

Health, Safety and Environment in Water-Related and Other Infrastructural Projects

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Abstract

A construction project on water resources and infrastructure should be aimed at its execution with due care of the health, safety and environment and free of accidents. Although there are enough rules and procedures on health, safety and environment (HSE), frequently these are not adhered to in real life construction. Hence, construction is the most hazardous of all the industries. Many agencies disown their responsibilities of providing the basic implements on health and safety due to lack of motivation and for cost saving. This is a composite responsibility of all agencies involved in construction and should be implemented as a culture and a way of life. The paper outlines the scenario in India and other developing countries with special reference to water resources and infrastructure development projects keeping in view the current status in the industrialised countries like the USA and the UK and proposes an action plan to correct the situation.

Keywords

Safety, Environment, Infrastructure, Construction, The USA, The UK Climate Change

HSE has a large impact in arresting project slippage. Unless these issues are strictly controlled during implementation, there may be large scale accidents causing loss or permanent disability to some construction workers. Any accident at site, fatal or otherwise, leads to immediate stoppage of work which may last for a few days. It takes time to get back the tempo of work resulting in loss of work directly or indirectly. Also, any accident leads to hardship and suffering to the families of the concerned worker. Impact on the environment and the health of the workers and the local population are equally important. All these are causes of

project slippage which should be arrested. It is recommended that a sound HSE standard be adopted and implemented throughout the implementation period which would make a substantial contribution towards arresting project slippage.

1.0. Introduction

Construction is a complex process of converting a concept into a reality. By this process, the project takes its physical shape to deliver the desired end-objectives. Construction is made through the involvement of a large number of agencies of diverse disciplines, interests and having complex interactions amongst themselves. This often leads to conflict of responsibilities, obligations, moral and socio-economic values. Attempts have been made to combat the problem of environmental health and safety in construction. The Bureau of Indian Standards (BIS) has published a number of IS Codes on site safety and health relating to various aspects of construction. Also, in-house safety manuals and codes of practices have been brought out by a number of establishments in both the public and the private sector. Safety departments with special powers and responsibilities to monitor health and safety have also been set up. But, the sad reality is that at real-life construction sites, especially in developing countries like India, it is still common to find workers without basic safety implements like, Helmets (Hard Hats), Boots (Safety Shoes) and Hand Gloves. Narrow, unsafe and unstable walkways, stairs and ladders, platforms without proper railings and toe-guards at construction sites are very common. It is also found that worn-out slings and wire ropes are being freely used at sites. The executing agencies, at times ignore, or even disown, their responsibility in this regard. The saddest part of the story is that the workmen and the labour unions are either ignorant, complacent or indifferent towards the essential requirements of environment, health and safety requirements at site. Thus, health and safety which should be everybody's business is frequently found to be nobody's business. This is a burning issue in the Indian construction sector. What is the way forward? Perhaps, it is possible to derive benefit from the experience of industrialised countries like the USA and the UK.

2.0. The Perspective of the United States of America

2.1. Improving Health and Safety at Construction Sites

As reported by ASCE, Civil Engineering Journal, Stanford University, Department of Civil Engineering, in their technical report in the 1980s on Improving Construction Safety Performance in the USA stated that work-related injuries and illnesses, including fatalities in construction occur at a rate 54% higher than all other industries making construction the most hazardous occupation amongst all the industries. The estimates include both direct and indirect costs of accidents, whether they are insured or non-insured. Indirect costs include

reduced productivity, delays in project schedules, administrative time and damage to equipment and facilities. Owners have the moral commitment to help reduce accidents at project sites by offering economic incentives in addition to fulfilling other humanitarian concerns. The owner should hire only such contractors who have a proven record of satisfactory environment, health and safety performance. This requires close attention during the process of qualifying bidders. Past practice indicates that contractors are seldom awarded contracts solely on the basis of anticipated environment, health and safety performance. Owners only require the contractors to operate in accordance with accepted industrial safety practices.

A contractor's safety programme normally involves three types of costs, namely:

Direct cost of accident and insurance.

Indirect cost of accident.

Cost of establishing and implementing safety programmes.

The contractor's safety programmes really do not cost him extra money. On the contrary, it saves him lot of money.

The indirect costs of accidents include:

Loss of productivity causing project slippage.

Disrupted construction schedules leading to delay and project slippage.

Administrative time for investigation and reports preparation and issue.

Training of new personnel in replacement of the injured workers causing loss of productivity.

Wages paid to the injured workers, which is extra cost to the project.

Cleaning-up and repair of damages leading to loss of time.

Third party liability claim against the owner and damages to equipment which is extra cost to the project.

In the USA, construction safety and health programmes cost about 2.5% of direct labour costs.

These include:

- 1) Salaries for safety, medical and clerical personnel.
- 2) Organising and holding regular safety meetings.
- 3) Inspection of tools and equipment, an essential aspect of implementing safety programmes.
- 4) Orientation and training sessions.
- 5) On-the-spot site inspection, which is most essential for continuous safety efforts.
- 6) Personnel safety and protective equipment.
- 7) Regular environment and health programmes.
- 8) Providing miscellaneous equipment and supplies.

2.2. Who should be Responsible?

In a report on Site Safety and Health in the USA published in the late 1990s, a view was expressed that liability often hinges on small details. Engineers need to be more aware of their legal obligations to protect themselves as they are expected to protect the lives of those

working on the project construction. About 10,000 construction workers were reported to be dying at the project sites each year which was more than in any other industry. In spite of caution signs displayed at most construction sites like:

“DANGER – HARD HATS AND SAFETY BOOTS MUST BE WORN ON THIS SITE”, accidents continue to occur. Who should be responsible for health and safety at site - the Contractor, the Engineer, the Owner or it is a shared responsibility?

The pros and cons of the responsibility - individual or shared are as follows:

2.2.1. The Contractor

Pros:

- 1) Contractors control the site, hire and supervise workers and the sub-contractors under them and determine the means and methods of construction.
- 2) Contractors have construction expertise and training.
- 3) Contractors responsibility is generally accepted and included in the standard contract documents.

Cons:

- 1) Some hazardous work may require technical expertise not normally possessed by a contractor.
- 2) Safety management in a multi-contractor job-site presents a challenging situation because of overlapping of contract responsibilities.

2.2.2. The Engineer

Pros:

- 1) The Engineer can design structures that are safe to build, including temporary works, shoring, shuttering, scaffolding, etc.
- 2) The Engineer can review construction progress and document and drawing submissions by the contractor.
- 3) Some hazardous work may require technical expertise not normally possessed by a contractor.

Cons:

- 1) The Engineer does not control the contractor's employees and is not generally able to mandate safety procedures.
- 2) The Engineer is not normally trained and experienced in construction safety methods.

2.2.3. The Owner

Pros:

1) Owners have the right to control the site and to select the contractors and the design professionals.

Cons:

- 1) Many owners have no training in construction and/or in health and safety in construction.
- 2) Traditionally, owners have delegated health and safety responsibility to the contractor.

2.3. Shared Responsibility

Pros:

1) Each project normally has unique health and safety problems and all parties should promote and thus, be responsible for, health, safety and environment at the construction site.

Cons:

- 1) Accountability is lost if responsibility is not assigned to a single party.

3.0. The UK Perspective

3.1. No-Compromise Attitude to Health, Safety and Environment (HSE)

A report, published in the year 2002, in New Civil Engineer, journal of the Institution of Civil Engineers (ICE) suggested a 'no compromise' attitude for a successful health, safety and environmental (HSE) programme. The approach to this attitude meant never turning a blind eye to any of these issues.

The 'no compromise' programme involved strict adherence and application of the following major disciplines:

Planning- meticulous planning for HSE well in advance of commencing construction at site.

Supervision- close supervision of HSE efforts and their implementation during the construction process.

Training- in-depth training of workmen before deploying them at the job site.

Motivation- offering suitable incentives to the workmen to adopt only safe practices at site in his own interest as well as, in the interest of his fellow workers.

Monitoring- continuous close monitoring and follow-up during the entire construction period.

Reward- workers demonstrating excellent safety efforts should be suitably rewarded through award of certificates of recognition and financial rewards.

Nothing new has been added in the above aspects except that all these are rigorously applied in the 'no-compromise' attitude. Such HSE programme resulted in a leading construction company winning 50 Safety Awards in 10 years and achieving a phenomenally low injury rate at site. Hazards need to be removed from the very outset with the Construction Design

Management (CDM) group playing an ever increasing role. Designers could eliminate construction hazards much more easily and readily than the contractors. Daily site-safety briefing to the workers should be a part of every contractor's training programme. Motivation techniques to promote good performance in construction, free-of-accidents have been found to be very effective in all kinds of construction projects including those in the water resources sector and related infrastructural sectors.

3.2. Designing for Health, Safety and Environment

A research report of ICE published in New Civil Engineer Journal in 2004 indicated that the UK construction Industry viewed Health, Safety and Environment (HSE) very seriously. But there has still been a great deal of confusion amongst the owner, the consultant and the contractor as to what could be done to achieve this and who would be responsible for taking the lead. The general view, however, appeared to be that actions should be initiated from the design stage itself. The report came out with the following broad findings:

- 1) Designers could do more to safeguard against health and safety risks during construction.
- 2) More information should be made available to the designers to design for safety.
- 3) More inputs from the contractor made designs safer to construct.
- 4) The CDM regulations have helped to improve safety in construction.
- 5) Most accidents in construction were due to poor management on-site.
- 6) More inputs from the client/owner also made designs safer to execute.
- 7) If the HSE team could place more site inspectors, safety in construction would improve.
- 8) Young engineers were not taught enough about health and safety in their engineering curriculum.
- 9) The professional institutions like the Institution of Civil Engineers (ICE), Institution of Structural Engineers (IStructE), Institution of Mechanical Engineers (IMechE) were expected to do a lot more to improve tackling the problem of construction safety.

4.0. The Scenario in India

Despite the fact that various codes, manuals, appliances and recommendations have been available in India over the last few years the status of health, safety and environment (HSE) at construction sites have been far below the desired level which occasionally lead to serious accidents. The key questions that needed to be addressed were:

- 1) Where has the Indian construction industry failed?
- 2) What were the constraints in providing the desired level of HSE at the Indian construction sites?
- 3) Who have been responsible for ensuring good HSE at the India project sites?
- 4) What could be done to correct the present situation in the Indian construction sites?

4.1. The Key Factors

A study of the analysis of causes of accidents pinpointed the following factors as the major reasons of accidents at construction sites:

- 1) The planner did not include the cost of implementing HSE requirements in the project estimate.
- 2) The consultants/designers had overlooked some of the HSE aspects in the designs/drawings.
- 3) The contractor did not include in his tender estimate the cost of HSE requirements.
- 4) The contractor was not clearly told about his HSE obligations.
- 5) The contract was silent or vague about the HSE obligations of the Owner and the Contractor.
- 6) The site supervisor was ignorant and/or had no authority to enforce the implementation of HSE requirements.
- 7) The workers were trained and skilled about the use of safety gears but did not use them properly either to show their smartness or they felt uncomfortable to work with implements like helmets, safety boots, gloves, safety harnesses, etc.
- 8) Strict adherence to HSE requirements led to a loss of productivity and was overlooked intentionally due to pressure of time to fulfil a fixed time schedule.
- 9) Female workers were neither trained in HSE nor did they use safety implements due to local customs and practices.
- 10) Child workers were illegally deployed at job sites as they were available at a much cheaper daily wages and could be hired and fired any day. This is an obvious consequence of the dismal level of poverty prevailing amongst a fairly large section of the Indian population.

The root cause of all the above factors was the failure of one or the other agency in regard to providing reasonable HSE parameters at Indian construction sites.

5.0. Recommended Health and Safety Practices

What should be done to ensure good HSE at our construction sites? The responsibility does not belong to any one agency or a department but on all those who matter in the complex game of construction. The work should be shared individually and collectively.

5.1. Role of the Designer/Planner

The following points are considered important for a satisfactory HSE status during the planning, design and implementation of water-related and other infrastructural development projects:

- 1) Providing adequate protection to prevent possible damage to adjoining structures.
- 2) Taking into account interference with existing facilities and services on-ground, over-

ground and underground and providing for diversions so as to cause minimal disruption to traffic and public life.

- 3) Ensuring effective drainage and sewerage avoiding water-logging during construction thus preventing spread of water-borne diseases.
- 4) Preparing time-and-cost estimates, with due consideration to the fact that fulfilment of HSE requirements could cost substantial amounts of time as well as money.
- 5) Providing for special safety outfits, not normally expected to be supplied by the contractors.
- 6) Providing for built-in safety features, temporary or permanent, keeping in view statutory regulations and practical aspects of construction.
- 7) Monitoring the construction so as to ensure execution of work in conformity with design and drawings and recommending intermediate changes to ensure that the required HSE standards are maintained.

5.2. Role of the Owner

The Owner has the moral responsibility of maintaining the desired HSE standards and causing the least inconvenience to the general public. The following actions are considered essential:

- 1) Maintaining good HSE standards at site as a matter of policy by employing specially trained personnel with adequate authority and observing a dress code avoiding outfits like dhoti and loose footwear commonly used by many workers at Indian construction sites.
- 2) Providing necessary training to all concerned.
- 3) Ensuring built-in HSE features in the design.
- 4) Implementing safety briefing daily [that is, DOs and DON'Ts] before commencement of work and conducting frequent safety audits.
- 5) Clearly spelling out HSE requirements and contractors responsibilities in this regard in the tender document and incorporating these in the contract agreement.
- 6) Founding special awards for contractors for completing the job with excellent HSE record, free of accidents.
- 7) Making a good HSE record an essential condition for pre-qualifying bidders.
- 8) Organising safety quizzes and on-the-spot safety checks to increase awareness amongst the workers and the supervisors.
- 9) Planning each job jointly with the contractor to ensure the maintenance of the desired standard of HSE.
- 10) Developing a positive and helping attitude towards the contractor.

5.3. Role of the Contractor

With regard to HSE, the contractor has the second major role, next only to the owner. The contractor's responsibilities should include, but should not be limited to, the following:

- 1) Clearly understanding the scope and obligations under HSE and including necessary cost in the quotation.
- 2) Faithfully and honestly implementing the HSE requirements as spelt out in the contract.
- 3) Taking a positive and humanitarian attitude on HSE and resolving any dispute arising thereof.
- 4) Ensuring strict compliance of HSE aspects by habit rather than by coercion.
- 5) Employing right personnel with adequate training and experience.
- 6) Ensuring that all essential changes at site are thoroughly checked by the designer and also ensuring that the site modifications are duly approved from HSE viewpoint.
- 7) Avoiding fumes, foul gas, noise and vibration. In short, not causing air, water and sound pollution.

5.4. Role of the Workmen

The workers role should be the third major as they have the real responsibility in implementing HSE. A dress code should be observed. The workers may demand essential safety outfit for a particular job and even refuse to work if the same are not provided. The workmen should definitely not indulge in the following habits which are occasionally found amongst construction workers.

- 1) Acting in haste. Patience should be exercised to the desired level.
- 2) Being tense, angry, excited and over-confident.
- 4) Gambling with their own lives and with the lives of others.
- 5) Inattentiveness and absent-mindedness.

5.5. Role of the Workers' Union

Maintaining good HSE standard at site is an important aspect of workers' welfare.

While the unions have to put pressure on the owner and the contractor to fulfil their obligations of providing the basic environment for good health and safety, they must impress upon the workers to make HSE a habit and a way of life.

The workers' unions should give regular training and briefing to the workers on HSE aspects and avoid accidents at all cost in the first place rather than claiming a big compensation after an unfortunate accident has already taken place.

The labour unions have a big role to play in spreading the well known message:
Safety First; Safety Is Everybody's Business.

5.6. Role of the Supervisor

The supervisors' role might be broadly categorised as:

- 1) Collecting and compiling the details of HSE requirements in construction work.

- 2) Ascertaining the responsibilities of various agencies in regard to maintaining good HSE standard.
- 3) Ensuring the availability of various methods and tools for implementing proper HSE.
- 4) Impressing upon the authorities to help in effective implementation of HSE.
- 5) Training the workers and daily briefing for developing a good HSE culture.

5.7. Role of the Statutory Bodies

Involving statutory bodies, institutions and organisations in India which are related to HSE right from the outset and obtaining the necessary guidelines from them well in advance. Some of the organisations/authorities involved could be:

- 1) Health Inspector.
- 2) Inspector of Factories.
- 3) Department of Explosives.
- 4) Electrical Inspector.
- 5) Boiler Inspector.
- 6) Department of the Environment/Pollution Control Board.
- 7) Bhaba Atomic Research Centre for storage, use and disposal of radio-active materials.
- 8) Fire Brigade, etc.

6.0. Health and Safety for Water-Related and Other Infrastructural Projects

Good standard of HSE is important in all construction projects including those in water and infrastructure. Most of these projects involve deep and wide excavation in pits and trenches which apart from the workmen is a source of danger for the local population. Sides of excavation and trenches should be provided with proper protection to prevent side slippage and damage to structures existing nearby. In case of excavation in rocky areas involving blasting, adequate warning and protective measures have to be taken. It is important to note that these projects are executed in areas which are wide open and at times close to human habitation. Suitable safety measures have to be taken in close coordination with local authorities. All the involved parties should understand that due care has to be taken not only of the workmen but also of the project-affected people.

Protection and preservation of the environment is an important consideration. The project site should be well drained and waterlogging of the area should be avoided. Since water and infrastructure projects normally do not have a well demarcated project area, interference with the daily life of the common people living in the area is common. In drawing construction water from local sources, care should be taken to avoid undue hardship to the locals. Care should also be taken to see that setting-up of these projects improves the local environment. In all respects, water and infrastructure projects should demonstrate substantial benefit in terms of improving the standard of living of the people in general.

7.0. Environmental Management

Construction of water and infrastructure projects, and in fact all types of construction, has a significant impact on the environment. Managing the environment in the backdrop of ongoing construction activities is not always an easy task. Environmental Management Systems (EMS) are relevant to all organisations operating in the construction sector irrespective of their line of specialisation and size. The EMS should match the needs, aspirations and culture of the concerned organisation to ensure obtaining tangible results. The British Standards Institution (BSI) has introduced in the recent past a British Standard (BS) on developing an environment management standard through a straightforward step-by-step approach and named it Easy Access Management System (EAMS) which can be developed in six phases with intermediate operational audit after each phase. With the environment becoming an all-important issue, such standards may have to be adopted in Indian construction sites in the years ahead.

8.0. Impact on the Environment

Projects on water and infrastructure normally lead to considerable impact on the environment directly or indirectly, on a long-term or short-term basis. Also, during implementation of these projects, the construction activities are likely to affect the environment of the project site. It is imperative that the environmental impact of the project should be carefully assessed and adequate protective measures provided before giving a 'go-ahead' signal to the project. So, a proper Environmental Impact Assessment (EIA) is an essential requirement in the initial planning stage.

Environment is a broad-spectrum subject that means different things to different sections of people. In reality, the word 'environment' includes not only the air, noise, water, plants and animals but also other natural and man-modified features which constitute the totality of our surroundings. Hence, the term environment means the entire complex of physical, social, cultural, economic and aesthetic factors that affect individuals and communities and ultimately determine their form, character, relationship and survival criteria.

The word 'impact' means any change, positive or negative, from a desirability point of view. An EIA, therefore, signifies a study of the probable changes in various socio-economic and bio-physical characteristics of the environment that may result from the implementation of the proposed project on water resources and infrastructure development. EIA is the documentation of an environmental audit which includes identification, interpretation, prediction and mitigation of impacts caused by the proposed project.

9.0. Global Climate Change and Energy Economy

When it comes to greenhouse gases and global climate change, the Atlanta Journal Constitution, a daily newspaper of Atlanta, Georgia, USA, on 29 June, 2006, reported that

Americans represent 5% of the world's population but contribute 45% of the world's emission of CO₂, the main pollutant that causes global warming. The figures are based on a report of the non-profit group Environmental Defense, USA. The report said that Americans owned 30% of the world's vehicles, drove farther each year than the international average and burnt more fuel per mile than the world average.

The per capita income in USA is about 50 times more than that in India. The per capita energy consumption in USA is more than 11,000 KWH per year as compared to about only 350 KWH in India. USA, with only 5% of world population, consumes about 30% of the total energy consumed in the world. As against this, India, with about 20% of the world's population, has been consuming only about 1% of the total energy consumed in the world. To stall the impending danger of global climate change, an efficient energy conservation mechanism and a better energy management system are essential requirements.

Emission of CO₂ with increasing consumption of fossil fuel may be blamed for global warming. Deforestation may be responsible for the increasing concentration of atmospheric CO₂.

Scientists believe that there may be 3 deg C to 5 deg C rise on the earth's surface by the end of the present century, when due to melting of polar ice-caps, the sea level may rise and some low-lying areas on islands and sea coasts may be submerged under the sea. A conservation-conscious planning and management of our activities would help in avoiding environmental air and water pollution and perhaps save the planet from a possible disaster. Engineers and planners should look for pollution-free energy sources like 'clean-coal' technology, solar power, wind energy, bio-mass energy, tidal energy and geo-thermal energy, etc. Conservation of energy on a sustained basis would also be of great advantage in minimising pollution and fight the hazard of climate change.

10.0. Environmental Considerations for Water-Related and Other Infrastructural Projects

These projects have considerable impact on the environment as most of them are spread over large areas. Also, such projects are executed in wide, open areas without any physical demarcation of the project area. Creation of a dam leads to inundation of large areas submerging farms, villages, towns, forests, etc. The first impact is the relief and rehabilitation of the affected people. In India, which is very densely populated, this causes a chain reaction. Large reservoirs created due to raising of major dams, apart from disturbing the flora and fauna of the region, sometimes endanger the lives of rare varieties of plant and animal species. The problem is complex but should be considered carefully from an overall national angle on a long term basis. The ethics behind the whole project effort should be the betterment of the overall environment. The people should be convinced that, in spite of the temporary hardships that they are likely to face during the implementation phase of the project, the project will, in the long run, be of immense benefit to the affected people.

11.0. Conclusion

Safer sites and fewer accidents should be a clear objective for all involved in construction activities. Safe sites are efficient sites and hence are more profitable. The following actions could be suggested to materialise the achievement of safer working in construction sites:

Better education and training for all those who are involved in construction.

New legislation like introducing a Construction Act comparable to the Indian Factories Act which has been in operation for many decades.

More international co-operation keeping in view that more of internationally funded projects are already coming up in India, particularly in the water and infrastructure sector.

Good health, safety and environmental (HSE) standards in the construction sector should be a culture and a way of life for the benefit and well-being of all concerned. This paper gives a few essential guidelines. Many other individuals/organisations may be required to play diverse roles to achieve an effective HSE standard, particularly in water resources and infrastructure projects. Construction is a team game requiring co-operation and co-ordination amongst a large number of agencies. Each member in the team must contribute his part to the desired level. Mutual co-operation, trust and understanding is vital to achieving a good HSE standard and an accident-free construction. With all heads and hands put together and working in perfect harmony, it is quite possible to achieve this important objective in India and other developing countries.

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