

EXCAVATION RISK IN SITES

RENATO LAGANA

DARTe, Università Mediterranea di Reggio Calabria, Italy

For excavation in sites often many firms proceed without effective and preventive estimates. The frequent accidents that occur indicate that we have not yet reached, especially in many sites of private clients, to a careful programming that allows reaching acceptable levels of security. The indications arising from the results of the inspections at construction sites and the reports drawn up following incidents highlight how often the work began without having first considered the factors potentially dangerous not only for workers but also for goods. The execution of the excavation by mechanical means or by hand requires an estimate of risk assessment process that, in addition to the specific characteristics of the site area, must consider the interference occurring with the conditions of the site and the neighboring areas (roads, presence of buildings, etc.) and the knowledge related to more general environmental context. The operating procedure, which has been initiated through some research undertaken in recent years by the "Mediterranea" University of Reggio Calabria is based on the comparison of experience in construction of knowledge. Through preventive observation (geological analysis, observations on morphological characters of area), project procedures that are being tested in some yards directly involving businesses and workers involved in specific processes.

Keywords: Safety management, Risk assessment, Cultural heritage, Construction site, Public safety, Emergence management.

1 INTRODUCTION

The excavation, according to statistics of the European Agency for Safety and Health at work, are among the most dangerous activities in the construction sector. Many accidents caused by improper protection of the place where service is the excavation. The lack of protections or insufficient susceptibility of works sealing of the walls determine conditions of danger.

The agency defines as priority measures to eliminate or reduce hazards at the source and ensure that those forms of collective protection.

European guidelines for Member States, in this area, indicating that previously must give the potential risks involved in this activity:

- Burial of workers.
- The collapse of the banks of the excavation for the weight of materials or infrastructure.
- The fall of people in the excavation.
- The sinking of motor vehicles.

The planning of an excavation activities requires information related to the knowledge of:

- Consistency geological area concerned
- Routes of underground services
- Available equipment and machines to perform the excavation
- How to remove and target materials removed.

2 TYPES OF EXCAVATION AND SAFETY MEASURES

Excavations most common on construction sites are assets of splateamento, excavation, construction of wells and construction of trenches.

For each of these two specific items of the Consolidated Law on Safety in the Workplace, adopted in Italy by Legislative Decree 81 of 2008 and subsequently amended, provide for safe conditions of work. They define the priorities of the use of the means of collective protection. The use of personal protective equipment is required to reduce the residual risks.

2.1 Excavations

They are those in which the horizontal surface is predominant compared to the depth. They are those in which the means of transport can accessed directly or via the ramp, to take away the excavated material. The operations of splateamento and excavation, in the presence of workers in the excavation area, must made to prevent landslides in the walls. In these should place armor support when the consistency of the ground does not guarantee stability. In case of rain or other adverse conditions, they have to consolidate the ground to avoid possible landslides. Workers must not be in the area of action of the machines when the work performed by mechanical means. In this case, the machine operators must have appropriate protection (cabins, sheds). Workers must not approach the base of the walls and near the edge to the higher altitude.

2.2 Excavations in Open Section

They are those in which the horizontal surface is large compared to the depth of the excavation (underground parts of new buildings, tops of foundation slabs etc. If around of the excavation there are, buildings or artifacts ranging armor and take suitable precautions. The foundations of these structures often discovered or weakened from the excavations.

2.3 Excavations in Restricted Section or Forced

They are excavations in which the width is equal to or less than the height. The excavations in the trenches in this category. When the depth exceeds 1.50 m and the consistency of the ground we do not offer guarantees of stability we have the fulfillment of shoring. Tables lining the walls protrude from the edges of the excavation of at least 30 centimeters. The piles of Trustees may cause shaking of the ground with damage to adjacent structures and danger for workers



Figure 1. Excavations in the trenches. Incidents in the year 2014 on construction sites in Turin and Rome.

2.4 Sinking

The size must allow the recovery of any injured worker. We must realize, in the wells of more than 3 meters, a robust scaffold that allows the passage of the bucket to protect the workers and to remove the excavated material. We must also ensure adequate outside assistance.

3 THE DOCUMENTATION FOR THE TRAINING AND INFORMATION OF EMPLOYEES

The chronicles frequently news of accidents related to mining operations. Many organizations working in the safety field prepared a rich production of documents, brochures and other materials addressed to prevent this risk.

In Italy, the Institute for Prevention and Safety at Work (ISPESL), now merged in the National Insurance Accidents at Work (INAIL), in 2008 drew up guidelines for the safe execution of activities excavation. They show that in the course of excavation activities occur often injuries caused by incorrect procedures or habits in the use of machinery and equipment. This is despite the availability of technologies and standards that allow for the adoption of safe working technologies.

The key elements to ensure safe execution of excavation activities are the proper planning and the provision of adequate working methods.

The guide intended to provide employers with information on choosing appropriate and proper use of the means employed to enable a proper risk assessment and for the safe execution of excavation activities.

In the same year, the Emilia Romagna, in a technical manual on site safety, gave ample space to the operating procedures for the excavation and trench excavation. In 2011, the autonomous region of Friuli Venezia Giulia has produced a document to suggest operating instructions in the excavation activities. In it, after stating the types of excavation, the authors place special attention to the problem of sealing the excavation faces. The designer must evaluate rigorously the ability to self-support the excavation wall and perform the preliminary geological and geotechnical investigations. It must be calculated in relation to the nature of the terrain, the slope safety to avoid collapse during excavation activities.

The document then deals with the topic of the construction of temporary structures of support and protection systems. They must be made before the workers inside the trench and are prepared outside and then lowered into the excavation. A rich array of cards provides many examples explaining the various techniques that implemented. These documents directed to employers and designers who need to use them to safety plan through documents required by legislation (Risk Assessment, Safety Plans, etc.). The training of workers in Italy are by the Building Schools. In addition to these facilities in Italy, we set up Regional Joint Committees for accident prevention, hygiene and the working environment. The Formedil, national body for training and vocational training in construction, has the task of preparing training programs on the safety of workers in the construction industry.

Among the educational materials made available to the operations sheets containing instructions are:

- The excavation protection.
 - (Ask for instructions on running; do indicate safety measures; perform timely protection measures, information on the path of pipelines, shore up embankments; workspace of a meter; delimitation of areas of activity of machines, protection eyelashes excavations; use the stairs, tied at the top, to go up and down in the excavation; avoid accumulating material on the edges of the excavations).
- The excavations done by hand.
 - (Recommendation on the proper use of tools to prevent problems lumbar spine; shoring the walls and not to undermine the walls of the excavation at the base, use of personal protective equipment)
- The excavations carried out with machines.
 - (Suitable distance from the excavators; prevent access to other non-radiation workers, communicate with the operator every movement; inform the operator of equipment failure; attention to the tipping machine).

4 EARLY INDICATIONS ARISING FROM A RESEARCH

Research, started last year, the University has investigated the causes of accidents, which continue to affect the business of construction.

The objective of the research is the identification of control techniques to improve the measures of prevention and protection when digging on construction sites. In the first phase was started a reconnaissance work at the national level, the types of incidents. The data collected from official documents to help identify the geographical areas, types of construction, reconstruction of the competent authorities, type of company and the type of workers involved.

The lack of preventive measures and protection, supported by an ineffective risk assessment, it was the determining cause in most cases where there have been fatal accidents. The filing of incidents detected served to build a grid to identify operational checklist tested at some sites. The results of the first investigations carried out have shown:

- Poor design of the excavation and insufficient knowledge of the types of land.
- Weaknesses Safety plans, drawn up by the companies, in the description of the individual work procedures. They often rely on improvisation or good sense of individual workers the realization of excavation work.
- Misinformation about the presence of emerging or underground distribution networks (electric lines, gas lines, aqueducts, sewers, etc.).
- Insufficient perimeters of the excavation areas and lack of protection in the eyelashes
- Access ramps unsuitable and dangerous.
- Failure of protective walls.
- Deficient information to employees at work.
- Presence of workers within the areas of action of the machines.
- Overload of materials along the perimeter

Table 1. Checklist Excavations.

1	It was performed a thorough geological survey of the land?	Yes No
2	The Safety Plan and the Operational Safety Plan are clear about the measures to be in the activity of digging?	Yes No
3	The workers were sufficiently informed about what to do and on the safety measures?	Yes Partly No
4	The excavation areas are sufficiently protected?	Yes Partly No
5	In the presence of overhead power lines, excavators observe the minimum safety distance.	Yes No
6	The company prepared a plan of possible interference of lines underground?	Yes No
7	They are cordoned off and marked the work area of the excavator?	Yes Partly No
8	The accumulation of materials occurs at a safe distance from the excavation?	Yes Partly No

5 CASE STUDY: THE PROBLEMS RELATED TO THE EXCAVATION OF A WELL

In some sites, you have carefully followed some digging dictated by special conditions. The construction of an elevator in a historic (Works enhancement Castello Aragonese) resulted in the creation of a deep rectangular pit about thirteen meters. In the well, it was subsequently placed a lift connected to the base by a short access tunnel from the lower level of the road. It was performed a dig deep for about 4.00 m. Reached the quota of the metal pipes are positioned valved diameter 120 mm complete with armor jet concrete. The planning of mining operations has followed the following steps:

- 1) Analysis and surveys to know the characteristics of the soil;

- 2) Boundaries of the excavation;
- 3) Before being excavated with small excavator;
- 4) Modeling of the walls of the excavation;
- 5) Consolidation with shot Crete walls;
- 6) Positioning of the drill;
- 7) Silting of reeds cemented;
- 8) Excavation of the shaft by hand and removal by crane of the material;
- 9) Metal hoops consolidation of the walls;
- 10) Laying wire mesh and shot Crete operations;
- 11) Completion of the excavation;
- 12) Realization of walls in reinforced concrete.

For each operation, it compiled a record operating (WBS) with the detailed description of the procedures and safety measures to be taken. The workers engaged in digging, daily informed on how safely to observe.

6 CONCLUSION

The first phase of the research made it possible to detect the importance of risk assessment excavations in the national context. The first results obtained allow deepening the complexity of these operations in relation to the role of stakeholders.

The design flaws are the cause of many accidents in this area in which they often operate machines and the man closely.

One of the themes that will explore is the one of the system of relief when an accident occurs. The situations identified appeared very important time management time help arrives. Equally important is the identification of the position of the worker under the ground collapsed. Experimenting with positioning signal, inserted in clothing or devices of the worker, and signal devices may be the solution to shorten the rescue time. Their collaboration with the technicians of the enterprises engaged in the highway sector has enabled simulation tests to test the rescue time.

References

- AUSL Reggio Emilia – Regione Emilia Romagna, *Guida pratica all'antifortunistica nei cantieri edili*, 2011.
- Bollettino R., Barrilà F., Locatelli F., *Scavi. Qual è il corretto approccio ai lavori per evitare il rischio seppellimento?* in *Ambiente e Sicurezza - Lavoro Sicuro* n. 2, 2012.
- CPT Roma e Provincia, *Lavori di scavo, sbancamento e movimento terra*, Quaderno della Sicurezza in Edilizia, Roma 2007
- Regione Emilia Romagna, *Manuale Tecnico procedure operative per la conduzione in sicurezza delle lavorazioni nei cantieri edili*, Bologna 2008.
- Sinopoli S e altri, *Riduzione del rischio nelle attività di scavo*, INAIL, Roma 2002.