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A RISK MANAGEMENT AND INTEGRATION PROJECT ABOUT EXCAVATION AND TRENCHING ACTIVITIES IN UGANDA

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Abstract
The Construction Industry in Uganda has registered many work-related accidents with excavations activities being the leading cause [1]. Three out of five fatal accidents on construction sites are because of excavation cave-ins with victims buried under collapsed soil. This paper presents the findings from an observational study of the safety measures implemented during the excavation activities phase of the Tilenga construction Project. The project involves excavation activities for prefabricated offices, a bund wall for fuel containment around storage tanks and a septic tank which should comply with international oil and gas industry standards.
The Risk Management Integration and Management Processes were examined in four phases: identifying hazards, analysing risk, evaluating risk, and a risk treatment process. A review of the Risk Treatment Process was then performed to identify challenges faced during implementation and to identify potential solutions to facilitate continual improvement. [2]
The main challenges identified include a lack of knowledge and competence, and heavy rains. Among the suggested recommendations is the provision of excavation hazards awareness training (for workers) and specialized competence training for the supervisors. Excavation activities should also be scheduled for the drier periods of the years.

Keywords: Risk Management, Excavations, Construction, Uganda

Introduction

Construction Industry

Construction is one of the largest economic sectors in all countries around the world. The building and construction industry accounts, on average, for 7-12% of a country's employment and gross domestic product (GDP).
Apart from its economic relevance and importance, the sector is also responsible for about 20-30% of allknown serious occupational injuries and, most probably, at least an equivalent share of occupational illnesses. [3] Poor construction safety and associated fatal and non-fatal occupational injuries have been reported in many studies from around the world. Estimates from the International Labour Organisation (ILO) suggest that approximately 337 million workplace accidents occur annually resulting in extended absences from work. [4]

Excavation and Trenching

Excavation is an early-stage activity in many construction projects where ground material is removed in preparation for foundation works and the submersion of pipes etc. Examples of hazards include the collapsing of the structure, people or substances falling into the excavated space, poor side-support system, unstable ground, heavy traffic, and excessive water falling into or around the area.
The collapse of an excavation is a significant hazard to people working in the excavated space. This caninvolve a rapid re-filling on the space with the ground material covering and trapping the workers underneath the material. The weight can cause crush injuries and impedes the ability to breath. The morematerial covering the worker, the less likelihood of a successful rescue in a timely manner.
Safety measures to reduce collapsing include sloping or benching the sides of the excavation, supporting the sides of the excavation or placing a shield between the side of the excavation and the work area.

Figure 1. *Sloping of excavation edges*

Figure 2. *Use of trench box*

Figure 3. *Sloping of trench edges*

Figure 4. *Shoring of lumber installed*

Traffic management systems can be implemented to distance vehicles where its heavy movement can cause vibration that can destabilase surrounding soil. Debris from the excavation and other constructionmaterials and equipment should also be located at a distance from the excavated area. Excavations should not take place near water sources, and they should be examined after any heavy rain. Pump systems should be utilized where water can encroach the excavated space.

Secondary hazards for excavations include falls from height by persons, materials and equipment, unsafeaccess and egress, unstable walking surfaces, potential confined space area (asphyxiation due to lack of oxygen, hazardous gases), contact with underground services (electrical, gas, oil) and poor emergencytraining procedure and equipment.

Excavation Safety Standards

The OSHA Excavation standards; 29 CFR 1926 Subpart P state contain requirements for excavation and trenching operations; namely:

i. Soils must be investigated and classified by a competent person according to the following categories; Stable rock, Type A, Type B and Type C.
ii. Excavations must always be inspected daily and after adverse weather conditions by a competentperson prior to entry by workers.
iii. Excavations of more than 4 feet (120cm) deep require use of protective systems ranging from; Sloping, Benching, Shoring and Shielding.
iv. Inspections of protective systems to be carried out by the competent person.

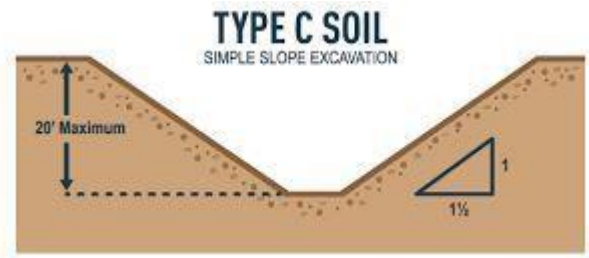

Figure 5. *Illustration of sloping for Type C soils*

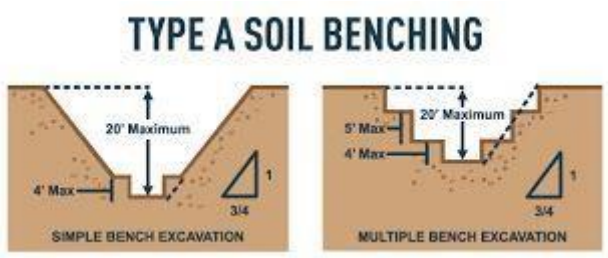

Figure 6. *Illustration of benching for Type A soils*

Figure 7. *Illustration of timber shoring*

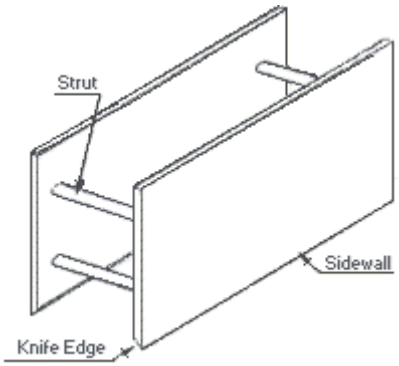

Figure 8. *Picture of shield box used for shielding*

Objective

The objective of this study was to perform a risk management evaluation of the excavation and trenching activities during the foundation preparation phase for the Tilenga Project Upstream facilities. The process included planning and preparation, hazard identification, risk analysis, risk assessment, risk treatment (including recommendations for risk elimination, risk prevention and risk reduction), and the monitoring and critical analysis of risk.

Tilenga excavation work

The scope of the Tilenga Project comprises excavation of various foundation bases for prefabricated offices with depths of 0.9 and 1.5 meters, 1.2-meter depth bund wall for fuel containment around storage tanks, 1.5-meter deep trench for culvert installation, and 1.6-meter septic tank.

Figure 9. *Backhoe excavating a trench 0.9m deep.*

Figure 10. *Excavated pits of 0.9m deep*

Figure11. *Trench 1.2m deep submerged with water*

Figure 12. *Excavated pit 1.6m deep for septic tank*

Material and Methods

The International Labour Organization (ILO) Code of Practice- Safety and Health in Construction and the OSHA Excavation standards (29 CFR, Part 1926, Subpart P) were reviewed, to provide a practical guidance on legal, administrative, technical and educational frame work for excavation safety.

A review of company safety management systems documents was performed to establish desired risk management objectives and compliance requirements. The evaluation process focused on the project'sHealth Safety and Environment (HSE) Plan, the Permit to Work Procedure, Trenching and Excavation Procedure documents, and checklists contained in their appendices.

After the information gathering activity, an inspection walk-about of the excavation sites was carried out.This enabled identification of hazards, existing control measures and inadequate/missing control measures. Informal questions/interviews with the workers enabled collection of details concerning commonly occurring incidents and ill-health conditions.

A risk matrix was used to determine risk levels for the hazards identified. The matrix is designed based on probability that a hazard can cause harm, along with the severity of harm to indicate a level of risk. The intervention requirements should be based on the level of risk. Higher risk required quicker interventions to control the situation and reduce risk to acceptable levels.

Results

The results are shown in the Table 1 below; with the Risk Assessment scores outlined in the subsequentMatrix table.

Table 1. *Risk levels*

Risk Assessment Process				
Hazard Identified	**Risk Analysis**	**Risk Assessment/Evaluation**		
		Likelihood	**Severity**	**Risk**
Cave-ins	• Workers working in deeper excavations and trenches of more than 1.2 meter are more likely to encounter cave-ins which can result in major injuries and fatalities. • Workers with in the excavation can be buried by collapsing soils and • Those above can fall to surfaces below	**5**	**5**	**25**
Deep Pits and Trenches	Pits of varying depth pose various risks to workers as elaborated: • Pits of 0.9 meters can result in major injuries as a result of falls below surface. • Falls into Pits of 1.5 meters can result in disabling injuries • Trenches of 1.2 meter depth also pose major injury risks like fractures. All workers working around or near these excavations are at risk.	5	4	20
Equipment Hazards	Hazards generated by mobile equipment comprise of noise and exhaust fume hazards. Unsafe movement of vehicles can result in struck by accidents due to impact with pedestrians.	**5**	**3**	**15**
Water logging	Accumulated water in the excavated pits and trenches can breed vectors like mosquitoes which could cause disease outbreaks.	**5**	**3**	**15**
Slips, Trips and Falls	• The cleared and loose spoils become very slippery after rains increasing the likelihood of slips and falls. • Loose spoils, tools or wastes piled on the sides of excavations can also become trip hazards.	**5**	**2**	**10**
Unsafe ingress and egress	This can arise from workers trying to enter the excavated pits without the appropriate ladders to manually trim the sides; resulting in falls into the excavations and consequently minor injuries.	**5**	**2**	**10**
Falling objects	Objects placed near the excavation edges are likely to fall into pits or trenches when destabilized; and strike workers below resulting in injuries.	**4**	**2**	**8**

Risk Matrix

			SEVERITY				
Health & Safety			• Death • Significant Production or Property Loss (>1000000) • Offence against law or regulation	• Serious illness or permanent disability • Major Production or Property Loss (>100000)	• More than 2 days absence • Medical treatment • Moderate production or property loss (>50000)	• 1 day absence • First Aid • Minor production or property loss (>10000)	• No lost day • Discomfort or irritation • No property damage or production loss
Score = Probability x Severity			**Catastrophic (5)**	**Critical (4)**	**Moderate (3)**	**Minor (2)**	**Negligible (1)**
PROBABILITY	**Most Certain (5)**	Will happen anytime in the year	**25**	**20**	**15**	**10**	**5**
	Likely (4)	Will happen in 1 - 5 years	**20**	**16**	**12**	**8**	**4**
	Moderate (3)	Will not happen in 5 years	**15**	**12**	**9**	**6**	**3**
	Unlikely (2)	Will not happen in 10 years	**10**	**8**	**6**	**4**	**2**
	Rare (1)	Will not happen in 20 years	**5**	**4**	**3**	**2**	**1**

Legend:

Score 20-25	Extreme Risk	Needs immediate attention, controls **must** be in place, prior to the commencement of job
Score 12-19	High Risk	Needs action as soon as possible. Control measures **should** be in place. Prior to the commencement of work
Score 06-11	Moderate Risk	Needs action whenever appropriate or feasible Job can be commenced with limited control measures
Score 01-05	Low Risk	No action needed, needs to be monitored only

Risk Treatment Process

The table below highlights the Risk Treatment Process undertaken to address the abovementioned hazards.

Hazard	Risk Treatment Process				
	Elimination of risk	Prevention of risk		Reduction of risk	
		Substitution	Engineering controls	Administrative controls	PPE
Deep Pits and Trenches			• Chain link installed along excavation slopes for slope protection. • Barrier meshes installed around excavated sites to restrict pedestrian and fauna access.	• All excavation activities are controlled by a Permit To Work procedure. • Caution tape and signs used to warn workers. • Excavation and Trenching awareness training carried out for all workers involved.	
Cave-ins			• Slope protection systems like sloping and soil nailing used where depth exceed 1.2 meters. • Earth bund and drainage channels built around excavations to reduce infiltration.	• Excavations are always inspected by a competent person prior to workers' entry. • Excavation and Trenching awareness training carried out for all workers involved.	
Falling objects	Ensuring materials or tools are not placed at the excavation edges.			Excavation and Trenching awareness training carried out for all workers involved.	
Slips, Trips and Falls	Proper housekeeping to remove objects which could pose trip hazards.			• Caution signs used to warn workers of slippery surfaces. • Excavation and Trenching awareness training carried out for all workers involved.	Use of slip resistant footwear like safety boots.
Water logging	Earth bunds are built around excavated pits Drainage channels are built around work sites to channel water Away from excavations		Water pumps are used to remove water from the pits and trenches	Excavation and Trenching awareness training carried out for all workers involved.	
Equipment Hazards			Periodic servicing and maintenance is carried out.	Daily equipment inspections are carried out to identify any mechanical and safety defects.	

Photos of implemented controls under the Risk Treatment Process

Figure 13. *Soil nailing used with chain link for 1.6m pit*

Figure 14. *Barrier mesh installed to restrict access*

Figure 15. *Caution tape and signs used*

Figure 16. *Wooden ladder used for access*

Discussion

Most observed non-conformances

These are list below with the most prevalent first;

i. Lack of soft or hard barricading around excavated pits.
ii. Unsafe means of access into excavation and in some none provided at all.
iii. Excavations not inspected prior to workers' entry.
iv. Leaving spoil soils and placing tools and materials at excavation edges.
v. Lack of warning signs about excavation hazards.

Challenges faced

These comprise the following;

i. Contractors are not knowledgeable about Excavation Safety standards and industry bestpractices and consequently their supervisors are not as competent as required.
ii. Heavy rains which continue to make the soils heavy and loose; increasing the likelihood of collapse or cave-ins.

Recommendations for improvement

i. Training for all Contractors involved in Excavations and Trenching activities should beemphasized; with the supervisors required to do specialized competence training.
ii. Excavation work should be scheduled for execution during the drier periods of the year to minimized rainfall challenges.
iii. More signs should be used to warn workers of excavation hazards and promote safety awareness.

Conclusion

With the implemented controls under the Risk Treatment process, all the identified risks have been mitigated to as low as reasonably possible (ALARP) and the activities deemed safe.
In addition, the recommendations made in section 4.5 will ensure that the non-conformances observedwill not recur, hence eliminating any chances of accidents occurring.

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