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RISKS ASSOCIATED WITH TRENCHING WORKS IN SAUDI ARABIA

M. OSAMA JANNADI
Chairman and Associate Professor, Department of Construction Engineering and Management, King Fahd University of Petroleum and Minerals, P. O. Box # 1978, Dhahran 31261, Saudi Arabia

ABSTRACT - Risks are present in every task we perform regardless of whether it is simple and straightforward or highly complex. Trenching excavations for public utilities involve difficult and dangerous conditions which can lead to injury and/or additional expense. The objectives of this paper are to explain the different types of potential risk that face contractors in carrying out trenching work in Saudi Arabia and to present the safety perception of contractors working in trenching excavation in Saudi Arabia. Data are gathered by surveying contractors involved with public utilities projects in Saudi Arabia. Finally, the paper discusses the safety measures that should be applied in trenching works.

INTRODUCTION

Contractors in the construction industry, as in any other business, face a certain amount of risk involving a loss of profits or over expenditure. Owing to the high degree of competition in the construction industry, all contractors are expected to operate under a certain amount of risk when constructing a project. The success or failure of any venture depends on how it is handled. The construction industry has had a poor reputation for coping with risks, with many projects failing to meet deadlines and cost targets. Clients, contractors, the public and others have suffered as a result (Thompson 1995). In public utilities projects such as water and sewage facilities and electrical and telephone lines, trenching excavation is one of the various risks faced by the contractor.

This paper will introduce the potential risk faced by contractors in trenching works and will explain their nature, occurrence and impact through identification, analysis and evaluation of those risks. In this connection, the safety aspect of trenching will also be discussed briefly. The safety performance of some local contractors surveyed through a questionnaire and interviews will be presented to define their performance in this field. Safety measures and the government's role in trenching safety will also be introduced and evaluated. Since this topic is very important and wide-ranging, this paper will simply present an overview of the subjects mentioned above.

RISK MANAGEMENT AN OVERVIEW

Webster (1965) defines risk as "possibility of loss or injury." Lifson (1982) defined risks as "the uncertainty associated with estimates of outcomes". Risk here means, therefore, that there is a chance that results could be better than expected as well as worse than expected.

Hammer (1981) defined risk as “expression of possible loss over a specific period of time or number of operational cycles”. It may be indicated by the probability of an accident times the damage in money, lives or operating units.

A risk is any exposure to the possibility of loss or damage to people, property or other interests. Risks are present in every aspect of doing business and offering services, ranging from the most obvious and simple problems to obscure and highly complex situations. Some risks are unavoidable elements of certain business services while others are completely self-inflicted. The first step in controlling risk is learning to perceive and categorize risks. In order to perceive all possible risk situations, the risk manager must have a clear understanding of risk. In the construction industry, risks involve design or construction problems that represent potential harm and /or loss to people, property, or other interests. Typical risk losses or harm are listed below:

- Loss of reputation and/or business
- Reduction in qualified personnel
- Loss of revenue
- Physical harm to employees
- Physical damage to the project
- Reduction in the quality of the project
- Bankruptcy

Good Engineering implies taking risks, yet knowing the risks and preventing failures nevertheless. It is worthwhile to distinguish the kinds of risks under consideration. At least three different categories of risks may be defined (Duddeck, 1987):

- Functional risks
- Structural risks
- Contractual risks

Size can be one of the major causes of risk, and so can changes in political or commercial planning. Other factors carrying risk with them include the complexity of the project, the location, the speed of construction, and the familiarity with the type of work (Thompson, 1995). The construction industry has many associated risks, but by implementing the risk management system, many risk impacts can be prevented or at least reduced to the minimum. Risk management is a control system similar to a time or cost control system that must be integrated into every aspect of doing business and offering services. Risk management systems are used to identify both obvious and obscure risks, weigh their possible impact against all other parameters, and either:

- accept or reject each risk
- reduce its potential impact, or
- eliminate it altogether

Risk management is a monitoring system to be understood, appreciated, implemented, and maintained by an organization throughout its existence or operation. In other words, risk management can be defined as the identification, analysis, and evaluation of risk and selection of the most advantageous method of treating it. The fundamental objective of risk management is the preservation of assets and earning power from loss and destruction. Safety management is also a control system that deals with providing the protection of people and property. Risk management may be defined as the minimization of the adverse effects of pure and speculative risks within a business. Risk management involves the identification, evaluation and analysis and control of risks within an organization (Ridely, 1983).

Risk management requires management responses and policies to reduce and control the main risks identified in the analysis. Risk analysis and management can be the most creative tasks of the project management. They should generate realism, and so increase a commitment to control. Through encouraging problem solving, risk analysis and management help to get projects completed through innovative solutions (Thompson, 1995). The greater the uncertainties, the more flexible the responses must

be. It is more likely that risk identification and analysis will reveal a need for re-design, more detailed design, further site investigation, a different packaging of work content, the use of alternative contract strategies or a different method of construction. Risk Management can involve the following (Thompson, 1995):

- identifying preventive measures to avoid a risk or reduce its effects
- proceeding with a project stage by stage; initiating further investigation to reduce uncertainty through better information
- considering risk transfer in contract strategy, with attention to the motivational effects and the control of risk allocation
- considering the risk transfer to insurers
- setting and managing risk allowances in cost estimates, programs and specifications
- establishing contingency plans to deal with risks if they occur

Risk management will not remove all risks from projects; its principal aim is to ensure that risks are managed most efficiently. Risk management has major benefits for any enterprise. It is more than just a way of helping to get projects completed on time and within the budget. It can (Thompson, 1995):

- enable decision-making to be more systematic and less subjective
- allow comparison of the robustness of projects to specific uncertainties
- make the relative importance of each risk immediately apparent
- give an improved understanding of the project through identifying the risks and thinking through response scenarios
- demonstrate company responsibilities to clients
- have a powerful impact on management by forcing a realization that there is a range of possible outcomes for a project
- improve corporate experience and communication

Risk management should be continued throughout the life of a project. It should influence each stage of commitment by the client, especially (Thompson, 1995):

- in deciding the project master plan
- in preparing the final proposal for funding
- in deciding the contract strategy and basis for awarding contracts

RISK IDENTIFICATION IN UTILITIES EXCAVATION

To manage the risk in construction works and provide safe environment and condition to such works, one should first identify the risk nature and its limits and then analyze and evaluate it to eliminate or minimize its occurrence and impact. Identification of exposures is a prerequisite of risk management. An excellent place to start in any risk identification analysis is to complete a detailed survey of the existing and anticipated assets and of the exposures of the enterprise.

Excavation as an element of almost all construction projects is subject to hazards and dangers for both people and property, and has some risks for contractors who work in this field. Trenching excavation for public utilities such as water and sewer lines and utility cables has uncertainty conditions which create opportunities for risk to cause over expenditure in the work and/or financial loss for the properties. In addition, any accidents that occur may result in over cost due to damage to property or injury to people.

Soil caving into trenching or other types of excavation is a primary hazard in underground work. One reason is that, if workers are buried over their heads, they will suffocate even if they are not otherwise seriously injured. For this reason, a common rule is that trenches or shafts over 5 ft deep must be supported regardless of their apparent stability. In deeper excavations, although walls are supported, emergency exits must be provided (Oglesby, 1989).

Working in trenching excavation needs very careful preparation to provide safe conditions for work that is free of hazards & dangers for both people and property. Also, it needs skilled and trained workers qualified to do work in a difficult environment. In trenching excavation, there is a great potential for damage and injuries. Also, additional work or modifications in the method of excavation trenching may be required. The following is a list of work and environmental conditions which may create risks for contractors:

A. Soil Conditions

A trench is more confined and generally more dangerous than other excavations especially because both walls can collapse, trapping the workers. However, the walls of a trench are easier to shore than the walls of an excavation. Both are dangerous if over 5 feet deep and can quite easily kill anyone who stands in the way of a collapsing wall. The hazard is not simply one of suffocation. For example, a cave-in can involve tons of falling earth, which can crush the body of the workers in its path. The "angle of repose" is defined as the greatest angle above the horizontal plane at which a material will lie without sliding. The science of soil slides is not exact, and this uncertainty thwarts attempts to control the hazards. So soil conditions are very critical factors affecting the stability of soil that may cause damage and injury to property and people. This damage and injury may cause an over cost in the work resulting from any costs and penalties incurred by the injury in addition to other responsibilities of the contractors due to any existing property damage. Several conditions that can be direct causes of trench failure are listed below (Merritt, 1986; Fang, 1991; Asfahl, 1990):

Previously excavated areas: Trenches are particularly dangerous if they have been dug through or adjacent to back filled areas. Disturbed soil, even if it is compacted, does not bind well to natural soil.

Intersecting Trenches: Digging utility line trenches that intersect a building excavation disturbs the soil and can cause a cave-in.

Wet Soils: Clayey and silty soils lose strength when they get wet. Water in the bottom of a trench is a danger signal as changes in water table affect the stability of the soil. This may disturb the soil since water makes clay swell, drying causes it to shrink, and pressure causes it to bulge resulting in the sliding of trench edges.

Clay Soil: Clay is one of the most dangerous materials because it appears to be solid and stable even when the trench faces are nearly vertical. The nature of this soil may make the contractors believe that the soil is not subject to failure.

Layers of Different Soils: Many soils are composed of two or more distinct materials such as clay and sand, so trenches dug in these soils may be unstable.

Loose Soil: Soil consisting of sand or silty soil is not stable especially in deep trenches where the soil loosens and the sides of trenches can disturb possibly causing failure or cave-in.

Rocks: Rock also has some danger if shoring is not used or is not used properly where the edges of the trench have cracks from equipment operation due to loads and vibration. This can cause failure and cave-in of the trench.

Adding to the uncertainty of the cave-in hazard are certain hazard-increasing factors such as:

- Rainy weather can all increase the likelihood of a trench failure, because rain can make the soil lose its strength and stability.
- Material or equipment too near the edge: Material or operating equipment placed at the edge of a trench or near it can overload the soil. This may cause failure and collapse the soil in the trench.
- Vibrations caused by traffic or heavy equipment operation may trigger a trench failure. Sandy soils are especially sensitive to vibration.
- Load from existing structures can cause a cave-in if the bottom of the trench is lower than the footing of an adjacent structure.

In addition to the soil conditions discussed above which they can cause cave-in and failure of the trench excavations, thus causing accidents and creating risks for the contractors, other work conditions affect the occurrence of accidents, such us the redesign of utility lines, rework, extra works, or work modifications, and they may require the repair of damage and the treatment of injuries.

B. Equipment Operation

Operating equipment in trenching works such as excavators, backhoe, crane, jackhammer, compressor, loader, and others, may all cause accidents resulting in damages or injuries. Modern excavation machinery digs the trench to the full depth before support work is installed. When this is the case, it is essential that a safe system of installing support work be adopted so that workers are not endangered during installation (Helander, 1981). Machinery must be kept away from the edge of all excavation to avoid the collapse of the sides and the risk of individuals falling in, or material falling in on persons (Ridley, 1983).

C. Material Handling

Material used for utility lines such as pipes and their fittings, bedding material, concrete, and shoring system fixtures may fall down hitting workers and causing accidents.

All materials used for timbering or sheeting must be inspected before use and any material found defective must not be used. Struts and braces must be fixed so that they cannot be accidentally dislodged. Materials must be kept away from the edges of all excavations to avoid collapse of sides. (Ridley, 1983)

D. Existing Utilities crossing and Obstruction

Work in trenching excavation is often exposed to obstructions from intersecting utility lines that may cause damage and/or delay in the work progress. If damage occurs to any utility lines, it must be repaired and penalties may be imposed by any government agent concerned. Also, it may cause injuries, damage to electrical cables, or trench failure due to broken water or sewer lines. Where overhead cables cross the line of excavation, particular care must be taken that the equipment does not, or cannot, touch live high voltage conductors. Underground cables, telephone or television links, together with gas piping present a more difficult problem. So, knowledge of the whereabouts of underground services is also necessary (Ridley, 1983).

E. Public Accidents

Trenching works for public utility lines usually take place in streets and roads where the public is exposed to danger if safety precautions have not been taken. For example, leaving the trench open, especially to children, and contractors will be held responsible. Construction, along with other industries, has been caught up in recent years in a rapid escalation in the cost of third-party insurance (Oglesby, 1989).

F. Traffic Accidents

As mentioned above, any traffic traveling through or beside trenches may cause accidents if proper safety precautions are not applied in the job site or if the drivers themselves act carelessly. Again, contractors may take some responsibility for this. Many accidents are actually cause by the poor design of equipment that results in difficulties in maintenance, poor visibility, and the like (Helander, 1981).

G. Workers' Actions and Behavior

Most accidents happen in the trenching works job sites due to the improper actions or behavior of workers. The probability of accidents is increased by the employment of unskilled workers or workers who have been inadequately trained in safe work practices and in the use of personal protective equipment and tools. It has also been found that individual attitudes of construction workers about safety most certainly are shaped by their backgrounds, the working situation, management attitudes and practices, and by peer pressure (Oglesby, 1989).

CAUSES OF ACCIDENTS

The interviews conducted with local contractors working in this field, confirmed the following causes of accidents:

- Insufficient, improper or nonexistent shoring system.
- Inadequate or improper equipment and tools conditions.
- Inadequate or nonexistent safety precautions.
- Unskilled or untrained equipment operators, workers and foremen.
- Job assignment, control and coordination of works in progress on site.
- Unavailability of, or failure to use, personal protective equipment and tools.
- Inaccurate utility line locations, to define routes and levels to ensure the protection of existing utilities.
- Poor housekeeping on the job site.
- Poor weather conditions such as rain and wind.
- Careless actions or behavior of workers especially involving manual tools.
- Accidents involving the public or nearby traffic.

To study the risk associated with trenching excavations, the probability of occurrence and degree of risk severity has to be defined and evaluated. Based on the results of the interviews, the contractors confirmed that the probability of occurrence (of events) depends on the site conditions, the project size, the contractor's experience, the contractor's financial ability, the client's influence on the project, and the project location.

The probability of those events varies from low to medium. Whether the risk resulting from them can be managed depends on the conditions mentioned above, and on the competitive environment. On the other hand, the probability of an accident occurring is subject to the management and control of the causes of the accidents and the actions which the contractor can implement to minimize their occurrence and impacts. These actions include all and any precautionary or protective safety measures. The probability of the occurrence of the cause of accidents as confirmed by contractors is medium to high, since contractors were less concerned with the protection of people than with the protection of their work. This is because the cost of meeting the safety requirement affects the competition in contract bidding. The risk resulting from work trenching excavation and accidents that may happen has some impact on the contractor's performance, where the contractor is exposed to a loss due to costs in the works and the impact of accidents.

RISK CONTROL

The last and most important part of risk management is the control of risks. Risk control strategies may be classified into four main areas (Ridley, 1983):

Risk avoidance: This strategy involves a conscious decision on the part of the organization to avoid completely a particular risk by discontinuing the operation producing the risk, and it presupposes that the risk has been identified and evaluated.

Risk retention: The risk is retained in the organization where any consequent loss is financed by the company. There are two aspects to consider under this area; risk retention with knowledge, and risk retention without knowledge.

Risk transfer: It refers to the legal assignment of the costs of certain potential losses from one party to another. The most common way of effecting such a transfer is by insurance.

Risk reduction: The principle of risk reduction relies on the reduction of risk within the organization by the implementation of a loss control program whose basic aim is to protect the company's assets from wastage caused by accidental loss.

CONTRACTOR SAFETY PERFORMANCE

It is very important to study the safety performance of contractors working in trenching excavation. In questionnaires and interviews with some contractors in Saudi Arabia, several questions about their safety performance were asked. The results are summarized in the following points:

1. Accidents Status: Serious cases averaging 0.8 case/year/100 employee. Injuries averaging 1.25 case/month/100 employee. Minor injuries averaging 3 cases/month/100 employee.

2. Contractors confirmed that they prepare and keep reports and records of accidents for the purpose of social insurance for employees; some keep records and reports for damage only for the purpose of insurance of works.

3. Most of the contractors do not have any specific measures of safety performance on the job site; some confirmed they have a general review of their safety performance on sites from time to time as needed.

4. Some contractors keep a first-aid case on the job site while some do not.

5. Contractors held safety meeting at different times. Some held meetings for supervisors and foremen as needed, while others held monthly or weekly meetings, not only for safety but also as part of the normal weekly agenda.

6. Most contractors did not have any written safety program or rules and instructions for their employees, while some had general instructions which were written or announced verbally.

7. Most contractors did not provide any specific training for their workers except on-the-job training by other workers or foremen.

8. Project managers mostly conducted a project safety inspection to ensure the protection of work and employees.

9. Contractors confirmed that the first person responsible for safety on the was the field engineer, then the project manager, and lastly the foreman.

10. Contractors confirmed that their workers showed fair to good respect for safety matters, and there were some national differences, for example Filipinos being better than Egyptians and Indians.

11. Contractors confirmed that there were some problems in learning safety rules, and this was attributable to communication difficulties due to different languages; personal habits and attitudes in their culture; and no motivation to be safe workers.

12. Most of contractors confirmed that a high percentage of accidents were caused by unsafe acts and the behavior of workers. This means the contractors did not give importance to providing safe conditions first.

13. Some contractors were not satisfied with their safety requirements on the job site, while others were satisfied with their safety requirements in general, and these, confirmed that their performance was good to fair.

14. Contractors also confirmed that their workers sometimes showed care towards safety and respected the instructions and rules of safety if the foremen and field engineers stressed safety as a part of the work.

15. The main problems obstructing the application of safety instructions and rules on the job site are the cost of providing complete safety precautions and requirements, the unavailability of trained workers, and the time required for safe work.

16. All contractors investigate accidents in order subsequently to make a claim with the insurance company and to claim social insurance for the employees.

17. Through the project manager all contractors advise their employees about safety during site visits, and they instruct them to inform about any hazards on the site verbally, or in writing for serious cases.

18. The contractors' workers and employees rarely use personal protective equipment and tools. Most contractors confirmed that this was not provided or was not provided to everybody, or that it was not used to the following reasons:

    - It was not the workers' habit to use those tools and equipment during their work.
    - Failure of workers to retain the equipment.
    - The equipment was not provided by the contractor if it would result in additional cost for him.
    - Weakness of enforcement, or no enforcement, by client or contractor management or any other government authority.
    - Workers keep the tools and equipment for personal use.

SAFETY MEASURES FOR TRENCHING EXCAVATION

Trench safety measures are the law, and they make money sense, too. In addition, a construction worker has the right to the safest possible environment. Safe environment is the management team's responsibility. Complete safety measures should be employed on trenching job sites at all time. These measures include providing safety precautions and requirements and training the workers and employees involved to work safely. The function of those measures is to provide protection for people and property, so it is very important to ensure the application of safety measures for all work at all times. These measures consist of the following (Helander, 1981; Hammer, 1981; Ridley, 1983):

1. Study soil conditions to define the requirements of the shoring system and to use the proper system that ensures the stability of the trench and consequently safe work.
2. Provide permanent perimeter guarding for the job site.
3. Train all workers and employees in safe practices.
4. Provide personal protective equipment and tools that includes head, eyes, hearing, and respiratory protection, and train employees to keep and use them continuously during the work.
5. Keep good housekeeping on the job site to prevent harmful materials from causing injuries.
6. Provide complete safety precautions that include barricades around the trench, traffic signs, warning signs and lights, flagging, and proper bridges across the trench for pedestrians and traffic if required.
7. Provide first-aid facilities and train some of the employees on the job site to use them in case of injuries.
8. Provide equipment in good operating condition, inspect all equipment regularly, and keep it maintained.
9. Provide protection for existing utility lines in coordination with the authorities concerned.

CONCLUSION

Safety is a very important matter for contractors, where it relates to his performance and to avoid accidents that may cause a loss for the contractor. In trenching excavation, safety will protect people and properties, and applying good safety measures will minimize the occurrence and impact of risk. The contractors should study carefully all the possible risks they may face in performing trenching excavation. All the risks discussed above are to be taken into consideration by the contractors on the job site who must provide the safety measures to avoid any accidents that may cause damage to property or injuries to people. The contractors should also improve their safety performance by providing all safety requirements, training their people for safe work practices, and applying all safety measures in the job sites at all times. Companies also have a role to play in applying and ensuring the complete safety measures by following up with inspections and by enforcing the measures with penalties and fines when they are necessary.

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