in 2010-11 (a share of around 8%)
(http://en.wikipedia.org/wiki/construction_industry_of_India). However, it is facing a huge shortage of manpower, especially those with skill-sets to sustain the rapid growth in infrastructure and housing sectors. The strength of skilled workforce in construction has dwindled substantially from 15.34 per cent in 1995 to 10.57 per cent in 2005, whereas relative proportions of unskilled workers have gone up from 73.08 per cent in 1995 to 82.45 per cent in 2005 (Government of India, 2008b) – the current statistics available and it is a clear indicator that there is a great demand for skilled workers in the construction sector. To make up this shortage, it has become imperative to convert semi-skilled or unskilled women workers into skilled workers. It is a recorded fact that outside the agricultural sector, a significant and gradually increasing proportion of women workers are engaged in the construction sector (Shah, 2002). The Planning Commission had estimated that the organized sector employs 1.2 millions, while the unorganized sector generates the rest (Pandey, 2009). Women are employed in semi-skilled and sometimes in skilled jobs in other industries but in the construction industry women are employed mostly as unskilled labourers (Jhabvala and Kanbur, 2002 and Baruah, 2008).

The industry provides direct employment to at least 30 million workers in India (Chen, 2007) but recent expansions (before the economic crisis) had resulted in a higher number. There is anecdotal evidence that some categories of returnee migrants from the Gulf have been absorbed in construction (http://www.thaindian.com/newsportal/uncategorized/andhra-absorbs-many-gulf-returnees-in-constructionsector_10087940.html).

The sector had grown much faster immediately after the Government had adopted the strategy of ‘Liberalization, Privatization and Globalization’. In the year 1998 there were 111 million construction workers worldwide and majority belonged to the developing economy like India. This is because employment intensity is much higher in the low income countries than the high income ones (Pandey, 2009).

The industry is an essential contributor to the process of development. Roads, dams, irrigation works, school, house, hospitals, factories and other
Construction works are the physical foundation on which development efforts and improving living standards are established. The product of the construction industry has linkage with rest of the economy in terms of generation of output and employment (Kulkarni, 2007). In India construction has accounted for around 40 per cent of the development investment during the past 50 years. Around 16 per cent of the nation's working populations depend on construction for its livelihood. The Indian construction industry employs over three crore people and creates assets worth over ₹20,000 crore (http://en.wikipedia.org/wiki/construction_industry_of_India).

India is seeing a boom in the construction sector mainly due to the government initiative in expansion of the developmental facilities. Economic upsurge has also generated enhanced generation of demand in the real estate sector (both residential as well as commercial). In India it is rising at a phenomenal rate of seven to eight per cent per annum (Economy Watch, 2010). The Indian economy has witnessed considerable progress in the past few decades. Most of the infrastructure development sectors had moved forward, but not to the required extent of increasing growth rate up to the tune of eight to ten per cent. With due emphasis on creating physical infrastructure, massive investment was planned in this sector (http://en.wikipedia.org/wiki/construction_industry_of_India).

Construction industry is one of the fastest growing industries and remains so with the continuation of the development process especially in the developing countries. With the process of development, the migration of people takes place from the rural to urban areas. This phenomenon is most significantly observed in India along with other countries.

**D. Studies Conducted on Women Construction Workers**

Construction workers are the backbone of the economy as they create the infrastructure necessary for industrial growth. In a globalizing economy, it is they who are constructing the new economic zones, the IT cities, the call centers and mega malls that are creating new forms of wealth today. It is they who are laying the cables for a rapidly expanding country-wide telecommunications network. Yet these workers, who are creating the base of
the new economy, themselves live in a time warp, trapped in low skilled, low paid, insecure working conditions, bound by feudal working relationships, often literally in bondage. About one-third of these workers are women and children (http://images.photogallery.indiatimes.com/photo).

The construction industry is considered to be dangerous and of a highly hazardous nature (Rowlinson, 2000; Haupt, 2001; Hinze and Olbina, 2008). Globally the construction industry has one of the highest injury rates, very often second only to the mining sector (Hinze, 2006).

Studies conducted by Parveen and Patil (2010), revealed that for women construction workers, the problems at work site are more, as they assumed dual roles. Further, their livelihood status was temporary, which lacked social security and privacy. Majority of the women construction workers were illiterates and they had no idea about the work and workplace. It is one of the primary reasons, for being exploited by the male construction workers. Sexual harassment and gender discrimination cases were also rampant. The study also emphasized that the wages paid to women construction labourers was also lower and discriminatory, based on the relation of the employers and employees. The problems of women construction workers was extreme, if they were pregnant or having small children. They find no provision to take care of their children at work site. They have no leave and if absent to work due to ill health and other reasons, had to face cut in their wages and/or lose their work.

A study conducted by Abrol et al., (2008) points out that as far as work is concerned their conditions are really worse. Women construction workers carry single loads of up to 51 Kg, far more than the weight limit recommended by occupation safety and health standards for women. They tend to carry heavier loads and climb up a job site, repetition of which takes a toll on the women, and their bodies. Out of the 564 female construction workers surveyed in Patiala (Punjab), the findings report that clinical anemia among women was found to be 54.9 per cent. Only 0.5 per cent of the subjects had received three or thirteen antenatal care check ups during their last pregnancy and only 9.7 per cent had consumed tablets of iron and folic acid for 90 days or more. Further the study found 64.7 per cent of the
respondents were unprotected against tetanus. Of these women, 15 per cent had institutional deliveries and only 18.5 per cent of those who had delivered at home were attended to by trained birth attendants. The children of the construction workers living on construction sites suffered malnutrition (70%) compared with national average of 21 per cent, under nourishment, and concomitant diseases. In the absence of clean drinking water and flush latrines, cholera and other diseases spread quickly and many of them suffered from cough caused by inhaling paint fumes and cement particles (http://www.mgliahd.org/download/national).

Ganguli in (2007), gave a description about women working on construction sites in Pune who were forced to negotiate with contractors and others for access to water in the vicinity and were often forced to walk long distances to fetch water, at times making six trips that can take up to 30 minutes per trip. Most of the workers, because they migrate, don't posses ration cards and were forced to buy food grain at higher market prices. The women also had to buy kerosene or firewood for cooking. They were forced to bathe and defecate out in the open. Healthcare at public hospitals was indifferent or came at a cost, and many women were forced to visit private clinics, especially during pregnancy. Gender based wage disparities existed. Wages were paid weekly. The division of labour was gendered. Women carry head loads of brick, sand, stone, cement and water to the masons, and also sift sand. Standards laid down for women labourers under the Factories Act, like handling limits of 20 kg, rarely applied to construction workers (http://www.infochangeindia.org). All norms remain negotiable in the construction industry and labourers and their organizations just give in to the demands of contractors and builders. In such conditions, women workers are especially vulnerable.

An empirical study conducted by Chandarsekar (2004) among women construction workers revealed that the respondents were subjected to several forms of sexual harassment such as inappropriate touching (80%), pushing (6%), pinching (16%) and sexual intercourse (6%). The perpetrators were co-workers, masons and contractors. Gopalakrishnan (2007) and Ramdoss (2010) also found 58 and 50 per cent of the women labourers to
have been subjected to sexual harassment by the employers at work place respectively, while sixteen per cent were abused both by the employers and the co-workers. The forms of abuses were inappropriate staring (84%) and unwelcome comments on their appearance (74%). Twelve per cent were subjected to ‘Quid Pro – Quo’ harassment by the employers’ i.e. “you do something for me and I will do something for you”. The employers demanded for sexual favours in return for better pay or a relatively easy job. Kamalakannan’s (2007) study found out 41 per cent of construction workers complain that the behaviour of the supervisors was unfavourable to them. Hence it is suggested that there should be a complaint mechanism as pointed in the Vishaka guidelines to combat this menace.

Study conducted by Barnabas et al., (2009) in Tamil Nadu, revealed a vast disparity in wages to exist between women and men construction workers. The contractors and the men construction workers had agreed that mostly women workers were paid less than ₹ 100/day and no woman gets wage more than ₹ 160/day. Two thirds of men construction workers wasted their income on drinking and smoking which affected their health and family whereas only two per cent of women drank. More than four out of five women used their wages only to meet their basic needs and more than half of the men construction workers went for a loan from money lenders to meet their needs during unemployment (when heavy interest rates bled them) whereas less number of women availed loans. When compared to men, more women were willing to go without food at the time of unemployment - a natural quality of women.

Further Sarde (2008) quotes from an ILO study that 165 out of every 1000 workers to be injured on the job. To sum up, it is found that women construction workers do not have access to social security, compensation for injuries, and access to drinking water or healthcare but suffer subjection, harassment and discrimination. India has the world’s highest accident rate among construction workers.

E. Work environment and Work related Hazards in Construction sites

Work environment refers to work conditions that may affect individual workers in the workplace. According to Koh and Jeyaratnam (2001), the
working environment may be associated in the causation of, or be an aggravating factor where a pre-existing condition exists. Akkers (1999) suggests that working conditions in the construction industry are challenging, the physical workload is heavy and there are many ergonomic problems. Construction workers complain frequently about the awkward and static postures, vibration and climate. All individual workers enter the construction work environment with a variety of strengths and weaknesses. These include age, gender, general health status, motivation, skill level, notions about how to perform the work - required expectations and ways of interacting with co-workers, supervisors and management. A healthy work environment builds on those strengths and motivations to develop continuous learning, and sharing work environment that rewards creativity, problem-solving initiative, responsibility and teamwork (Zavadskas et al., 2010).

Construction, a major employment generator across the globe, is also a sector associated with a proportionately high number of job-related accidents and diseases. According to ILO (Facts on safety at work, 2005) estimates:

- Each year there are at least 60,000 fatal accidents on construction sites around the world, i.e. one fatal accident every ten minutes.
- One in every six fatal accidents at work occurs on a construction site.
- In industrialized countries, as many as 25 to 40 per cent of work-related deaths occur in construction sites, even though the sector employs only six per cent to ten per cent of the workforce.
- In some countries, it is estimated that 30 per cent of construction workers suffer from back pain or other musculoskeletal disorders (http://www.ilo.org/public/english/bureau/inf/download/sh).

Construction workers are exposed to a wide variety of health hazards at work. The exposure differs from job to job (Kulkarni, 2007). Since these labourers are engaged in several types of tasks, they are exposed to multiple physical, chemical and biological agents, which make them vulnerable to various health problems that include - injuries, respiratory problems, dermatitis, musculoskeletal disorders and gastro-intestinal diseases (Gaurav et al., 2005). The hazards for construction workers typically are those listed in Box 1.
1. **Occupational Health hazards**: Other than the home environment, the workplace is the setting in which many people spend the largest proportion of their time. Indeed, for many people, particularly in developing countries, the boundary between their home and workplace environments is blurred. In favorable circumstances, work contributes to good health and economic achievements (http://www.who.int/peh/Occupational_health/). Workplace health hazards generally differ from those found in the general environment. Furthermore, because workers are often exposed in confined spaces, exposure levels to workplace hazards are often much higher than exposures to hazards in the general environment (http://www.who.int/environmental_information/Occuphealth/ strat.htm). However, the work environment exposes many workers to health hazards that contribute to injuries, respiratory diseases, cancer, musculoskeletal disorders, reproductive disorders, cardiovascular diseases, mental and neurological illnesses, eye damage and hearing loss, as well as communicable diseases (http://www.who.int/peh/Occupational_health/). Exposure to a wide variety of serious occupational health and safety hazards and the rate of fatal accidents in the construction industry is four to five times that of the manufacturing sector. Exposed to hazardous substances have high potential to cause serious occupational diseases such as silicosis, lead poisoning, asbestosis, dermatitis and cancer; however, the awareness is negligible (Narayanan, 2010).

**Box 1: Occupational Health Hazards**

1. **Physiological and Psychological**
   a. **Physical/Physiological**
   b. **Chemical**
   c. **Biological hazards**
   d. **Reproductive hazards**
   e. **Psycho-social hazards:**
      i. Unfavourable Workplace culture
      ii. Inappropriate Personal Protective Equipment and Clothing
      iii. Sexual Harassment
      iv. Stress
   f. **Lack of Sanitary Facilities**

2. **Ergonomic issues and degenerative disorders:**
   a. **Work-related Musculoskeletal Disorders (WMSDs)**
   b. **Risk Factor of WMSDs**

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The process of constructing buildings and other structures involves a very wide range of tasks; some of them involve risks too (Shaun, 2007). This covers various types of occupational diseases, ill health, and accidents (Gyi et al., 1998 and Pritchard, 2004). The prevalence of skin diseases among construction workers is much higher than in the common working population.

Systematic studies that examine workplace hazards and link them to reproductive health outcomes are rare. Reproductive hazards in the workplace include around 200–300 chemicals known to be mutagenic or carcinogenic. The reported adverse effects include infertility in sexes, spontaneous abortion, fetal death, teratogenesis, fetal cancer, fetotoxicity and retarded development of the fetus or newborn (http://www.who.int/peh/Occupational_health/).

Stress is a work-related disease of multicausal origin. It can be defined as a physical or physiological stimulus which produces strain or disruption of the individual's normal physiological equilibrium. The most frequent disorders range from chronic fatigue to depression by way of insomnia, anxiety, migraine, emotional upsets, stomach ulcers, allergies, skin disorders, lumbago and rheumatic attacks, tobacco and alcohol abuse, heart attacks and even suicide (http://www.ilo.org/public/english/protection/safework/gender/womenwk).

In Chicago Women in Trades (CWIT's) report, 80 per cent of tradeswomen had encountered worksites with dirty toilets or no toilets (Freeman, 1987). Washing and toilet facilities, if present at all, hardly met current standards (Koningsveld, 1997). Lack of sanitary facilities for construction workers exposes them to hazards (Ringen et al., 1995). The construction industry includes many ergonomic risks to which workers are exposed during daily tasks. Most contractors do not determine the potential or actual costs relative to the various phases of the construction process, or the value of positive interventions during the various phases of the construction process (Bridger, 1995 and Gibb et al., 1999).

Musculoskeletal disorders due to MMH include: many types of musculoskeletal symptoms in the form of pain, tingling, numbness, loss of
strength or loss of joint movement; part of the body affected - back, neck, shoulder, arm, wrist or knee; the major cause that led to the non-traumatic injury such as repetitive motion, awkward postures, fixed postures, heavy lifting, lack of rest breaks and period of suffering (Ramana et al., 2005). Various risk factors, including personal characteristics (for example physical limitations) as well as societal factors, may contribute to the development of work related musculoskeletal disorders (Armstrong et al., 1993 and Idoro, 2008). These injuries affect a wide variety of construction occupations and are not specific to any type of a job or work activity. Different construction trades are exposed to various kinds of physical workload, involving different parts of the body (Holmstrom et al., 1995) and the incidence of WMSDs in this sector is considerably higher than in most other occupations (Schneider, 2001 and Kaminskas, 2007). Construction workers handle tasks that range from carrying heavy loads to performing repetitive tasks, placing them at risk of serious injury. The physically demanding nature of this work helps to explain why injuries, such as strains, sprains, and work-related musculoskeletal disorders, are so prevalent and are the most common injury resulting in days away from work. Backaches and pain in the shoulders, neck, arms, and hands were the most common symptoms reported by construction workers in a study done by Cook et al., (1996).

Many types of musculoskeletal disorders have considerable work-related component (Hagberg et al., 1995; NIOSH 1997; Punnett and Bergqvist 1997). This is particularly true where there is a high exposure level and where there are combinations of difficult conditions, for instance lifting loads with outstretched arms at a high frequency is stressful for shoulder region. There is also strong evidence that low back disorders are associated with lifting, high exertion and awkward back postures (Punnett et al., 1991 and Marras et al., 1993).

Repetitive, forceful, or prolonged exertions of the hands, frequent or heavy lifting, pushing, pulling, or carrying of heavy objects, prolonged awkward postures, and vibration contribute to WMSDs. Jobs or working conditions that combine risk factors will increase the risk for musculoskeletal problems. The level of risk depends on how long a worker is exposed to these
conditions, how often they are exposed, and the level of exposure. Thus occupational health hazards are caused by various physiological and psychological aspects as discussed below.

a. Work-Related Musculoskeletal Disorders (WMSDs): According to National Institute for Occupational Safety and Health Centers for Disease, the term musculoskeletal disorders (MSDs) refers to conditions that involve the nerves, tendons, muscles, and supporting structures of the body. WMSDs are described as a whole range of injuries and illnesses which are not typically the result of an acute or instantaneous event but the result of chronic development. According to OSHA (1999), there are number of well known diagnoses of musculoskeletal disorders (http://www.elcosh.org/en/document/581/d00056). They include carpal tunnel syndrome, raynaud’s syndrome or white finger diseases, tendinitis, thoracic outlet syndrome, back pain, degenerative disc disease, sprain and strain.
Physical/Physiological hazards: Physical hazards mean exposure to excessive heat, cold, humidity, pressure, radiation, electricity and sound, which may result in illness. If the individual is exposed to levels beyond acceptable limits without protective measures\(^4\). Falling, slipping, tripping and any injuries in workplace are also categorized as physical/physiological hazards\(^6\).

b. Chemical hazards : are caused by dust, fume, mists, vapours or gases and chemicals\(^7\). The chemical hazards are on the increase with the introduction of newer and complex chemicals. Chemical agents act in three ways: local action, inhalation and ingestion. The ill effects produced depend upon the duration of exposure, the quantum of exposure and individual susceptibility\(^5\). Hazardous chemicals can cause external or local problems such as irritation, skin burns or ulceration\(^7\).

c. Biological hazards: Exposure to infective and parasitic agents at the place of work,\(^1\) form this category. Malaria, dengue, animal attacks and histoplasmosis (a lung infection caused by a common soil fungus) and other diseases due to poor sanitation and unsafe drinking water\(^4\) are the risks listed.

d. Reproductive hazards: A reproductive hazard is the presence of any substance or condition that can damage the male or female reproductive system or a developing fetus. Reproductive outcomes associated with workplace exposures include menstrual disorders, chromosomal and gene defects, abortions, cancers, malformations, behavioural disorders, low birth weight of babies, infertility and premature menopause. Numerous organic solvents and toxic metals, many biological agents, such as certain bacteria, viruses and zoonoses, as well as heavy physical work, are also associated with an increased risk of reproductive disorders. The reproductive hazards of ionizing radiation are now well-established, while hazards from non-ionizing radiation are under intensive study. Both male and female workers may be affected by these hazards, but protection of women of fertile age and pregnant women is of particular concern (http://www.who.int/peh/Occupational_health/).

e. Psycho-social hazards: If employment is permanently temporary, frequently changing employer and most projects require living in work camps away from one’s home and family. These features of construction work, as well as heavy workload, possibility of work place violence or community violence and limited social support are the factors associated with increased stress in the work force. The problems of women workers are still not addressed adequately both by law makers and the employers\(^8\). Psycho-social hazards are caused by unfavorable workplace culture, inappropriate personal protective equipment and clothing, stress and sexual harassment.

i. Workplace culture: A safety culture needs to be developed as an integral part of the work culture states\(^9\). A hostile workplace presents safety and health concerns on several levels, ranging from a lack of training and safety information to physical assault. Distractions while working can lead to not taking proper safety precautions, resulting in on-the-job injuries. The effects of a hostile workplace can be reflected in acute as well as chronic stress reactions. OSHA had recognized workplace violence as an occupational safety and health issue report\(^10\).

ii. Inappropriate personal protective equipment and clothing: Many women in nontraditional jobs, such as the construction trades, complain of ill-fitting personal protective clothing (PPC) and equipment (PPE) or lack of it. Clothing or equipment that is not sized, or does not fit, not appropriate or proper can compromise personal safety. It also may not function effectively in the manner for which it was designed and can cause serious safety and health risks for women. Having inappropriate or ill-fitting clothing, boots, gloves, or safety equipment presents a safety hazard for any worker.

Studies by NIOSH and the U.S. Department of the Army found that most tools, equipment, and clothing are not designed for a woman’s physique\(^11\). Personal protective equipment intended for use by women workers should be based upon female anthropometric (body measurement) data\(^8\). Work gloves must fit properly. Overly large gloves impair the transfer of sensory information from the hand, resulting in excessive force being applied. Tight gloves can restrict blood flow. Hand tools should be designed so that the stress concentrations can be spread evenly throughout the hand state\(^8\). Courts have found that the lack of appropriate sanitary facilities is discriminatory and violates OSHA standards.

iii. Sexual Harassment: It is a serious problem for female construction workers (http://www.whoint/environmentalinformation/Occup_health/strat.htm). It affects all women in some form or the other. At work it is an extension of violence in everyday life and is discriminatory, exploitative, thrusting in atmosphere of threat, terror and reprisal\(^12\). It is all about expression of male power over women that sustain patriarchal relations. It reminds women of their vulnerability and subjugated status\(^13\) and the most significant factor contributing to stress in the work environment.

iv. Stress: Occupational stress is increasingly recognized as a cause of serious personal injury for women in both the workplace and personal life. There is no simple way of predicting what will cause harmful levels of stress. Female workers, especially respond to different types of pressure in different ways. Problems identified most frequently at work were unrealistic targets and workloads, excessive hours in continuous and uncertain work, poor communication and lack of support\(^13\). Job-related stresses like sexual harassment, being jobless, gender-based discrimination, proneness to different health hazards, physical problems, insomnia, nausea, headache, and other adverse outcomes are typical of women workers\(^12\).

f. Lack of sanitary facilities: Access to sanitary facilities is frequently a problem on a new construction site. Temporary facilities are usually unisex, often without privacy, and generally not very well maintained. Sometimes there are no sanitary facilities available for women to use. Due to the lack of facilities, women report that they avoid drinking water on the job, risking heat stress and other health problems. Unclean facilities can result in disease as well as urinary tract infection (for those who delay urinating rather than using such facilities). The availability and cleanliness of restroom facilities are major concerns for tradeswomen.

2. Ergonomic issues and degenerative disorders: Gibb et al., (1999)\(^11\) state that workers exposed to handling loads, such as lifting, carrying and pushing, repetitive handling work, static work or working at the extremes of the range of movements of the body increase the risk of injury to the worker, and includes most activities in the building and civil fields, which lead to musculoskeletal disorders in them.

- Injuries: Most injuries in construction workers are sprains and strains of the muscles. The work also causes injuries to the joints, bones, and nerves. These injuries often occur from constant wear and tear on the body. Musculoskeletal injuries can cause temporary or even permanent disability, which can affect the worker’s earnings and the contractor’s profits. Taken together these injuries are called musculoskeletal disorders. Generally, musculoskeletal disorders in construction workers affect the hand and wrist, the shoulders, neck and upper back, the low back, and the hips and knees (http://www.elcosh.org/en/document/581-d00056). WMSDs are caused by job activities and conditions, like lifting, repetitive motions, and work in confined areas. Construction workers have an increased risk of these injuries if they often carry heavy loads, work on knees, twist hands or wrists, stretch to work overhead, use certain types of tools, vibrating tools or equipment (http://www.cdc.gov/niosh/docs/2007-122/).

- Accidents: In most countries construction workers are at the top of records of occupational accidents. Falling, tripping and slipping accidents form the largest group. The number of lost work days and compensation costs (developed countries) are both high.

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1. Park (2007)
7. NIOSH (1996)
**b. Risk Factors:** Risk factors that can cause or may have the association with WMSDs include repetitive, forceful or prolonged exertions of hands, frequent or heavy lifting, pushing, pulling or carrying heavy objects and prolonged awkward postures. Similar high physical work demands are considered the primary risk factor for work-related musculoskeletal complaints (Marras et al., 2000; Hoozemans et al., 2002; Lotters et al., 2003 and Fung et al., 2008) especially among construction workers.

All these reiterate the need for a mandatory OSH standard. WMSDs are the leading cause of disability for people in their working years. They can be caused by frequently working in a way that puts stress on the body such as those given in Box.

<table>
<thead>
<tr>
<th>Gripping</th>
<th>Kneeling</th>
<th>Lifting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working in awkward positions</td>
<td>Applying force</td>
<td>Repeating movements</td>
</tr>
<tr>
<td>Bending</td>
<td>Working overhead</td>
<td>Twisting</td>
</tr>
<tr>
<td>Using vibrating equipment</td>
<td>Squatting</td>
<td>Over-reaching</td>
</tr>
</tbody>
</table>

Source: (http://www.cdc.gov/niosh/docs/2007-122/)

**F. Occupational Safety and Health**

Occupational safety and health (OSH) is a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment (http://www.ornl.gov/). As the term “**occupational safety and health**” implies, there are two aspects to this field. One is the area of safety, which seeks to make workplaces safe for workers so that they do not suffer injuries. Poorly designed or laid-out workplaces or equipment may pose a serious hazard to workers, and more than 400,000 injuries occur at work each year. Separate from the concept of safety is that of occupational health, where the goal is to prevent the occurrence of illnesses among workers because of exposures at their place of work. With regard to safety issues, the greatest numbers of injuries seen at work, most of which are preventable, involve hearing loss, musculoskeletal disorders, and cumulative trauma problems such as carpal tunnel syndrome (http://www.answers.com/topic/advisory-committee).
The concept of occupational safety and health is detailed under:

❖ **Scenario of occupational safety and health**

According to OSHA (2000), providing a workplace free of ergonomic hazards can do the following:

- Lower injury rates as MSD incidences go down
- Increase productivity by making jobs easier and more comfortable for workers
- Improve product quality because fewer errors will be made when using automated processes that demand less physical effort
- Reduce absences because workers will be less likely to take time off to recover from muscle soreness, fatigue, and MSD-related problems
- Increased turnover as new hires are more likely to find an ergonomically designed job within their physical capacity
- Lower costs as workers’ compensation and other payments for illness go down
- Improve worker safety
- Increase worker comfort
- Reduce worker fatigue and
- Improve worker morale.

**Assessing hazards:** Hazards are defined as physical conditions with inherent qualities that can cause harm to a person (Hinze, 2006). If a hazard exists, the worker potentially at risk should place the necessary attention on avoiding the hazard; this diverts the worker’s attention from the real task activities. Quality and productivity are therefore negatively affected. Workers who do not place adequate attention on the hazards may potentially be at higher risk to injury. Thus eliminating hazards should be the primary concern of managers and foremen if they are to achieve better quality products, improved productivity and reduced rates of injury (Eppenberger, 2008).

The occupational health scenario is undergoing a paradigm shift with rapid industrialization in the developing countries. The Indian trade boom is attributed to economic liberalization. With over 40 million belonging to the working class, (http://www.censusindia.gov.in/) India has a very large population base engaged in industrial activity. This group is at a special risk of
occupational hazards and diseases. The health needs of these populations also differ according to the industry of work.

Workers who describe their workplaces as having satisfactory pay, benefits, training and job security, in addition to good advancement opportunities, flexible schedules and work-life balance, will lose fewer days due to illness and injury (Lowe, 2000). There are many negative aspects to work in construction. The industry is notorious as a dangerous place to work. Data from a number of developed countries show that between 20 and 40 per cent of all occupational fatalities occur in the construction sector. This means construction workers are three to four times more likely to die from accidents at work than other workers (Lopez-Valcarcel, 2001).

With an estimated 17 million occupational, non-fatal injuries (17% of the world) and 45,000 fatal injuries (http://www.nihfw.org/ndc-nihfw/html/Programs/NationalProgramForControlTreatment.htm.2008) – 45 per cent of the total deaths due to occupational injuries in the world – India significantly contributes to the global occupational injury scene. India is also estimated to account for 1.83 million cases of occupational diseases (Kulkarni, 2006). However, out of an estimated 500 million workers in India, only about five to ten per cent of them have access to occupational health services (Lehtinen, 2008). The provision of optimum occupational health services is estimated to require one physician and two nurses per 5000 workers; with a wide variation, depending on the branch of industry and workplaces, as well as, the geographical distribution (Rantanen, 2008). The estimated 500 million workers would need a staggering 100,000 doctors! The number of allopathic doctors possessing recognized medical qualifications (under the IMC act) and registered with state medical councils for the year 2005 was only 660,801 (National Health Profile, 2006). This highlights the fact that although the creation of a new specially trained cadre can continue, there must be a strong motivation for the inclusion of occupational health training is the very ethos of general health care. Although, no definitive data on the exact number of doctors working in occupational health services on a full time/part time status or the level of qualification/training is available for India, this number is expected to be low (Zodpey et al., 2009).
**Strategies and steps for ensuring improved conditions of occupational health status**

In developing countries, governments mainly claim health-related policies that favor the workers' health needs. In this respect it is worth mentioning that the elitist (Vilanilam, 1980 and Barker, 1996) as well as the structuralist theories (Gupta, 1970) are mainly responsible for the failure of significant occupational health policies in developing countries. In India inaction or destruction of demand and use of power appeal to the existing bias of the system, (Kamuzora, 2006) and also exportation and the flexibility of labour structure may be the most probable reasons for poor occupational conditions around the nation.

The hazard to which the working population is exposed at the workplace necessitates special attention to occupational health issues; preventive as well as curative. This necessity stems from the specialized screening, diagnosis, and provision of care for occupational diseases, the planning and designing of characteristics for ergonomically safe workplaces, and the development of preventive strategies for specific occupations. While the State is responsible for the overall health status of its population, the responsibility for the health of the workforce is shared by the State and the employer in varied proportions across the world, including India. The provision of these occupational health services, however, shows a high degree of variation (Zodpey et al., 2009).

According to Mandal (2009), strategies and steps for improving the conditions of occupational health status are as follows:

- **Health awareness and factors to measure the safety analysis of the laborers working in particular industry.**
- **Make professionals available through training and development and enabling them to play an active role in the generation of information and knowledge through proper research.**
- **Assigning work depending upon two principles, which are: ‘**worker fit for job**’ and ‘**fit the job for worker**’, so that the employer generates interest on the work and avoids lack of attention.**
• Impose a strict vigilance upon hazardous materials. The government should also weigh the pros and cons between environment and health costs of workers and cost of importing them from elsewhere.

• Record the life time job history, job titles, information on past occupations, industries, occupational conditions, and identification of other causal confounders.

• Maintain record books for toxicity of chemicals, group of chemicals, industrial processes, and other complex mixtures along with their carcinogenic effects must also be kept. Issuing of job/occupation cards for the workers like ration card can be done for keeping records.

• Surveillance of diseases in industrial belts, maintenance of death certificates, and using record-linkage techniques between various resources help improve research.

• Quality assurance, creating awareness, accreditation, and capacity building (strengthening skills and developing competencies) will be needed in the field.

• Model programs and pilot projects/surveys may be undertaken with the support from ILO/WHO and different NGOs like the Indian Association of Occupational Health (IAOH), for the unorganized sector.

The main social policies according to Construction Workers Federation of India (CWFI) are listed below:

• Equal wages for equal work, especially for female workers.
• Provision of toilets and bathing facilities especially for women.
• Assured drinking water supply.
• Risk and accident monitoring at site and insurance for workers.
• Minimum wages or Provident fund for workers (http://www.cwfigs.org/social_policies.htm&sa).

Damodaran (2006) laments that safety in construction was frequently pushed to the bottom rung of priorities, and that it was high time a Construction Safety Manual was evolved and made a part of the decision-making criteria submitted along with the standard tender document by every bidder and strictly enforced by the supervising agency. He also stated that before passing the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (BOCW Act), the
construction safety fell within the mandate of the Industrial Disputes Act, the Central Labor Act, and other related legislations. The Central Rules and State Rules need to be made and the enforcing agencies need to be notified. However, to date apart from the Center only two states, namely Delhi and Kerala, have set up the necessary State Rules. Effective tailgate training (brief job site safety meetings) can be a powerful tool to promote hazard awareness and safe work practices for the workers of the construction industry (Harrington et al., 2009).

**Need for promotion of occupational safety and health of women workers**

- **Legislative Measures:** Occupational health not only deals with work-related disorders or diseases, but also encompasses all factors that affect workers' health. The goal of OSH programs is to foster a safe and healthy work environment (http://www.ornl.gov/). As secondary effects, OSH may also protect co-workers, family members, employers, customers, suppliers, nearby communities, and other members of the public who are impacted by the workplace environment as well as reduce medical care, sick leave and disability benefit costs. OSH may involve interactions among many subject areas, including occupational medicine, occupational (or industrial) hygiene, public health, safety engineering/ industrial engineering, chemistry, health physics and ergonomics.

Despite the fact that many legislation have been made applicable to the construction sector, the working conditions of workers in this industry is highly deplorable and the women construction workers are the worst sufferers as their employment is regarded as secondary to male workers (Nathan, 1999).


**a. Women Labour Cell (1975):** A separate Cell for women labour is functioning in the Ministry to pay special attention to the problems of women labour. The Cell is responsible for the following tasks.
i. Coordinating effort in respect of women labour within the policy framework on women, drawn by Ministry of Women and Child Development – the Nodal department on the issue.

ii. Work in conjunction with the Ministry and provide useful inputs on women workforce for effective formulation of Programmes and Policies on the subject.

iii. Implementation of the Equal Remuneration Act, i.e., its extension to various employments/industries and examination of the difficulties, if any, pointed out by the units/industries.

iv. Setting up of Advisory Committee for promotion of employment of women under the Equal Remuneration Act, 1976 and providing secretariat assistance to the Committee.

v. Follow up action on the Supreme Court Judgment in the matter of prevention of sexual harassment of women at their work place and periodical reviews of the initiatives taken in the matter in consultation with related agencies viz. National Commission for Women, Ministry of Women and Child Development, National Labour Institute, etc.

vi. The Cell is also administering a grants-in-aid Scheme for providing financial assistance to organizations (voluntary and non-government) for taking up actionprogrammes/projects for the benefit of women labour.

b. Equal Remuneration Act, 1976: The implementation of the Equal Remuneration Act, 1976 is done at two levels, central sphere and state sphere which are as follows.

➢ Central Sphere: The Act is being implemented by the Central Government in relation to any employment carried on by or under the authority of the Central Government or a railway administration, or in relation to a banking company, a mine, oil field or major port or any corporation established by or under a Central Act.

➢ State Sphere: In respect of all employments other than those where the Central Government is the appropriate Government, the implementation rests with the State Governments. Enforcement of the provisions of the Act is done by the officials of the State Labour Department. The Central Government monitors the implementation by the State Governments.

➢ Central/State Advisory Committee: A Central Advisory Committee has been set up at the Centre under the Act to advise the Government on providing increasing employment opportunities for women and review the steps for effective implementation.
c. **Grants-in-aid Scheme:** The Ministry is running a Grant-in-aid Scheme for the welfare of women labour since 1981-82, and is administered through voluntary organizations by giving grant-in-aid to them for the following purposes:

i. Organizing working women and educating them about their rights/duties legal aid to working women.

ii. Organizing seminars, workshops, etc. aiming at raising the general consciousness of the society about the problems of women labour.

d. **Committee on Prevention of Sexual Harassment of Women Workers:**

The Ministry of Labour and Employment has constituted a committee to deal with sexual harassment complaints by employees of Main Secretariat of the Ministry and Subordinate Offices of Directorate General of Employment & Training and Chief Labour Commissioner (Central) and similar committee has been constituted in the V.V.Giri National Labour Institute (NLI), Noida. In Visaka v. State of Rajasthan, the Supreme Court of India has defined “sexual harassment” to include “such unwelcome sexually determined behaviour (whether directly or by implication) as, physical contact and advances, demand or request for sexual favours, sexually coloured remarks, showing pornography or any other unwelcome physical, verbal, non-verbal conduct of sexual nature.

Most of the labour legislations apply to the organized sector, leaving the unorganized sector, where a majority of the women work, unattended. Even in the organized sector, where these legislations apply, the statutory are not strictly complied with, in many cases it has been found that protective measures such as crèches, maternity benefits, separate toilets and washing facilities etc are neither provided nor properly maintained. The penal provisions of these enactments are not deterrent enough to prevent the employer from violating them. The machinery for inspection and enforcement is inadequate and ineffective (Giri, 2007).
Suggestive measures:

- Effective implementation of all these welfare legislations to protect the women workers at their workplace by expanding their scope and application
- Creation of awareness among women workers about their rights at their workplace
- Ensuring active participation of NGO’s and women’s organization in this regard
- Promotion of women workers for formation of their own trade unions to fight for demands
- Early enactment of proposed legislations on prevention of sexual harassment of women at workplace and the unorganized sector workers social security.

**Ergonomic measures:** The best way to reduce WMSDs is to use the principles of ergonomics to redesign tools, equipment, materials, or work processes. When ergonomic changes are introduced into the workplace or job site, they should always be accompanied by worker training on how to use the new methods and equipment, and how to work safely. The goal of the science of ergonomics is to find a “best fit” between the worker and the job conditions. Ergonomics tries to come up with solutions to make sure workers stay safe, comfortable, and productive. Ergonomics is a new topic for the construction industry, but the ideas have been around for many years (http://www.cdc.gov/niosh/docs/2007-122/).

Ergonomics interventions that combined education with practice found improvement among groundskeepers, custodians, clerks, and grocery workers (Hultman et al., 1984; Schwartz, 1989; McCauley, 1990; Christopher and Sehnal, 1993). Komaki et al., (1978) found an increased use of ergonomically effective techniques weekly personal feedback was provided. Tiraboschi et al., (2002) found 86 per cent of administrative assistants who received personalized feedback and one-to-one instruction in ergonomics demonstrated at least one behavior change relating to instruction. Brandenburg and Mirka, (2005) studied volunteers in a laboratory setting and found that after an ergonomic training program, people who received positive
reinforcement as they were performing tasks had a more positive view of the program, a factor that has application in the motivation of the worker to make behavioral changes.

The International Labour Office’s international programme for the improvement of working conditions to assist industries in finding practical solutions for improving working conditions is a worldwide comprehensive attempt in this area (ILO, 1996). However, awareness regarding ergonomics and its application is still low in many industrially developing countries (Shahnavaz 2000 and O’Neill 2005). The field is not well recognized by name, either (O’Neill, 2005). Creating ergonomics awareness in those countries is the main aim of ergonomists who try to improve the work environment (Shahnavaz, 1996 and Scott, 1999). Different models and methods for building vision and developing a change programme have been presented in the literature (Jungk, 1987 and Senge, 1990).

Safety needs to be seen as an integral part of every lesson. For every work activity - whether it is cutting a sheet metal or climbing a ladder - there is only one acceptable procedure - the safe one. Training should ensure that before workers start a job – whether it be starting a machine or using inflammable liquids – it is safe (Nathan, 1999 and http://www.unesco.org/education/uiie/confinte/pdfpoverty). Safe work promotes an integrated multi-disciplinary approach, which takes into account the physical, mental and social well - being of men and women workers.
There are legislations to ensure a conducive work environment for the safety of people engaged in construction work, but these lack effective implementation (Narayanan, 2010). In the context of legislations, the major legal provisions for the protection of health and safety at workplace are the Factories Act and Mines Act. The Factories Act, 1948, deals with occupational health and safety as well as welfare of workers employed in a factory. However, more than 90 per cent of the Indian labour force does not work in factories; hence, they fall outside the purview of the Act (http://www.occuphealth.fi/NR/rdonlyres/04399102-514B-4444-C90DCC3D9A3D/0/7DoOHServicesreallyexistinIndia.pdf).

In India, this responsibility of provision of occupational health services is governed by specific legislations (http://www.niifw.org/ndc-niifw/html/legislations.htm, 2008). These include The Factories Act, 1948, The Mines Act, 1952, and The Dock Workers (Safety, Health, and Welfare) Act, 1986. Other legislations such as the Workmen’s Compensation Act, 1923, and the Employees State Insurance Act, 1948, are directed toward compensation after injury, disease or accident. However, for the effective service provision, the legislations must be adequately complemented by the creation of an appropriate infrastructure and enabling an environment for policy implementation (http://www.occuphealth.fi/NR/rdonlyres/04399102-514B-4444-C90DCC3D9A3D/0/7DoOHServicesreallyexistinIndia.pdf).

The long term objectives of the ILO programme of activities in the field of occupational safety and health, aim essentially at:
- reducing the number and seriousness of occupational accidents and diseases
- adapting the working environment, the working conditions, equipment and work processes to the physical and mental capacity of all workers
- enhancing the physical, mental and social well-being of men and women workers in all occupations
- encouraging national policies and preventive action programmes on occupational safety and health and supplying appropriate assistance to implement them to governments and employers’ and workers’ organizations (OSH 2000, http://www.ilo.org/public/english/protect/safework/gender/womenwk).

Exhibit 4: How effective are the Protective Covenants?