

Occupational Health And Safety In Dam Construction Sites

*Omer Levend Asikoglu¹, Ozge Akboga Kale²

*(Civil Engineering Department, Ege University, Turkey)

** *(Civil Engineering Department, Ege University, Turkey)

Corresponding Author : * Omer Levend Asikoglu

ABSTRACT: *In the last decades, many international studies in the literature appear to be involved in the search for a solution to the failure of the dam under the topic of "dam safety". However, it is significant that there is almost no work addressing the occupational health and safety in dam constructions. This study aims to draw attention to the risks and occupational health and safety conditions in dam constructions. In this work, firstly the construction process of the dams are explained and the potential hazards of the processes has been discussed. Then, precautions taken to ensure that the potential hazards identified do not cause an accident are explained. It is emphasized in this study that not only the danger of failure but also the occupational safety is very important in dam constructions.*

I. INTRODUCTION

In recent years, parallel with the increase on work health and safety in private sector and also in academic studies, it has been observed that the sensitivity to the issue has also increased. However, it is noteworthy that this positive development is generally confined to the studies that deal with the issue in general. In addition to the fact that conceptual knowledge about worker health and work safety is generally the same, the differences in the functioning of the sectors and the variability of the processes need to be examined separately for each sector and each branch. In the construction sector as well, the working areas vary considerably from one another. The construction sites, which are characteristically very different from each other such as dam, port, road, airport, bridge, infrastructure, residence, should be investigated separately in terms of occupational health and work safety. The potential hazards that each of them may occasionally meet in a common ground, vary according to the nature of the construction site. This leads to a need for privatization in the improvement proposals that need to be developed. Dam construction has been investigated in this study, which has not been thoroughly investigated in terms of occupational health and work safety, although it has been the cause of many fatalities and injuries in the past. Many national or international studies in the literature appear to be involved in the search for a solution to the failure of the dam on "dam safety" [1-6]. However, it is noteworthy that there is almost no work addressing the occupational health and safety in dam constructions. Completed research studies have been found to concentrate more on survey or observation studies [7-9].

This issue is reflected in the ICOLD bulletin 73 (1989) as "in the majority of dam sites, the risk of fatal accident risk for workers during the construction is higher than the risk of dam break failure" [10]. The aim of the study is to draw attention to this shortcoming, to help improve occupational health and safety conditions in dam constructions, and to draw attention to the issues of work safety that carries a high accident potential.

II. DAM CONSTRUCTION PROCESS

The dams generally serve to store water during periods of high water content and regulate flow regimes of irregular streams to meet the water needs in arid periods. The dams are built functionally to benefit from water, to protect from the effects of floods and to control water quality. In the wider sense, the purpose of construction of dams can be classified as water supply, irrigation, hydroelectric power generation, flood control, wildlife conservation and sediment control. In addition to the benefits it provides, there are various risks involved in the construction and operation processes of dams.

External risks that may arise from: 1) The meteorological and hydrological extreme events such as flood, drought, temperature, icing and wind 2) The earthquakes; the mining explosions 3) The unbalanced slopes on the upstream side and the impacts of the dams on the upstream side 4) Extreme social events such as terrorism and sabotage.

Internal risks that may arise during the process of : 1) The design of the dam, 2) The construction of the dam, 3) The operation of the dam, 4) The reservoir operation, 5) Future plans and operations such as upgrading the dam or loading additional services to the dam [11].

This work focuses on the accidents that may occur during construction process. In order to evaluate the dam construction sites in terms of work safety, the construction process and its stages need to be identified. The dam construction works usually consist of the following phases, which can be completed in a long time and require a lot of work and machine power:

- i) Infrastructure services to be provided to the dam site; preparation of the construction site and establishment of necessary facilities (such as quarries, concrete plants etc.)
- ii) In order to construct a dam, it is first necessary to remove water from the construction site where the dam will be placed in the river valley. This is usually accomplished by transferring the flow with diversion tunnel from upstream side to the downstream side. The tunnel is built along one side of the valley around the planned construction site. In the process of opening the tunnel, the explosives placed in the drilling holes opened on the rocky slopes of the valley are exploded first, and then the soil and broken rocks are removed from the area. This procedure is repeated several times to complete the tunnel. The diversion tunnels are usually covered with concrete.
- iii) Diversion works usually begin in summer, when the river level is low. Excavation materials are used in the coffer dam (upstream coffer dam) which will be built at the upstream of the dam construction site. The upstream cofferdam serves as a barrier and allows the flow to be diverted to the tunnel. Another coffer dam is built to prevent the back flow in the downstream of the dam construction site (downstream coffer dam). Pumps are used to prevent water leaking coffer dam and flowing to the construction site.
- iv) Construction methods used for dam construction as well as facilities (quarries, concrete plants, etc.) vary depending on the type of dam to be built. The first stage of construction involves ground preparation works, usually of loose rocks and debris removed from the valley sides and river bed. After that, the foundation is built to fix the dam to the base and to the sides of the valley. In the next construction stages, body filling, sealing on the base and on the body according to the type of dam, spillway, upstream and downstream surface coatings are applied.
- v) Buildings and facilities such as water intake structures, water transmission structures, surge shafts, power plants, etc. are built according to the purpose of the dam during the construction. When the dam is completed, the dispersion tunnel entrance is closed and the lake is started to fill. The dispersion tunnel can be used as a bottom weir in order to discharge the dam.

The works like topographical studies, roads and infrastructure facilities reaching dam site and material resources, concrete plants installed in site area, geotechnical studies, construction of diversion tunnels and dam body, construction of turbines and power plants, construction of water intake and transmission lines, cover many branches of civil engineering as well as some other disciplines. The organization of tasks involving all these different areas of expertise requires serious planning, as well as the fulfillment of the requirements for workers health and safety.

III. POTENTIAL HAZARDS AND PRECAUTIONS IN DAM CONSTRUCTION

Although the construction industry is generally considered as a whole, different potential hazards are at the forefront in each work field, as the areas of operation differ from each other [12]. When it is considered from the point of view of dam construction, the following dangers are noteworthy. First of all, in dam construction, rock blasting and tunnel works exist different from other construction works. Dam constructions, especially tunnel works, contain underground activities similar to mines. As a result, workers may be exposed to dangers such as collapses, cave-ins, toxic or suffocating gas emissions, gas explosions, dust explosions, component falls, and floods. In addition, hiding, storing, transporting and exploiting explosives such as dynamite, which are used in work such as rock blasting and tunneling, potentially dangerous. Big bursts are inevitable in the unauthorized storage and usage processes.

Precautions in the storage, usage and after application process of the explosives should be attached to detailed instructions to avoid explosion accidents. Applications should be carefully watched according to the instructions. Explosives should be used by workers who have a certificate of competence. Special containers must be used for the transport of explosive materials and there should be no other materials in these containers. Before blasting, appropriate safety precautions should be taken around the area to be blasted and all employees should be informed about the explosion with various warnings. It is very important to plan before starting work in order to avoid trench cave-ins. In addition, to reduce the possibility of accidents, it is necessary to take proper precautions according to the soil type, to build suitable ramps for safe access to the excavation site, to carry out the inspections of excavation work machines and to work with competent drivers and operators.

As an accident type, vehicle accidents do not come to the forefront in the construction industry, but dam construction sites are located far away from city centers so this type of accident is more prominent in dam construction. The lack of accommodation area for those who work on the construction site obligates daily departure on the construction site, which increase the possibility of traffic accidents. It is possible to reduce this type of accidents with specific arrangements. The daily transportation needs of the occupants can be eliminated by arranging accommodation places which is suited according to occupational safety and health with the beds and materials up to the number of the employees.

In addition to all these, workers who works at body of a dam are at greatest risk of falling. Fall from height is a type of accidents that stand out throughout the construction industry which is also frequently occur in dam sites. Moreover, high-frequency fall-type accidents are also violent, in other words, fall-type accidents usually ended with fatality. Thus, many researchers have indicated that fall from height is one of the leading causes of accidents (22% to 33%) in construction industry [13-17]. Fall from height can be avoided by collective protection measures such as guardrails, safety nets, warning system, and usage of personal protective equipment by occupants. Proper use of personal protective equipment, the prospect of use and other essentials must be communicated to employees in the training program

Many construction machines work together in dam construction areas. In addition, workers are also active in these areas. This work environment, which is complicated by the nature of the work, causes various accidents. Vehicle accidents and hitting work machines to pedestrians are the prominent types of accidents. Especially noisy working environment prevents the vehicle sensors from being heard and causes accidents. In order to prevent possible accidents, vehicle drivers must comply with the traffic signs and speed limit within the site. The workers also have to follow the traffic signs and the warning signals of the vehicles. In addition, working with the help of the signalman will be effective in reducing the accident frequency. It is seen that most of injuries and fatalities due to the struck by falling object occurred in irregular construction sites with working carelessly. In order to prevent from such accidents, it is necessary to be careful of both the crane operator and the people who works around the crane, especially in the process of moving materials with crane. It is also important to connect the cargo to be transported correctly by crane. Apart from this, workers who work at high level need to take precautions in order not to drop down especially small hand tools. Safety nets have the added advantage of preventing workers from struck by falling hand tools in addition to preventing from falls.

IV. CONCLUSION

The construction industry is one of the sectors in which severe occupational accidents frequently take place all over the world. Accidents mostly can cause undesirable results such as injuries, fatalities, amputations, machinery and equipment damage, reduced productivity and business interruption. However, trying to produce solutions for occupational health and safety as considering the sector as a whole when we consider that there has not been a decrease in the number of accidents in the past years does not provide the desired improvement.

Different production sites (ready-mixed concrete production facilities, prefabricated elements production facilities, cement factories, etc.) and construction sites (road construction site, residential construction site, dam construction site, etc.), which have different application principles and potential hazards, should be examined separately. In this research, accident types coming out of the dam sites were sorted and a solution proposal was submitted to prevent duplication. One of the issues that must be addressed in the end is the difficulty in reaching the accidents. Difficulties in accessing the past accident records required for the assessment and analysis of the present situation make it impossible to conduct sectorial analysis in terms of academic studies. In the same way similar accidents are frequently repeated and it is difficult to develop a solution proposal.

REFERENCES

- [1]. D. C. Froehlich, Predicting peak discharge from gradually breached embankment dam, *J. Hydrol. Eng.*, 21 (11), 2016.
- [2]. G. Daniel, A. Abdulhamit and D. Stematu, Assessment of Gura Raului Dam Safety Using Measurements of Structural Response to Ambient Vibrations, *Procedia Engineering, Volume 161*, 2016, 722-728
- [3]. J. D. Pisaniello, T.T. Dam and J.L. Tingey-Holyaok, International small dam safety assurance policy benchmarks to avoid dam failure flood disasters in developing countries, *Journal of Hydrology, Volume 531, (3)*, 2015, 1141-1153
- [4]. T.T. Dam, R.L. Burritt and J. D. Pisaniello, Adequacy of policy and practices for small agricultural dam safety accountability and assurance in Vietnam, *Agricultural Water Management, Volume 112*, 2012, 63-74
- [5]. L.M. Zhang, Y. Xu and K.S. Jia, Analysis of earth dam failures - A database approach, *Georisk*, 3, 2009, 184-189
- [6]. F. Alcrudo., and J. Mulet, Description of the Tous Dam break case study (Spain). *J. Hydraulic Research*, 45, 2007, 45-58.

- [7]. A. Maleki, E. Darvishi and S. Moradi, Safety culture assessment and its relationship with the accidents in a dam construction project, *Journal of Health and Safety at Work*, Vol.4 (4), 2015.
- [8]. M. Colvin, A Dalvie, J.E. Myers, I.A. Macun and B. Sharp, Health and Safety in the Lesotho Highlands Dam and Tunnel Construction Program, *International Journal of Occupational and Environmental Health*, 4(4), 1998, 231-235
- [9]. I. Yuksel, M. Kurt and E.N. Dizdar, The analysis of labour accident in the construction of Atatürk dam and hydroelectric power station, *Teknoloji*, No: 3-4, 2002, 105-111
- [10]. Hydrocoop, 2013, *Dam Construction Sites Accident Prevention*, <http://www.hydrocoop.org/dam-construction-sites-accident-prevention/> [09.05.2017] ICOLD Bulletin 80, 2013.
- [11]. G. Uckun, T. Cangel, A. Yüksel and B. Demir, *Relationship between dam safety and private safety*, 2013, Gaziantep. (in Turkish)
- [12]. M. K. Ekin, Occupational Health and Safety in Dam and Hydroelectric Power Plant Construction Works, <http://www.isgturkiye.com/konu/baraj-ve-hidro-elektrik-santral-insaati-islerinde-is-sagligi-ve-guvenligi.3484/> 2016, (Access: 25.04.2017) (in Turkish)
- [13]. T. Ore, and N. Stout, Traumatic occupational fatalities in the US and Australian construction industries”, *Am J. Ind. Med.* 30, 202–6, 1996
- [14]. J. Hinze, C. Pedersen and J. Fredley, Identifying root causes of construction injuries, *Journal of Construction Engineering and Management*, Volume 124, (1),1998, 67-71.
- [15]. S. Baradan, Ö. Akboga, U. Cetinkaya, and M. Usmen, Univariate and Cross Tabulation Analysis of Construction Accidents in the Aegean Region, *IMO Technical Journal*, 448, 2016, 7345-7370 (in Turkish)
- [16]. V. Fabrega and S. Stakey, Fatal occupational injuries among Hispanic construction workers of Texas, 1997 to 1999”, *Human and Ecological Risk Assessment*, 7, 2001, 1869–83.
- [17]. S.A. Jackson and D. Loomis, Fatal occupational injuries in the North Carolina construction industry, 1978–1994, *Applied Occup Environ Hyg* 17, 2002, 27–33.

Omer Levend Asikoglu. “Occupational Health And Safety In Dam Construction Sites .”
International Journal Of Modern Engineering Research (IJMER), vol. 07, no. 08, 2017, pp. 57–60.