Health and Safety Management on Construction Sites

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Submitted to the
Institute of Graduate Studies and Research
In partial fulfillment of the requirements for the Degree of

Master of Science
In
Civil Engineering

Eastern Mediterranean University
February 2014
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

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ABSTRACT

The success of any construction project is highly depending on health and safety management and its objective is to obtain a clear and successful work on the construction sites without fatalities or injures among the workers and other administrators on the construction site.

The fatalities or injuries among human resources on construction sites will lead to various types of negative effects. Visiting and observing some sites have taken place in Northern Cyprus in order to investigate the applications of Health and Safety issues on construction sites. It has been achieved that there is no real Health and Safety expert supervision on construction sites.

Therefore, it is important to have an investigation and develop health and safety plan program in order to reduce the injuries and fatalities by training the new generation of engineers or workers on construction sites, and reach a general health and safety plan for the most critical activities of construction projects.

Keywords: Safety management, Health and safety plan.

ÖZ

Bir inşaat projesinin, işçi ve yönetici kadrosunu etkileyecek ölümlü veya yaralanmayla sonuçlanan kazalardan azalması için, başarılı bir iş sağlığı ve güvenliği yönetimine ve bu iş güvenliği yönetiminin hedeflerine bağlıdır. İnşaatlarda yaşanan ölümlü kaza ve yaralanmaların, proje, personel ve inşaat sektörü üzerinde çeşitli olumsuz etkileri vardır.

Bu sebeple, bu yaralanmaları ve ölümlü kazaları azaltmak için bir dizi araştırma yaparak en riskli aktiviteler için genel bir iş sağlığı ve güvenliğinin planını yapmak oldukça önemlidir.

İnşaat alanlardaki ölümlü veya yaralanmalar insan kaynaklar arasında olumsuz sonuçlarla etkilenecektir. Sağlık ve güvenlik açından, Kuzey Kıbrıs da bazı inşaat alanlarda ziyaret ve incelemeler yapıldı. Sonuç olarak, bir uzman tarafından herhangi bir sağlık veya güvenlik planı yapılmamaktadır.

Bu sonuçdan dolayı, inşaat alanlardaki ölümlü kazaların ve yaralanmaların azalmaları için, sağlıklı ve güvenli bir plan yapılması önermektedir. Bu nedenle, yeni inşaat mühendislere ve işcilere bir eğitim programı gelişti ve uygulanamsı önermektedir.

Anahtar Kelimeler: Güvenlik yönetmenliği, Sağlık ve güvenlik planı

To My Parents Who Supported Me All The Way

Hoping That I Made Them Proud

ACKNOWLEDGMENT

I would like to thank Prof. Dr. Tahir Çelik for his continuous support and guidance in the preparation of the study. Without his invaluable supervision, all my efforts could have been short-sighted.

Special thanks to the construction management staff of Eastern Mediterranean University and their academic and scientific support through my M.Sc. study.

I owe quite a lot to my parents who encouraged me to complete my master degree and supported me through all my study. I would like to dedicate this study to them as an indication of their significance in this study as well as in my life.

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INTRODUCTION

1.1 Introduction

Health and safety management has a high responsibility, especially in construction industry since it is one of the huge sectors among other industrial sectors. Moreover, it has large number of workers and those workers need to be controlled by administrators such as managers, contractors and site engineers. Therefore, it is important to train and educate the novice engineers and workers and have health and safety plan and also follow the safety regulations to reduce the expected and unexpected accidents on construction sites.

Accordingly, the good management system for the construction activities on construction site should have powerful health and safety plan. Lingard (2005), mentioned that previous studies have shown how there is poor performance in occupational health and safety, and statistics from those studies revealed that workers are injured or killed at work sites (Lingard, 2005).

Additionally, the European Agency for Safety and Health at Work (2007) states that there have been 4.5 million accidents and more than 5,550 deaths annually. Figures like these mean that EU countries lose approximately 146 million working days yearly. This massive number of working days lost will cost the economy of EU countries only about 20 billion Euro (Eurofound, 2007). It is noted also that in the

United Kingdom alone more than 1.3 million people have suffered work-related injuries in 2009 (HSE, 2009).

In the Turkish Republic of Northern Cyprus (TRNC) work accidents in the field of the construction industry caused in losing yearly 3000 days from 1997 to 2006 (Çelikağ, 2008). On the other side of the island in the Republic of Cyprus, the ministry of Social Insurance reported that 103,102 days were lost because of work-related accidents in 2007 (Stavrou, 2010).

What is clear from the data listed above regarding working days lost and damage to the economy because of injuries to workers in their place of employment is that there is a direct link to the ineffectiveness – or indeed absence - of occupational health and safety planning, irrespective of whether it is within the EU or in countries elsewhere. Thus, the data shed light on the regulations and planning for occupational health and safety within the TRNC, which needs to undergo a major overhaul in its regulatory base in order to ensure greater safety on construction projects, to minimize hazards and to promote occupational health and safety.

1.2 Research Problem

All work activities on the construction sites are considered as dangerous (HSE, 2006), regardless of their nature or size while the health and safety regulations of the construction site are not applied or controlled by Health and Safety experts on the construction site. Besides that, the most critical problems related to Occupational Health and Safety in the TRNC are the activities on construction site, which are beyond the compass of regulations drawn up by the European Occupational Health and Safety at Work. The problem is further exacerbated by worker ignorance of

Health and Safety procedures that might protect them from on-site accidents during their work on the construction project. Furthermore, there is little or no real supervision or an authorized Health and Safety experts on the worksite to monitor whether the workers are adhering to and implementing the health and safety regulations. Moreover, much of the equipment used on site is either out-dated or so old as to place it beyond health and safety regulations. Therefore, it is important to educate and train the new generation of engineers and workers on health and safety issues on construction sites by developing a knowledge based system.

1.3 Research Scope and Objectives

The significance of health and safety plan on the construction site is not thoroughly recognized, either by workers or by managers in TRNC. It is only the responsibility of the expert site managers to supervise and control the Health and Safety issues on the construction site.

Hence, knowing how to control and apply the occupational health and safety plan on construction sites is very important. Therefore, the objectives of this research are:

1) To investigate the health and safety problems on the construction sites in North Cyprus.
2) To find out the critical activities on construction site work in North Cyprus related to occupational health and safety.
3) To develop Health and Safety Fast Guide (HSFG) software program to contribute in preparing health and safety plan for the critical construction activities.

4) To train and educate the novice engineers and workers about health and safety issues on construction sites by developing a knowledge based expert system.

1.4 Methodology

This research explores the theme of preparing health and safety plan in relation to the activities on construction sites. Also, it aims to train the novice engineers in health and safety issues on construction sites. The methods used in this research based on the following main headlines:

- Visiting and observing some sites in Northern Cyprus to investigate the applications of health and safety issues on construction sites. Taking in to consideration the critical activities for health and safety issues on the sites.
- Checking the application of health and safety features on construction sites and their compatibility and linkage to the European Occupational Health and Safety at Work regulations.
- Designing and modeling a knowledge based computer program called HSFG Software by using Xojo programming language in order to formulate a health and safety plan for the construction site activities in addition to training the workers and engineers.
- Evaluating the HSFG software by presenting it in front of domain experts.

The first phase of this research is recognizing and then classifying the problem of occupational health and safety on construction sites using data gathered from three construction projects located in Northern Cyprus. Considered as a case study, this research is conducted in order to determine the most critical activities by visiting and observing the construction sites of these projects. Furthermore, based on what the

inspection and investigation of these construction sites revealed, it was clear that excavation, formwork, scaffolding, work done on heights and work on roofs were considered the most critical activities, and all were found in need to be checked out as they are against the regulations demanded by the European Occupational Health and Safety at Work.

The second phase consists of using the European Agency for Safety and Health at Work, the Australian code of practice, enhanced by other Occupational Health and Safety organizations such as the Health and Safety Executive (HSE), and Occupational Safety and Health (OSH), as resource agencies for preparing the Health and Safety database of the HSFG software.

The third phase consists of designing and modeling the HSFG software by using the Xojo's language program. The database contains collected information from different resources that refer to the issues of health and safety. Moreover, the governing theme function of the HSFG software is that it not only contains the most critical activities which have been mentioned previously but solutions for the resolution of these activities with an easy format that gives flexibility to the user to shift between the tabs and the regulations for each on-site construction activity.

The fourth phase consists of evaluating the HSFG software by presenting and sharing the software in front of experts in occupational health and safety and computer engineering. Based on their judgments and recommendations, the software has been modified several times in order to reach the applicable theme for the user and with good features that let the new generation of worker and engineers develop their knowledge base and improve their health and safety skills.

1.5 Works Done

In the research the following tasks have been taken:

1) An investigation of health and safety practices on construction site projects in Northern Cyprus carried out by observing each activity of those projects in the case study.
2) The most critical activities on construction sites identified after the investigation and the observations. This was done based on the similarity and compliance of health and safety regulations and practices with those of the European Occupational Health and Safety at Work. The critical activities were chosen based on the highest rate of accident, injuries and fatalities from different statistics on construction activities.
3) Developing a knowledge-based expert system (HSFG) software program, by using Xojo's programming language in order to formulate a health and safety plan for critical construction site activities.
4) The evaluation of the HSFG software was done based on the domain experts' recommendations and judgments in the field of Occupational Health and Safety and computer engineers.

1.6 Achievements

The following aspects were achieved based on the data taken from the case studies:

1) Proof that the health and safety on the construction sites in North Cyprus are in need to be developed.
2) The most critical activities on the site work of construction projects in North Cyprus were extracted and proved that it is out of European health and safety regulations.

3) Developing the HSFG knowledge system has been achieved and ready to be used by the engineers on the site work and training institutes.
4) Using the HSFG knowledge system in institutes and organizations will develop the knowledge of the workers and engineers on the site work, and reduce the expected failures in the health and safety in the most critical activities on the site work of construction projects. This was stated by expert contractors and managers in the field of construction management.

1.7 The Structure of the Thesis

In this research, the structure of the thesis as follows. The first chapter gives an introduction to the subjects, the background, the problems. The scope and objectives and methodology of the subject has been stated at the end.

The second chapter deals with the concept of health and safety management in construction. It gives description of this concept and accident comparisons between TRNC, Turkey and Europe. It involves the review of various related literature.

The third chapter deals with HSFG software and how it is used as a guide in health and safety in construction operations. Furthermore, it introduces Xojo program which is the software that is used to program the HSFG software.

The fourth chapter provides an evaluation for HSFG software. The goal of evaluating software and the criteria of evaluating have been presented.

The fifth chapter is the conclusion which sums up the study in the chapters and gives the advantages that are gained from the HSFG software and how HSFG software will be helpful.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Health and safety issues have a strong influence on different areas of life such as business, daily occupations and economic activity. Health and safety issues also play a crucial role in industry, the conduct of companies, institutes of education, places of entertainment and offices (Eurostat, 2010).

The issue of health and safety is of great importance because it resembles a problem in the field of construction. Matters of health and safety may be considered as issues that concern humans, the environment and the economy. This is because they are intimately connected to the welfare of people and the environment in general. Health and Safety matters spread across all questions of industrial progress and the standards and regulations that determine and govern advances made in that field (Eurostat, 2010).

However, although questions of health and safety are primarily matters of human or environmental consequence they have a broader and more negative impact on the economy of any single country as a whole. The initial costs of accidents and illnesses represent a relatively small part of the more general damage done as there are other larger and greater consequences (Hughes, 2009).

The European Agency for Safety and Health at Work has confirmed that hundreds of workers have been killed and thousands of accidents have taken place in 3 days of absence from work site. The loss of these working days has resulted in massive harm being done to the European economy as a whole. This loss of working days yearly affect the economy of Europe in general (OSHA, 2010).

According to the Turkish Social Insurance Agency (Sosyal Sigortalar Kurumu (SSK), the annual loss of working days due to illnesses or accidents at work was calculated at 2 million through the years 1997-2006 (OSHA, 2010). The result of this loss is about 36 million Turkish Lira (about 25 million US dollars), according to the Turkish Ministry of Labour and Social Security (Çalışma ve Sosyal Güvenlik Bakanlığı) (Çelikağ, 2008). The ministry also claimed that 3,000 days were lost in Northern Cyprus during the same time period while 103,102 days were irretrievably lost due to accidents or illnesses at worksites in the Republic of Cyprus (Stavrou, 2010).

2.2 Accident Occurance Comparison

It is evident from the figure 1 below that there was a significant decline in the rate of work-related accidents in EU countries between 1996 and 2007. It is clearly shown that there was a significant decrease of about 40% per 100,000 employees over the 10 year period. The time between 2001 and 2002 witnessed the highest decrease of about 13%. During those ten years, 3,490 less were recorded per 100,000 persons. The year 1996 represents the highest rate of accident incidence for 100,000 employees at 18.013%.

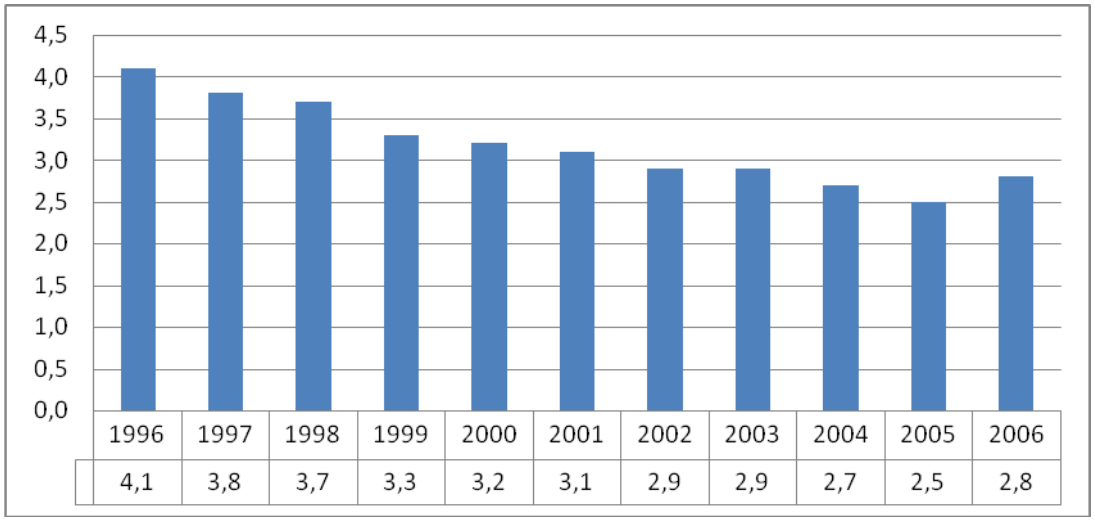


Figure 1: Incidence of work fatal accidents in per 100,000 workers 15 EU countries (Eurostat, 2010)

From 1996 to 2006 in figure 1, the reduction in the rates of fatal accidents can be noticed. In ten years in Turkey, there is 50% drop. But the rate varies in this period of time. For example, it witnessed an important drop in 2002, and then in 2005 after being stable for more than 3 years as shown in figure 2 (Stavrou, 2010; Çelikağ, 2008).

In figure 2 also, work related fatal accidents statistics in Turkey show that there are variations. The number of accidents occurring at work was much less than that of the EU over the same time period but was higher than the EU countries surveyed in terms of fatality. The years 1997-2006 witnessed an average yearly fatality rate of about 18 per 100,000 employees. In general, an increase in 2006 has been shown (OSHA, 2010).

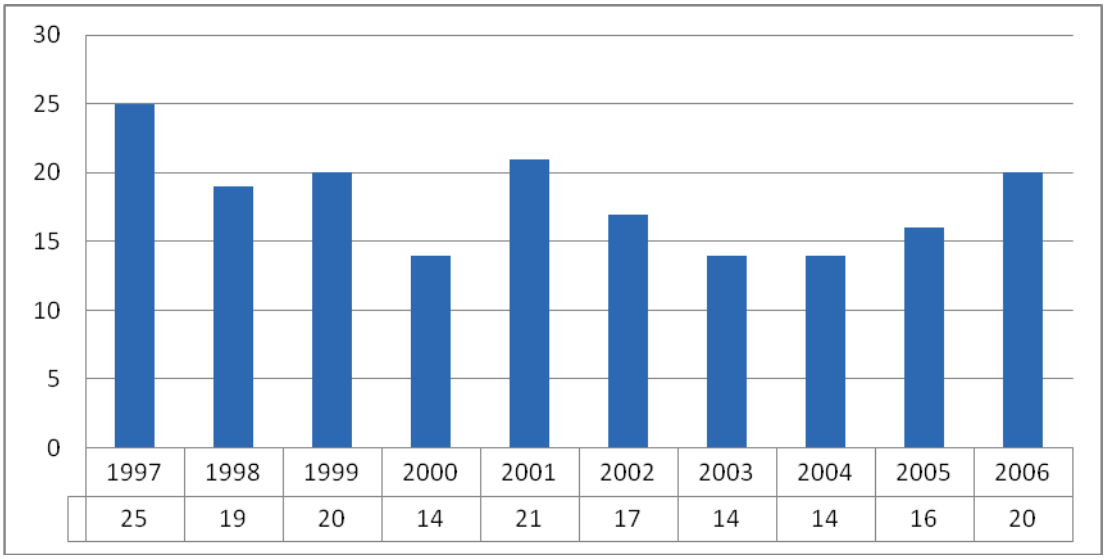


Figure 2: Incidence of work fatal accidents per 100,000 workers in Turkey according to the Turkish Social Insurance Agency (EU-OSHA, 2008)

In Figure 3, the available data for work-related accidents in the Turkish Republic of Northern Cyprus only cover the years 2006-2009. As the numbers injured were less than 100,000, a proportional system was used in the calculations. There was an increase in 2007 and the figure shows a decrease in 2008. There was an overall fall of about 5% over the 4 years in the accident occurrence which is less than that documented in either Turkey or the EU.

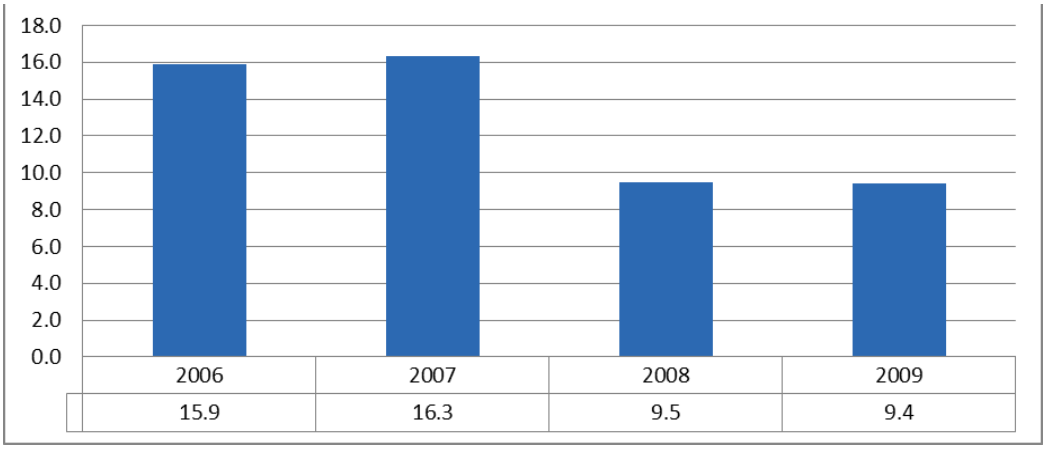


Figure 3: Incidence of fatal work accidents per 100,000 workers in the TRNC according to the Ministry of Labour and Social Security (ÇSGB, K., 2011)

As shown in figure 3, there was a 41% reduction in the rate of fatal accidents within the time frame 2006 to 2009. In the TRNC and Turkey, the rate of non-fatal accidents is much less than the rate observed in the EU. But the opposite is true of the occurrence of fatal accidents. For example, the number of non-fatal accidents in 2006 was 1,953 per 100,000 employees in the European countries while it was 1,011 Turkey and 426 in TRNC. However, concerning-fatal accidents for the same year, we have get a figure of 2.8 in the EU while in Turkey we have 20 and in TRNC we have 9.4. The major cause of accidents at work in the TRNC are falling from heights, onsite accidents involving vehicles and moving objects from one place to another.

2.3 The Meaning of Health and Safety In General

The two words ‘health’ and ‘safety’ are often paired together when considering working practices in the workplace. The words complement each other in significant ways and it would be difficult to contemplate or examine the meaning of one word without doing the same for the other. However, to define more clearly and provide a better of picture of what is under review here it is best examine the precise meaning of these words when related to the working environment.

Concerning safety, HSE (2009) gives the definition of ‘safety’ as “the absence of danger”. EASHW (2004) suggests the following meaning, "protection state". Also Phil Hughes (1999) gives the idea that "no risk" is involved in a specific work. In this sense, it is not possible to eliminate completely a risk factor and so there is no such thing as absolute safety, that no situation in the workplace can be utterly risk-free.

‘Health’ is a necessary part and a corollary to the notion of ‘safety’, especially when it refers to conditions in the working lives of people. For example, there are

references in the literature to the idea of being ‘well’ or being in a state of ‘wellness’ in a general sense. Being healthy therefore is paramount when we apply the term to the work setting. A healthy workforce is an essential element in any working situation.

Hence, health and safety management at a workplace should be done together and at the same time. In the same sense, it can refer to the management of the environment in collaboration with the work place. More recently, as is known, environmental issues are in need of management and control. To properly supervise and oversee the construction site and the environment generally, it needs to employ the same codes, practices and procedures (EASHW, 2004; HSE, 2009).

2.3.1 Health and Safety Basic Terms

In order to understand the criteria of this thesis, there are some basic terms that require definition and elucidation,

a) Accident

The word refers to any event and the consequences of that event in relation to health and safety on a construction site. An accident in this context is therefore an undesired event with undesired results that can be physical, environmental or both (Phil Hughes, Ed Ferrett, 2007).

b) Hazard

The word refers to the ability of something in to cause harm or be a threat to life, health, property or the environment. Hazards can sometimes be the outcome of the interaction of components as in the chemical filed. (Phil Hughes, Ed Ferrett, 2007).

c) Injury

The word refers to the physical consequence of an accident or incident. Here, it can be noted in the construction industry, hundreds of incidents take place at workplaces causing injuries (Phil Hughes, Ed Ferrett, 2007).

d) Risk

The word 'risk' means the chance or likelihood of loss or gain resulting from the taking of that ‘risk’ (Phil Hughes, Ed Ferrett, 2007).

Cascio (1986) defines hazardous events as 'aspects of harm in the environment of work', such as working at a height, working on a roof, working on scaffolding, formwork excavation, electrical work.

Such hazards have the potential for immediate harm. Another other kind of harm might affect the health of the employee slowly and over a lengthy period of time and sometimes in an irreversible way such as in diseases of the respiratory system, cancer and so on. Also, Cole (2002) has referred to the conditions of work that can be considered as typical environments of hazards.

2.5 Management and Causes of Accidents on Construction Sites

Work conditions and work behaviors are the direct causes of accidents. Proper management throughout the workplace can control these causes in the sense that management can create or maintain a suitable working environment. Health and safety management usually minimizes the possibility of accidents in the working arena by introducing and enforcing standards and regulations and so protecting employees from the risk of workplace injury or even death. This kind of management

needs to be committed to administering a safe working environment. (European agency for safety and health at work, 2005).

The workers should be in a position to interact with this management in such a way that their working behavior is controlled and monitored. As a means to that end and in the interests of creating a safer and healthier workplace, workers should be informed and educated. Hence, Training, in this regard, will develop the workers' skills. Moreover, a system of work that is healthy and safe should be developed and the unsafe practices should be corrected or reported (Amis R. H., 1991).

Work conditions and workers' behaviors that are unhealthy and unsafe are known as primary causes of accidents in the workplace. However, a failure in management strategy regarding health and safety rules and procedures may be cited as secondary reasons for accidents in the work environment.For example, an unhealthy system at the workplace, the absence of training in the health and safety aspects of work, bad planning, and maintenance are all contributing factors that can allow for a hazardous working situation and lead to accidents (Health and Safety Executive HSE, 1992).

Also, this can expand on the negative features listed about under the titles listed below:

- **Unsafe act such as:**

Unauthorized work, no sign warnings of danger, equipment left in disrepair, use of equipment in the wrong way or used to perform the wrong task, the absence of protective equipment, lifting loads in the wrong way ,bad maintenance of work place machinery and the non-supervision of workers who may be smoking, drinking or taking drugs during working hours.

- **Unsafe conditions such as:**

Tools and equipment that are defective, platforms missed, missing quads, bad fire system, bad environmental conditions, bad light and too much noise.

- **Secondary causes of accidents:**
  - In relation to management, it may include the lack of a clear policy on health and safety issues, a neglect of minimum standards for a safe workplace, shortage of finance, and a disregard for training and information. In relation to the social aspect, there is often a disregard on the part of contractors on the need to invest financially in protecting the working habitat, bad behaviors at the workplace, and lax social attitudes to risk, trade and industry (Phil Hughes, Ed Ferrett, 2007).

2.6 Evolution of Health and Safety on Construction Sites

Making a profit was the aim of employers who were managing projects in the early years of the last century. Employers had little or no regard for the health and safety of their workers. One can say that health and safety were not the concern of anybody. For example, employees in the United States who had been injured at work had to take their case against their employer to court in order to claim for compensation. More often than not this proved impossible given the cost of court procedures. Those cases that were fought through the court system often failed if it could be shown by the employer that the worker had been made aware of hazards or had chosen to ignore information on health and safety matters (Alli, 2008).

It became clear that matters of health and safety in the place of employment should be given special attention. Hence, there was the establishment of a national safety council 1913 in the USA. Then there was the establishment of the International

Labour Organization in 1959. This organization has provided that health and safety practices should be available either in or near a place of work (ILO, 1977).

A health and safety policy is the direct consequence of recognizing the importance, as a concept, of health and safety in a construction workplace. This concept should be taken into consideration in order to raise its awareness level in a working climate. And a health and safety policy is a source of information that should be available to everybody involved given to everybody to involve in construction work including clients, contractors. directors, managers, and individual workers or employees (HSE, 2000).

A health and safety policy includes information about everything relevant to health and safety in construction work. In this way, it is possible to identify the terms of knowledge that should be made available and familiar to the worker carrying out the work. Workers on site should be given information about the duties relating to health and safety such as the stability of structures, energy distributors installation, traffic routes, emergency procedures and the risk of fire (HSE, 2000).

Prior to this knowledge, workers should be gives a brief description of the work to be carried out, residual hazards, hazardous material and equipment, marketing of services and drawings of the structure. All this is for the benefits of integrating health and safety into the management of a construction project. It is also a kind of encouragement to the management of a project through identifying the risks and targeting efforts in the field of health and safety. It helps to review health and safety through the life of the project (HSE, 1994).

Generally, guidance should be put so a knowledge gap related to health and safety issues can be filled. It is to achieve the best practices and to use some site safety techniques and tools.

2.7 Critical Activites on Construction Site

Based on the tables and statics below, figure 4, figure 5, figure 6 and table 1, for the activities in the sectors mentioned below. Shows that has high number of accidents either injuries or fatalities in European countries. Also in TRNC, ÇSGB (2011) mentioned that falling from height "Yüksek Yerden Düşme" is 11% and falling from the same level "Aynı Seviyeden Yere Düşme" is 15% on construction sites.

Furthermore, these numbers shows the importance of health and safety plan to be considered on the site work of those activities.

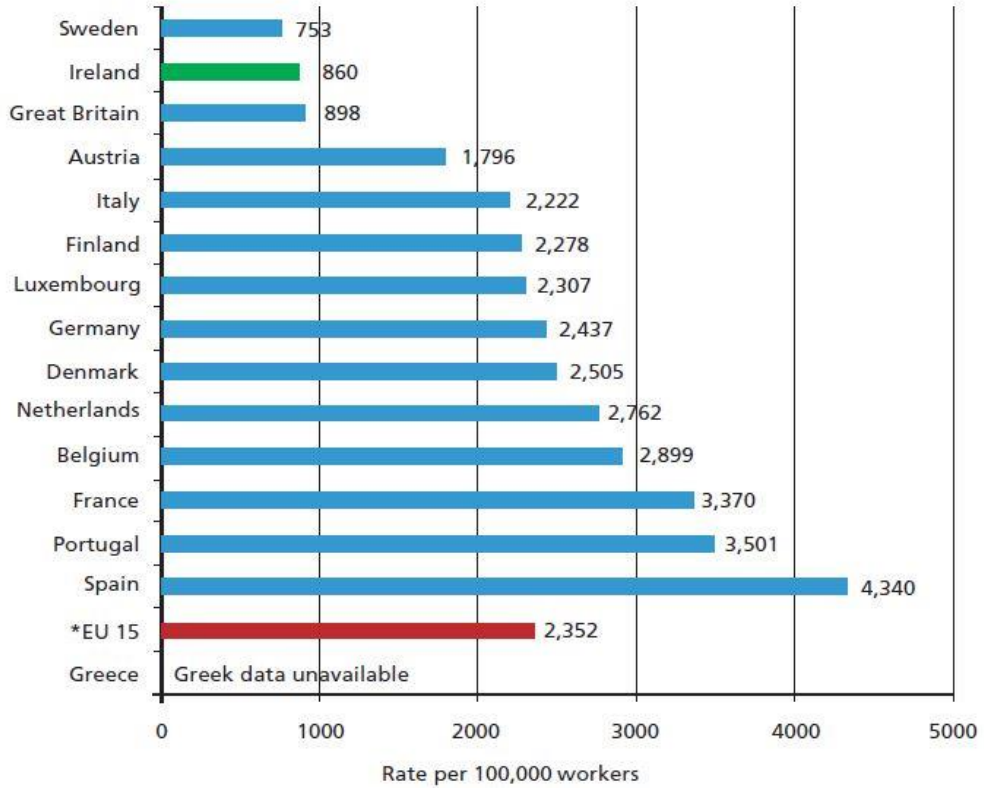


Figure 4: Rate of 4 +/- days injuries in EU 2008 (HSE, 2008)

Table 1: Accident in some of the construction activities in EU

Type of accident	96/97	97/98	98/99	99/00	00/01
Falls from a height	35%	37%	37%	36%	37%
Slips, trips or falls on level	19%	19%	20%	21%	21%
Struck by moving vehicle	3%	2%	3%	2%	2%
Struck by falling object	21%	20%	18%	18%	18%
Handling, lifting or carrying	8%	9%	9%	10%	8%
Other(e.g. excavation, form work)	14%	13%	13%	13%	14%

Agent group no.	Agent description	2001/02	2002/03	2003/04	2004/05	2005/06p
01	**Surfaces, structures and building access equipment**	2 594	2 338	2 244	2 239	1 866
01.01	Floors (e.g. fell through floor)	374	109	71	65	49
01.13, 01.14	Scaffold	209	215	278	235	199
01.15, 01.16	Ladders	1 195	1 233	1 205	1 186	1 059
01.03, 01.04	Roofs	112	134	131	135	81
01.07, 01.08	Stairs/steps	254	251	167	179	119
01.09	Doors, walls, partitions	71	64	65	71	61
	Other specified agents	367	313	303	322	260
01.90	Not known	12	19	24	46	38
02	**Surfaces and structures – below ground level**	28	25	26	31	21
03	**Systems for the distribution of materials or substances**	6	8	10	9	4
04	**Hand held tools and equipment**	2	3	2	2	1
05	**Systems for energy and storage, motors**	2	1	4	5	3
06	**Conveying/ lifting/storage systems and hand held pushed/pulled trnspt**	180	228	293	265	255
06.06	Elevators, lifts, hoisting devices	21	34	5	9	6

Figure 5: Major injuries to employees(workers) due to falls 2001/02-2005/06

07	**Vehicles, plant and earth moving equipment**	673	713	771	805	709
07.26	Lorry loader (n/a after 2002/03)	120	115	-	-	-
07.27	Van/light van	54	60	58	69	67
07.28	Other heavy goods vehicle	128	126	266	293	232
07.29	Trailer	150	183	157	146	155

Figure 6: Major injuries to employees (workers) due to falls 2001/02-2005/06

2.8 Responsibilities of Employers and Employees in Relation to Health and Safety

Health and safety of the workers should be ensured at the construction site. It is the responsibility of the employers to take procedures that help the health and safety of workers; thus, the employer should take into consideration the following duties:

- Preparing accident reports.
- Preparing records of maintenance.
- Health and safety notices and information should be posted.
- Employees should be educated and trained on health and safety measures.

It is not only the responsibilities of the employers but also it is the responsibility of the employees to take care of health and safety at the work site mainly through:

- Having the appropriate equipment and the specific protective clothing.
- Any breaking of the rules or codes of practice should be reported (Dessler, 2001).

As well as their responsibilities, the rights of the employees have been mentioned by Downey (1995) as following:

- Knowing the hazards of the work place.
- Participating in the process of health and safety.
- Refusing any work that they believe to be unsafe.

2.9 Health and Safety and The Law In Construction

In reference to HSE (2003) the following points should be taken into consideration:

- An employer should present a healthy and safe work system on construction sites.

- Health and safety aspects should be present and clear in the construction sites such as transportation, storage and use of materials.
- The employer should supervise the workers and provide them with the necessary training, education and instructions that are important in keeping the workers as well.

2.10 Overcoming Problems of Health and Safety

Preventing accidents at the construction sites involves much more than merely listing rules or making inspections. What is important is a health and safety management system that is suitable for the specific work and which accords with the law. Some of the measures of overcoming the problems of health and safety have been referred to (Turner, 1965).

The measures can be summarized as follows:

- Hazards should be identified from the beginning, from the earliest design stages and through all other steps in the engineering process.
- Workers should be isolated from harmful substances.
- Employers should replace potentially dangerous substances with ones that secure a healthier and safer working environment Protective clothing and equipment should be provided in order to keep the workers safe from hazardous substances or situations.
- Workers should be trained and also should be medically examined before employment.
- Medical programs that develop the standards of health and safety at construction sites should be available.

- Increasing the effectiveness of health and safety can be achieved by following the steps which are stated by Holt (1993), the steps are:
    - Notices and messages related to health and safety should stress the positive rather than the negative.
    - Messages should be given at the place to the right person.
    - Using simple and clear messages allow the worker to comprehend what is announced without difficulty.

2.11 Health and Safety Experts Committee

Cole (2002) stated that employers and employees should cooperate at work. This cooperation can be enriched by the establishment of a Health and safety committee. This committee will be composed of representatives of health and safety at the construction sites. The committee can play an important role, in the sense that the committee can investigate, codify and set in site codes of practice regarding measures of health and safety at the construction sites.

The functions of the Health and safety committee have been identified as the following:

- Accidents should be studied carefully and suggestions and advice offered to correct the situation.
- Reports have to be studied and proposals presented in order to avoid the recurrence of similar accidents.
- Reports should be delivered to workers by representatives of the Health and safety committee to workers.
- Proposals should include detailed recommendations for new health and safety procedures (Cole, 2002).

According to Michael (2006) the participation of the employees should be apparent in the plans for health and safety. The experts committee should include workers from different sections and different levels of the organization. The expert committee should have a specified meeting time has also its own meeting time and agenda in order to review what has taken place and to present recommendations for future work.

2.12 Health, Safety and Security in Construction Site

Expectations of health, safety and security at the construction sites are supposed to be presented by employers to their employees. However, some employers explain away the incidence of accidents or illness at the construction sites as in the natural order of things that cannot be avoided.

Jackson (2004) defines health to be in a state of emotional, mental and physical balance. Health management means to keep persons at the construction sites healthy. Safety has the same meaning, and procedures that ensure safety will prevent the reoccurrence of accidents in relation to work. This will lead to what are called safety programs.

Hence, security means the act of protecting employees in all aspects of their work at their place of work. It should also be emphasized that cooperation between the managers and the representatives of health and safety will lead to a healthy and safe workplace. This healthy and safe site can be achieved through certain procedures such as investigating hazards and how to avoid them, educating workers about the importance of a secure construction site and putting in place training programs that will lead to the best possible working environment (Jackson, 2004).

In keeping a healthy and safe site, the role played by the managers and supervisors of departments should not be forgotten. An example in this regard is the role of the warehouse supervisor who would demand that workers wear protective clothing and headgear, keep the work area clean, replace damaged or defective equipment and oversee the possible use of drugs or alcohol in the construction site (Jackson, 2004).

More recently, a new position in the construction site has been instituted. This is the officer of for the environment. The role of this officer is mainly to check the level of pollution and its source in the sense of how it effects the environment as well as those who work within it.

2.13 Organizational Commitment and Safety Culture

The organizational commitment to the safety effort is at the heart of safety management. This should involve everyone and should be seen to a significant part of the working habitat. Some accidents can be prevented by employers if they make the proper equipment and machines available. For example, they can They can, for example, provide switches for emergency lights or heating (Jackson, 2004).

Jobs should be designed in the correct away–in the sense that particular attention should be paid to the place in which the job is to be carried out. This will safeguard the performance of workers and effect an outcome that is satisfactory. In general, safety can be affected by many and varied factors like the usage of materials, area size, space between different area of work, noise levels and traffic.

All the previous rules, procedures or policies are efforts to preserve safety that are important in the field of work and they have effects on all of the worksite personnel. In addition to the procedures and measures listed above, we can add the behavior of

the worker as part of the overall strategy that can improve the safety of persons (Jackson, 2004).

2.14 Health and Safety Training

Tsui (1988) states that health and safety training is important for the employees and it should be given at different times and in different ways. That is to say:

- Sessions should take place regularly including all persons related to health and safety.
- Different media should be used, such as TV, video or the internet.
- Health and safety training should be updated using newsletters, posters or bulletin boards.

2.15 Employee safety motivation and incentives

Rewards should be given to the employees who have good records in relation to health and safety behavior. These rewards can be of different a different kind but are intended to encourage the workers to continuously diligent during their working day (Michael, 2006).

2.16 Accidents Investigation

An immediate investigation should be made by the experts committee of health and safety once, and the accident occurs in order to guarantee that the site and cause of the accident cannot be altered in any way. Interviews can be conducted as part of the process of determining the cause of the accident and as a way of reviewing what facets of the health and safety program might need review (Eva, 1981).

2.17 The Cost and Benefits of Health and Safety in Construction

It is necessary that employers contribute to maintain a healthy and safe construction sites by investing in additional protective measures. This may include something as simple as appointing extra employees to maintain and guard machines. By ignoring

these costs employers run the risk of further accidents. Payments can go to the health and safety committee for posters or health and safety training to finance the purchase of films or to pay for experts to who deliver lectures (Cascio, 1986).

However, the resulting benefits of the added costs will include the further reduction of construction site accidents and lesson the occasions of hazardous risk. Other long terms benefits that accrue from the extra expenditure on safety and health include:

- Saving on payments for time lost.
- Damage to the equipment.
- Money saved that would otherwise be paid for overtime to complete specific work.
- Money saved on wages for the activities related to the accident.
- Money saved for medical treatment to the victim or victims of accidents and the the time lost for post-accident investigation.
- Time saved on training new workers to complete jobs.

All this highlights the gain to be had from making the efforts that should be taken to minimize the accidents and to keep the workers in a healthy and safe sites.

2.18 Organizational Health and Safety Programs

Pirani (1976) mentions two main causes for accidents. First, there is the work condition that could be unsafe physically and environmentally. Secondly, there is work behavior that may be sometimes unsafe sometimes. "Lack of protective equipment, inadequate machine guards and defective equipment. Are examples of the physical aspect while Noise, stress, fumes and radiation are examples of the environmental aspect.

As stated before, unsafe behavior might cause accidents. A typical instance of this is a worker lifting or twisting heavy object is an unsafe way act. To solve this problem, we must correct the procedure by providing a set of instructions that will correct the movement or furnishing a device to be used by the worker that can carry out the action safely. Accordingly, work conditions and workers behaviors can be improved either through new instructions about manual movements or by engineering controls. Safe behavior can be increased through management supervision and discipline (Pirani, 1976).

2.19 Promoting Job Safety and Health

There are four approaches to this subject. These are:

- Technically, equipment can be replaced or redesigned while worker protection and construction sites can be provided and modified.
- In relation to information, changes can be made in transmitting information relevant to health and safety.
- Health and safety procedures or policies as well as the authority structure can be changed in relation to administration.
- Externally, certain political or legal actions can be undertaken to work alongside the regulation of health and safety (ILO, 1977).

However, Byars (2008) states that many things can be done in the field of promoting health and safety such as:

- Making the work more interesting whenever possible. Stress, boredom and fatigue are the characteristics of uninteresting work and accidents are the likely outcome of such situations. One can make certain changes to make the

work interesting. If employers enhance the sense of challenge and responsibility, this will give satisfaction to the employees.

- A safety expert committee can be established to involve employees in the programs of health and safety.
- Contests between employees. The employees who have good records in relation to health and safety can be given prizes. Employers can hold tests to check the knowledge of employees in relation to health and safety.
- Reports of accidents should be announced and ideas in relation to the avoidance of accidents should be obtainable.
- Using media, such as sketches, pictures and bulletins can help in avoiding accidents.
- Meetings and programs in relation to health and safety training should be held regularly.

2.20 Employee Assistance Program

In the past, a troubled employee was usually not accepted into an organization. Recently, government legislation and union pressure has brought about a change in this attitude. The present point of view is that the personal problems of employees are private, and should only be taken into serious consideration insofar as they affect the employees work. Employees should receive help to solve their problems which can be of a different nature such as financial, psychiatric or medical. (Mills, 1983).

2.21 Cost of Personal Problems

Personal problems can affect the availability and productivity of workers. Personal issues are often cited as a common cause of regular absenteeism from work. Troubled employees can be agents of stress, friction and bad feeling among working

groups. Troubled employees can lead to a loss of business and spoil the image of the organization in the eyes of the public (Stringer, 1968).

2.22 Maintaining a Healthy and Safe Work Environment

Stephen (1999) states that the productivity of workers will decrease if they are forced to work in an unhealthy environment. Problems such as headaches, sight and breathing problems or fear of being exposed to harmful materials, will affect the work. Instead of this, a healthy environment should be created to help both employer and employee. The building or the office that contains elements of pollution or harmful materials is often referred to as a 'sick building and the feeling of discomfort felt by employees is known as 'sick building syndrome.

Palmer (1989) insists that maintaining a workplace in a safe and healthy condition is dependent on a number of factors:

- The availability of fresh air.
- The avoidance of suspicious materials that may be hazardous
- Toxins should be checked in the new buildings.
- Air ducts should be kept clean and dried periodically.
- The complaints of the workers should be taken into consideration.

2.23 Occupational Diseases

In relation to working environments, there are many factors that affect the specific work sites or industry. Such factors cause occupational diseases or accidents. For example, there are the psychological factors and the biological factor. Clearly, workers' productivity's is affected by their health and their health, in turn, is affected by the kind of work they are doing. Fortunately, occupational diseases can be

prevented and this will improve the health aspect of work and will increase the productivity of workers (HSE , 1999).

2.24 Aims and Functions of Occupational Health and Safe Services

The International Labour Office (1996) have specified the main concerns of occupational health services:

2.24.1 Suitability for Job

People who have a history of medical problems cannot be suitable for certain jobs.

In this sense, an examination or a questionnaire before employment will help to determine whether the person is suitable or not for the specific job is they applying for. This examination can be repeated regularly in order to be sure that the person is still able to continue or not.

Alternative jobs can be offered as advice or suggested by the health service when it is found that the worker cannot meet the job requirements they are applying for. (International Labour Office, 1996).

2.24.2 Safety Training

All workers in a workplace should be informed about the health problems that might face them. This is the responsibility of an occupational health service. It is the health service's responsibility to explain to the workers all the measures that can protect their health. Based on this, the workers should understand what they should do as a necessity. For example, workers should wear face masks or any other protective material when required by the job, and instructions and training should be given about the procedures of first aid that will help the employees in case of danger (International Labour Office, 1996).

2.24.3 Certain Appropriate Service and Advice

Appropriate and specific services and advice will be given to different groups of people when they are exposed to certain kinds of material. Toxic agents, for example, are harmful to all people.

Among the services offered is the identification of the type of health and safety hazard any group of workers might be exposed to. It has been proved that there is a direct relationship between the kind of illness suffered by the employee and the kind of exposure, in terms of hazardous materials, that the worker has had in the working environment. For example, it can refer to the diseases that might attack the lung, nose and heart if workers are exposed to asbestos, carbon disulfide or other toxic materials that will directly attack those parts of the body (International labour Office, 2010).

2.24.4 Responsibility of Occupational

It is the responsibility of the occupational health and safety service to overcome or determine the level of toxic materials. Procedures should be put in place as precautionary measures when there is a sign of overexposure.

Also, medical experts can prevent or minimize the risk in relation to health and safety by designing and providing the sites with safer machines and equipment (WHO Regional Office, 2002).

2.24.5 Treatment at Construction Site

Complications can be prevented and recovery can be achieved if site treatment is available. Economically, this is beneficial as it will save money, time, and the agony of traveling (WHO Regional Office, 2002).

2.24.6 Health and Safety Education

Health and safety education and counseling can be offered by occupational health and safety service. The occupational health and safety service can give advice to the workers in relation to certain topics important for their health and safety. For example, by informing those abuses of smoking or drugs and the benefits of exercise, the workers can improve their health and safety and productivity and they can minimize illnesses and other related problems. Organizing programs in relation to health and safety is another activity that can be done by the health and safety service (WHO Regional Office, 2002).

Chapter 3

HSFG SOFTWARE

3.1 Introduction

This chapter deals with developing the HSFG program. Xojo's language was used for programming the HSFG software because Xojo's language can be learned easily. Those who are experienced in programming will find Xojo's language powerful and strong. A short time is enough to accomplish a lot whether the user is a new or experienced programmer. Xojo's language can be characterized as a kind of builder. Its graphical user interface (GUI) is of the visual kind. This helps in creating one's own user interface by simply knowing how to drop. Interface controls have been provided by Xojo's language (Xojo, 2013).

Xojo's language is very accessible. Writing or debugging is easier with such programming language because there is a similarity between the writer's code and the real world in relation to objects. Figure 7 shows the feature of Xojo's programming language. (Xojo, 2013).

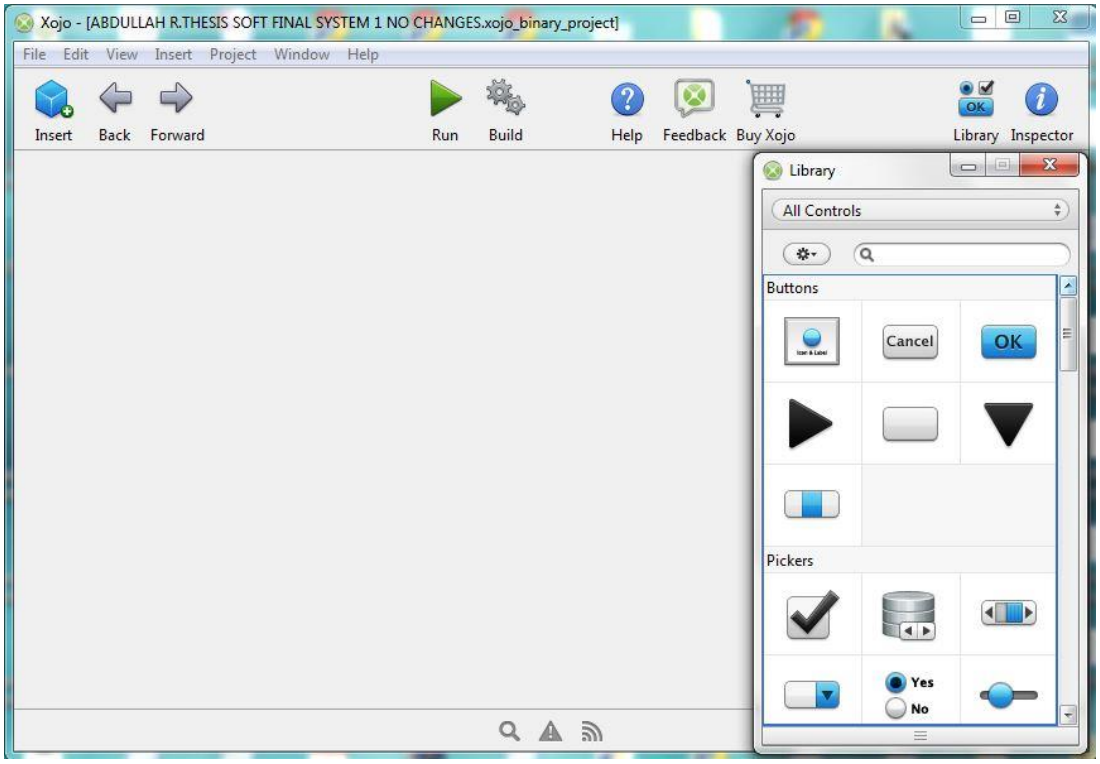


Figure 7: Feature of Xojo's programming language

There is no need to know the accessing route of the interface programming of a system. In this way, the development of the application is made easier and faster than it would be using other languages. There are commands in thousands existing in the application programming interface (API). The programmer does not need any of those commands in order to build his own applications using Xojo's programming language (Xojo, 2013).

3.2 The Advantages and Features of Xojo's Language

Having previously worked with programming tools such as Delphi and Visual Studio, and being in search of a cross-platform development, it will be found that Xojo's programming language had got all the features a programmer would be in search of using the following criteria:

3.2.1 Cross- Platform

By using Xojo's programming language almost no effort is needed to support Windows, Linux or Mac. This is because Xojo's programming language differs from other tools of cross-platform development. A user interface is created by Xojo's programming language for every single platform (Xojo, 2013).

The programmers using Xojo's programming language are helped greatly in creating the user interface. This is created with guidelines that are automatic. This is for "default control sizes", "spacing controls" and other items that can be moved to locations that are different. All this is based on the system of operation (Xojo, 2013).

3.2.2 Integration

Many databases and web technologies are integrated with Xojo's programming language, such as Microsoft SQL server (windows only), My SQL, Oracle and Posters.

3.2.3 Rapid Application Development

Xojo's programming language, when compared to C++ or Java, is four times faster, This helps to giving the programmer the ability to use software, test it and write in a faster way (Xojo, 2013).

3.2.4 Interface Toolset

Xojo's programming language permits drawing up/designing/operating menus, that are dynamic, quick, and with interface elements. This can be changed according to the queries of the database, image formats and checks that are conditional (Xojo, 2013).

3.2.5 Security

Xojo's programming language translates a code into a machine code that is secured. In this way, Xojo's programming language reduces the concern in relation to security when working with Java's byte code (Xojo, 2013).

3.3 Reasons Behind Choosing and Using Xojo's Programming Language.

There are many reasons for choosing Xojo's programming language to build and then use the HSFG program. Such reasons are:

- Minimal changes are required because of the stability of the database provided by Xojo's programming language.
- From Carbon to Cocoa is now the movement of Xojo's programming language. A good work is required to change the source code in order to comply with updates of other tools of development.
- In comparison to X code, a development time that is streamlined is offered by Xojo's programming language. This is seen in the availability of planning that can cover the needs or answer or support the problems that appear due to development (Xojo, 2013).

Xojo's programming language made things easy. This is markedly clear in the devices that use easy serial communication in relation to interfacing. Hence, the devices have been supported in a simple way through the serial port support within Xojo's programming language as follows:

- Working on reverse engineering through writing small apps has been made simple and quick by Xojo's programming language. An immense help is apparent in relation to memory block classes especially when the binary data

way is manipulated and then transmitted from the device to the application (Xojo, 2013).

- By the use of Xojo's programming language. a the development time is decreased. This means that the new interface can be mocked up quickly. This is quicker than what we can do with X code projects or project of visual studio. In this sense, clients can be provided with a quicker time (turn around) with their application requests (Xojo, 2013).

3.4 The HSFG sofware program

Xojo's programming language is used to build the HSFG program. The HSFG program will be beneficial to engineers on worksites as it is fast and can be used as a reference in the field of health and safety. It can be beneficial also to the new generation of engineers as an educational program. Figure 8 shows the interface and start screen of HSFG software program.

Figure 8: The start screen of HSFG program.

The HSFG program supports itself by using online tools such as a smart sheet. This gives the flexibility to write and make plans. This can be applied in planning health and safety of a site or processing any kind of project management system online. Many reasons are behind using the smart sheet online tool. It is used in the HSFG program because of its flexibility, and easiness in making comparisons with saving data.

The HSFG has its own data saved in the program in relation to the health and safety plan in the field of construction. As well as using a smart sheet, it will fix a lot of problems as it is an online tool. It will remedy the problem of communication between the engineers. In this sense, the manager can send his plan online directly to the other engineers.

By saving this data in this tool online any engineer who has access, can see the latest updates in the management plan whether it is related to health and safety or any other issue that is in need of resolution as a team by engineers in different locations.

3.5 What is Included in HSFG

As the construction industry includes different activities, HSFG software includes a variety of approaches to problems related to health and safety on construction sites.

First of all, the program clarifies and elucidates the problems that could take place on construction sites, defiance the issue and the way it takes place. Secondly, the program deals with the measures and the information that should be undertaken or known to minimize these problems. Figure 9 clarifies the location of the problems inside the program.

Figure 9: Location of Activity Tabs inside the program.

The program deals especially with the problems related to health and safety on construction sites. The program deals with excavation collapse, falling materials, people or vehicles falling in excavation.

The program also deals with the formwork in relation to stripping, jumping, or falling from the formwork. Scaffolding is another issue that is fully tackled by the program, the scaffolding environment, the design of scaffolds and the safe operation of scaffolding are all thoroughly examined. Working at a height is another concern that comes under scrutiny. Here, there is a reference to the falling arrest system, protective equipment, and ladder and edge protection. Finally, the program refers to the problem of working on roofs and how to protect people from all aspects of the danger. Therefore, the main tabs in the HSFG program are:

- Excavation
- Formwork
- Scaffolding

- Work on Height
- Work on Roof

3.5.1 Excavation

Excavation means a dug out area of ground and includes a deep foundation excavation, trench, tunnel and shaft and open excavation means an excavation in which the width is greater than the depth, measured at the bottom. Work injuries or fatalities continue to exist in the industry of excavation, this is because worker or employer forget the idea that they are creating and opining when they remove soil from the ground.

A healthy and safe work place should be provided within the area of excavation; otherwise, excavation will be a problem as shown in the following pages (HSA, 2004; HSE, 1996).

3.5.1.1 Excavation collapse

1) Hitting the side and the ends at a safe angle prevents collapse. If battering is not possible, the walls can be supported by timber or any other suitable supporting material.
2) Excavation work should not commence unless the excavation site has been supported or battered in a suitable way
3) Excavation areas should be cordoned off from people for fear of working in front of the support is not acceptable.
4) It is dangerous to work in trenches that are shallow. A support is needed in the case of having to bend or kneel.

Figure 10 And Figure 11 show how to reach the recommendation of excavation collapse issue in the HSFG program and what has been described previously is the content of the tab after the selection

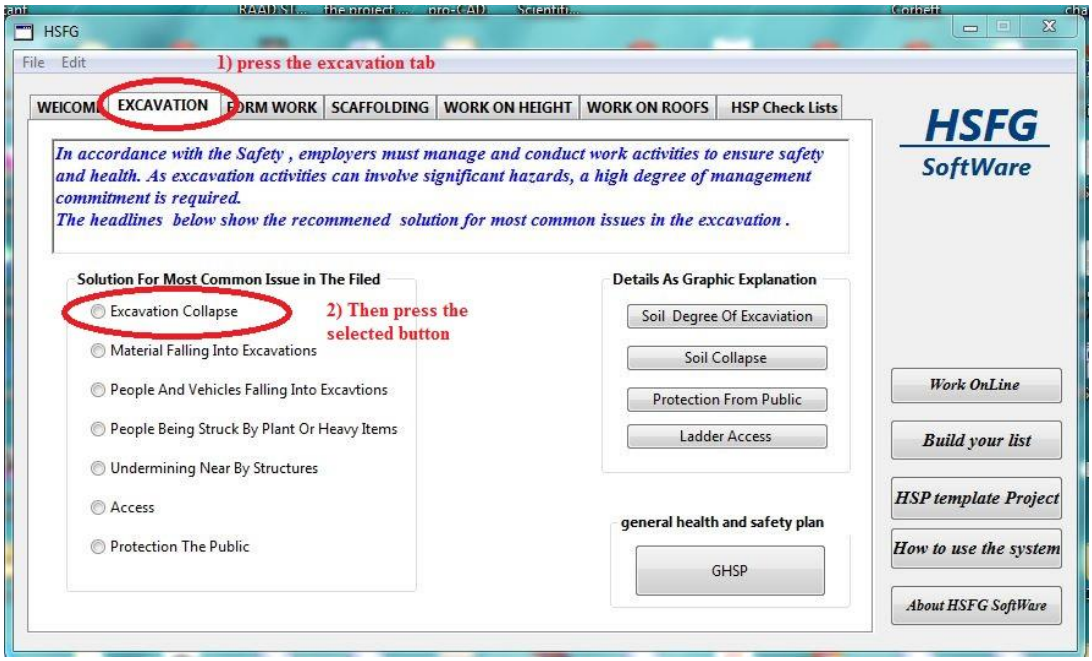


Figure 10: The location of excavation collapse

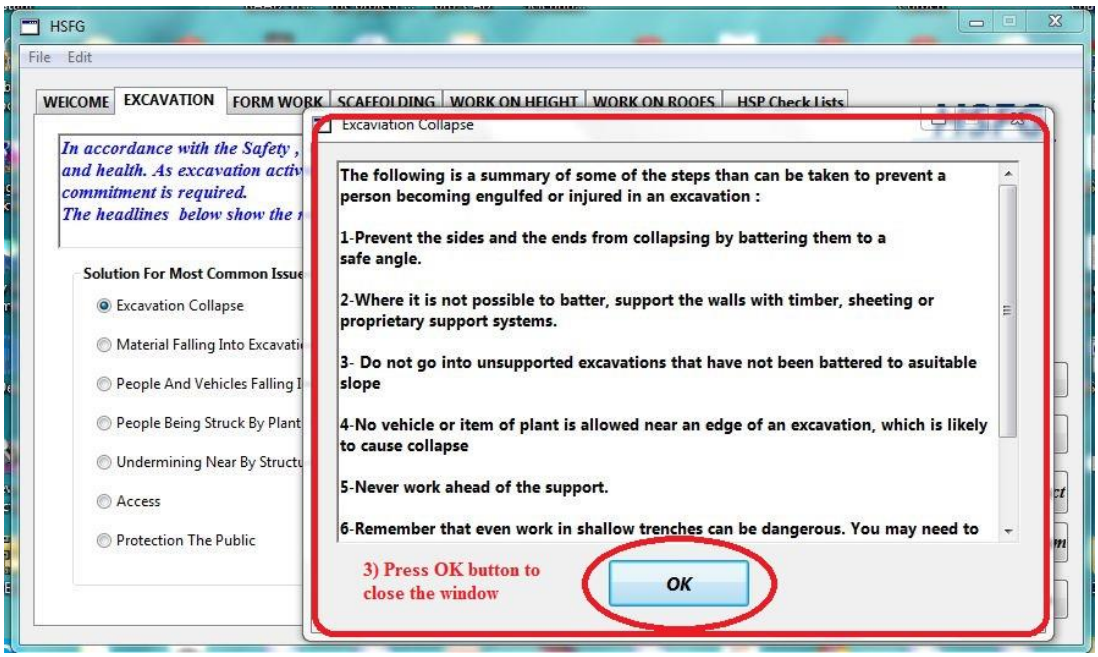


Figure 11: The solution of excavation collapse

3.5.1.2 Material falling in excavations

The falling of materials into excavation should be treated through the following steps:

1) Waste material should be kept at a safe distance from the collapse sides of the excavation site.
2) The edges of the excavation site should be protected against falling materials.
3) Protective clothing and headgear should be worn by workers on the excavation site.
4) Netting is advisable when there to protect against falling rock on rock excavation sites (HSA, 2004).

Figure 12 and Figure 13 show how to reach the recommendation of material falling in excavation issue in the HSFG program and what has been described previously is the content of the button after the selection.

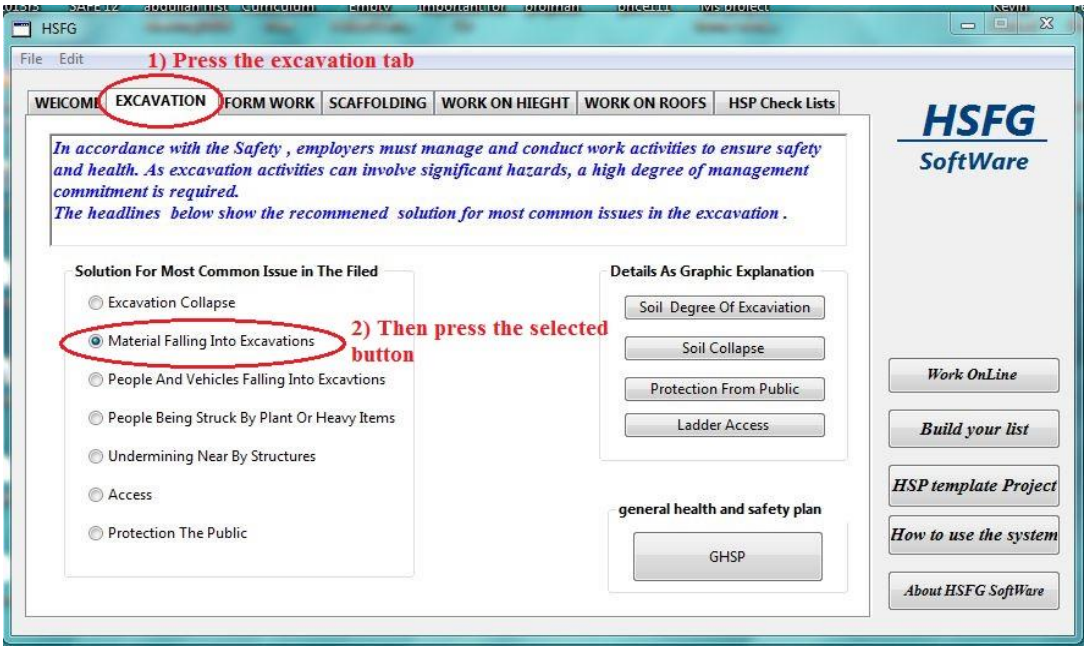


Figure 12: The location of material falling in excavation

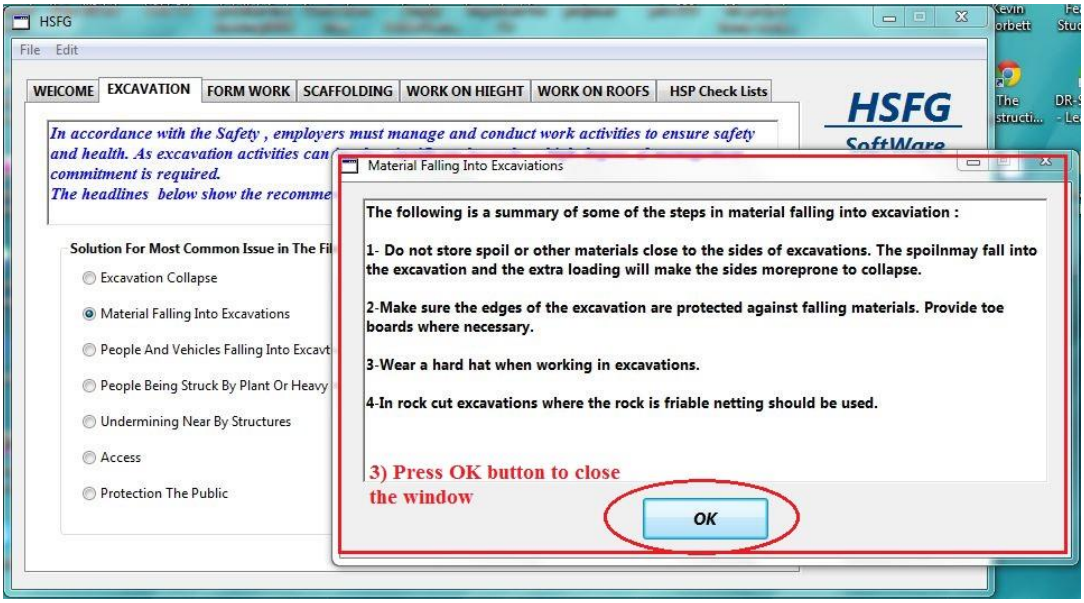


Figure 13: The solution of the material falling into excavation

3.5.1.3 People and vehicle falling into excavations

To prevent the falling of vehicles or people into excavation sites the following precautionary steps are recommended:

1) Toe boards and guardrails should be provided as barriers against the danger of people falling.
2) Vehicles should be kept at a safe distance from the excavation site. Barriers or stop blocks can be used to this end.
3) Vehicles tipping material from the site can be prevented from over-running with the provision of stop-blocks.
4) Workers should be prevented from being in the excavation area when a working machine is in operation. Collapse may be caused due to the additional weight of the machine (HSA, 2004).

Figure 14 and Figure 15 show how to reach the recommendation of vehicles falling into excavation issue in the HSFG program and what has been described previously is the content of the tab after the selection.

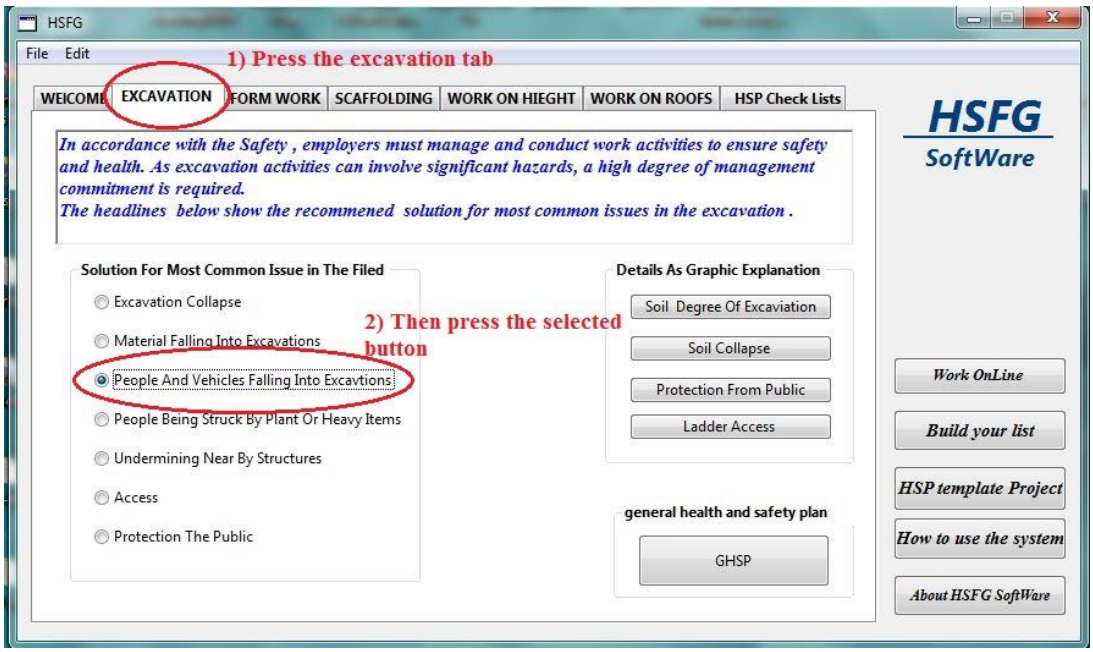


Figure 14: The location of people and vehicles falling into excavation

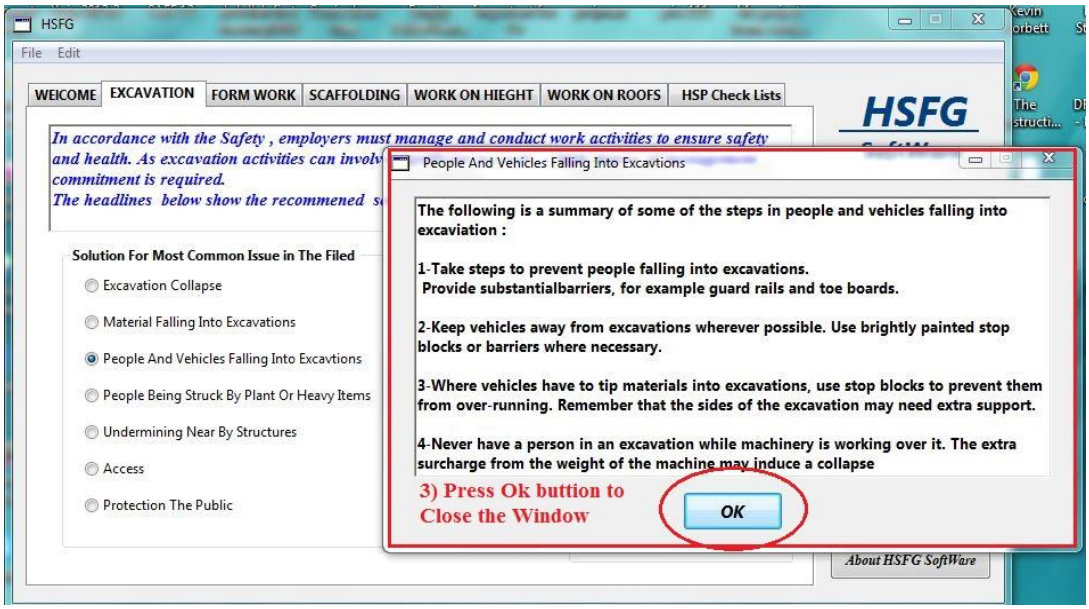


Figure 15: The solution of people, vehicle falling into excavation

3.5.1.4 People stuck by plant and heavy items

When workers are impeded by the presence of machines or other materials, the following precautions are advised:

1) Moving machines should be removed to a safe distance from worker activity. Workers, for examples, must not be in close proximity to the bucket of an excavator. Further safety features and procedures should be included.
2) Workers should be skilled and trained.
3) Mobile work equipment such as articulated dump trucks, must be fitted with auxiliary visibility aids because of their reduced visibility when in motion.
4) All attachments should be securely fastened.
5) In order to carry out work to guide workers, a trained person suitably equipped with the knowledge to perform the task should be employed to fix and check lines.
6) An official list or record of equipment and tests must be maintained and be available at all times (HSA, 2004; COSH, 2005).

Figure 16 and Figure 17 show how to reach the recommendation of the people being sucked by plant or heavy items issue in the HSFG program and what has been described previously is the content of the tab after the selection.

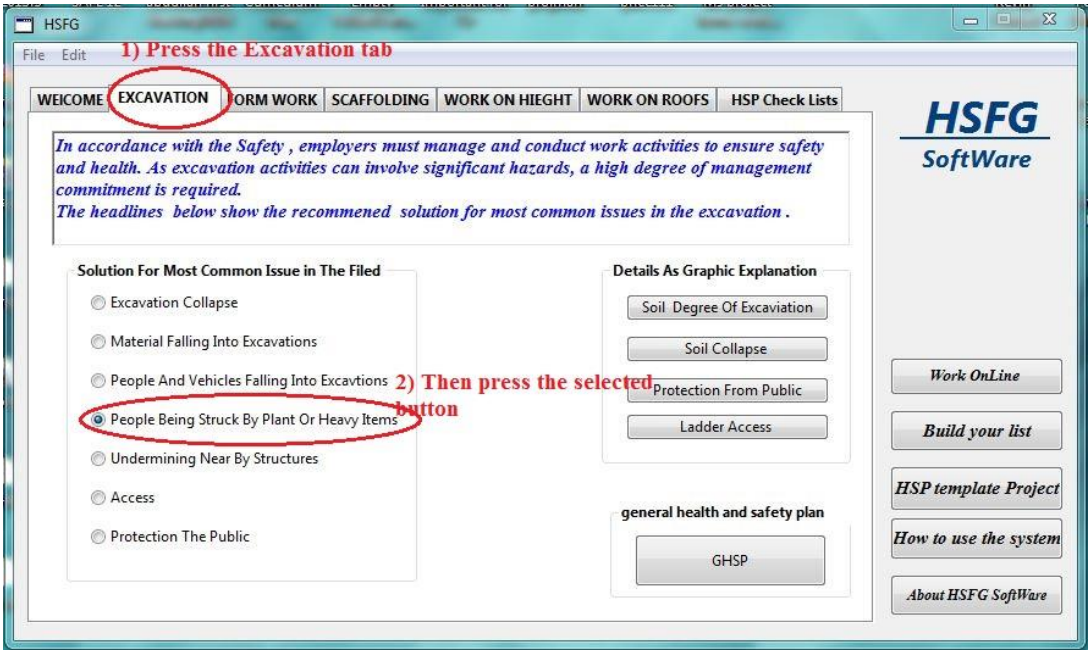


Figure 16: The people being sucked by plant or heavy items

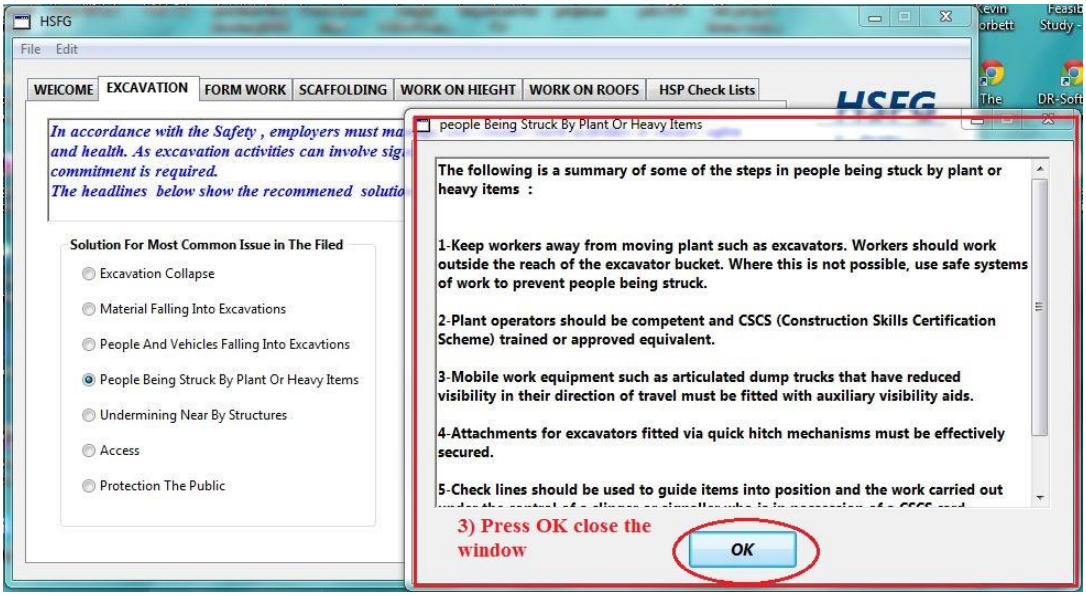


Figure 17: The result of the button people being stacked by heavy items

3.5.1.5 Undermining nearby structure

Digging close to a structure must be carried out as follows:

1) The position or status of scaffolding as well as the base of nearby structures such as foundations should not be affected by excavation.

2) Before digging commences, it should be ascertained by an engineer as to whether the structure is in need of support.
3) The structure's stability should be kept throughout the process of excavation. This means that additional support is sometimes needed to maintain the integrity and strength of the structure (HSA, 2004; COSH, 2005).

Figure 18 and Figure 19 show how to reach the recommendation of undermining nearby structure issue in the HSFG program and what has been described previously is the content of the tab after the selection.

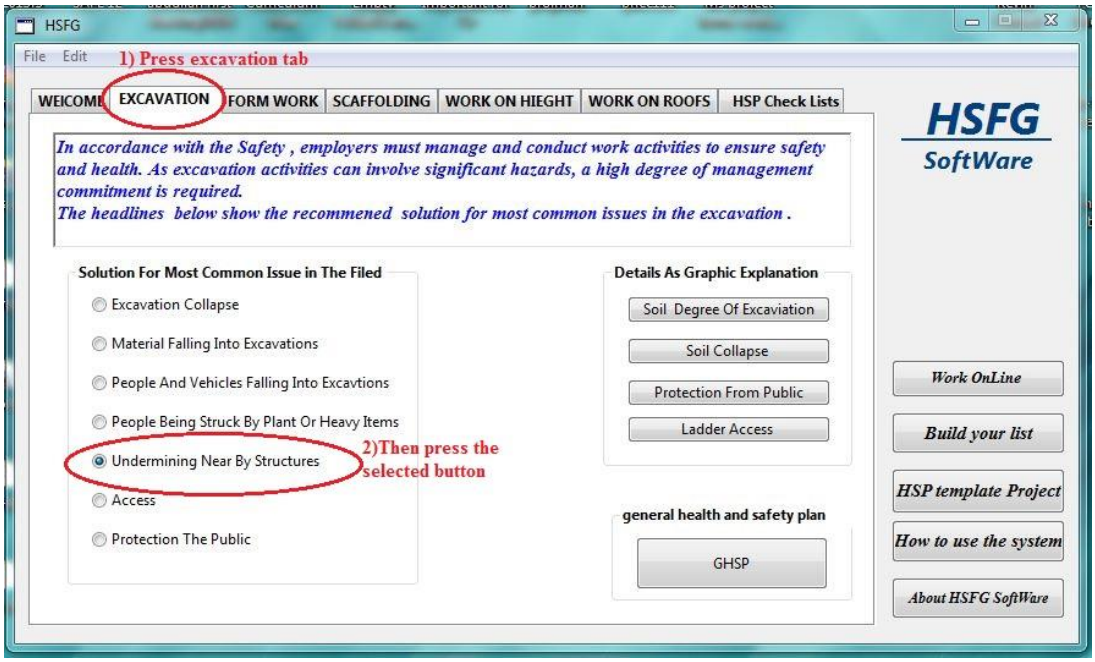


Figure 18: The location of undermining nearby structure

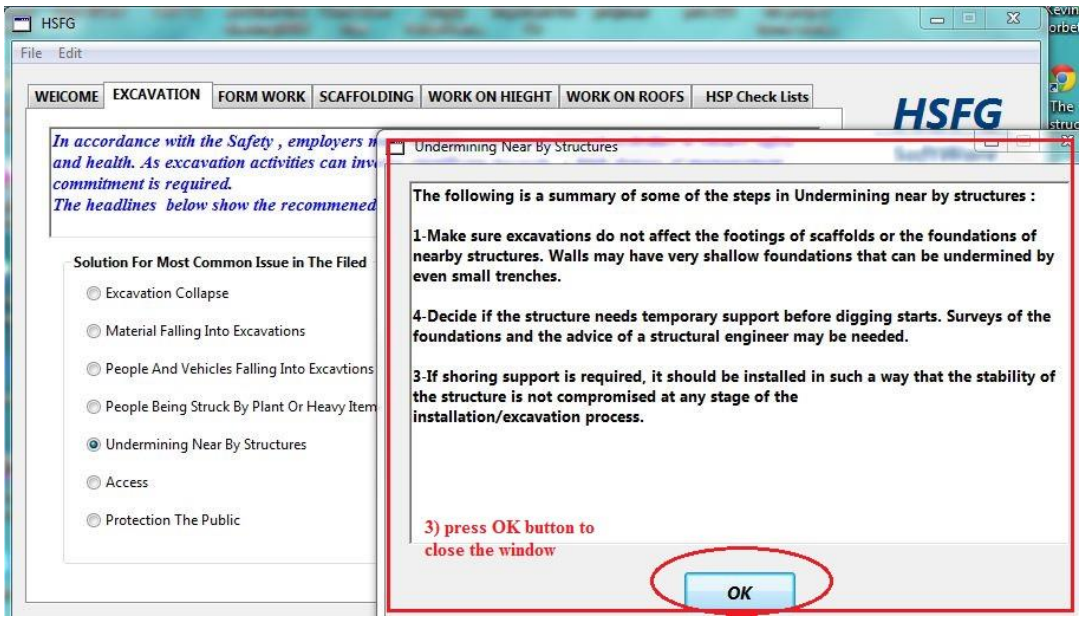


Figure 19: The result of the button undermining nearby structures

3.5.1.6 Access

Access to and exit from the excavation site should be facilitated in the following ways:

1) A good ladder or an alternative climbing device should be provided.
2) Safety emergency procedures in accordance with standard codes of practice should be in place for particular areas of danger like trenches that are small and fully surrounded (HSA, 2004; AXA, 2006).

Figure 20 and Figure 21 show how to reach the recommendation of Access in excavation issue in the HSFG program and what has been described previously is the content of the tab after the selection.

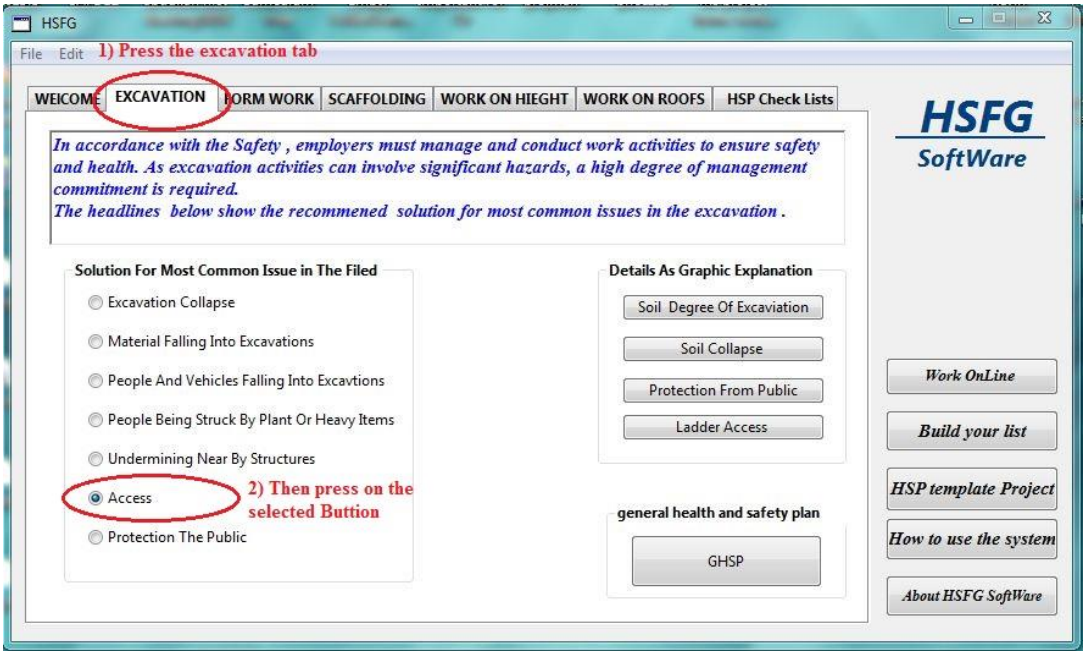


Figure 20: The location of the access in excavation tab

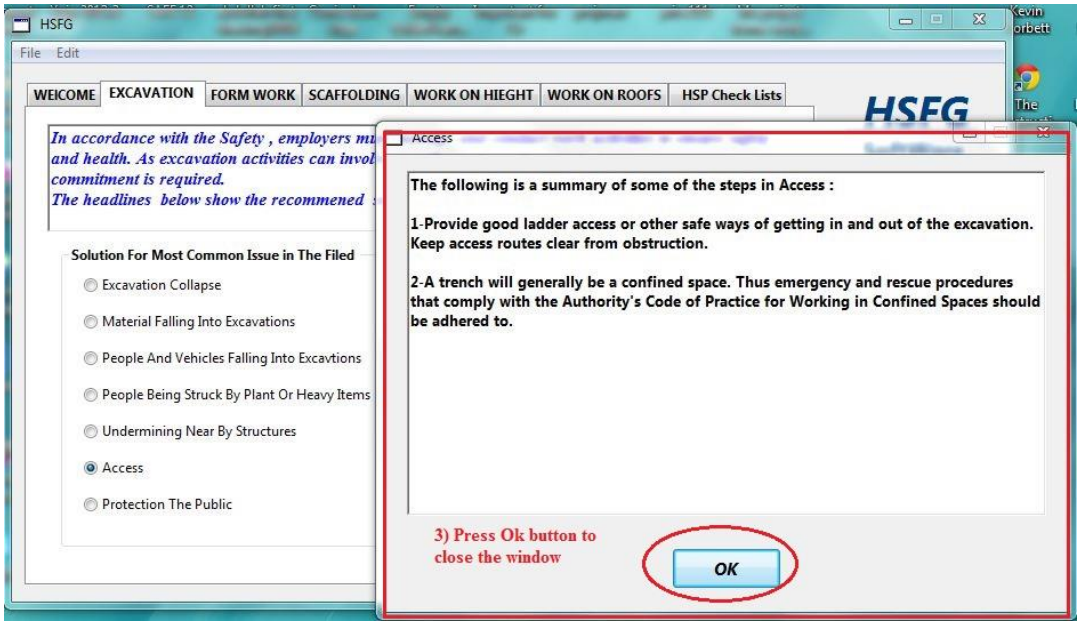


Figure 21: The solution of the access problem in the program

3.5.1.7 Protecting the public

The following steps should be followed to protect the public from danger:

1) Public places in proximity to excavation sites should be fenced off in order to avert the danger of people falling into them.

2) Particular attention should be given to safeguarding the well-being of children who might inadvertently find themselves on the excavation site.
3) Covering or backfilling excavations on public roads at night will safeguard the public against the possibility of accidents.
4) Light and signs should be provided and be clearly visible on all roads or paths. It is also recommended to have guards as a further precautionary measure against accidents.

Figure 22 and Figure 23 show how to reach the recommendation of protection the public issue through the excavation process in the HSFG program and what has been described previously is the content of the tab after the selection.

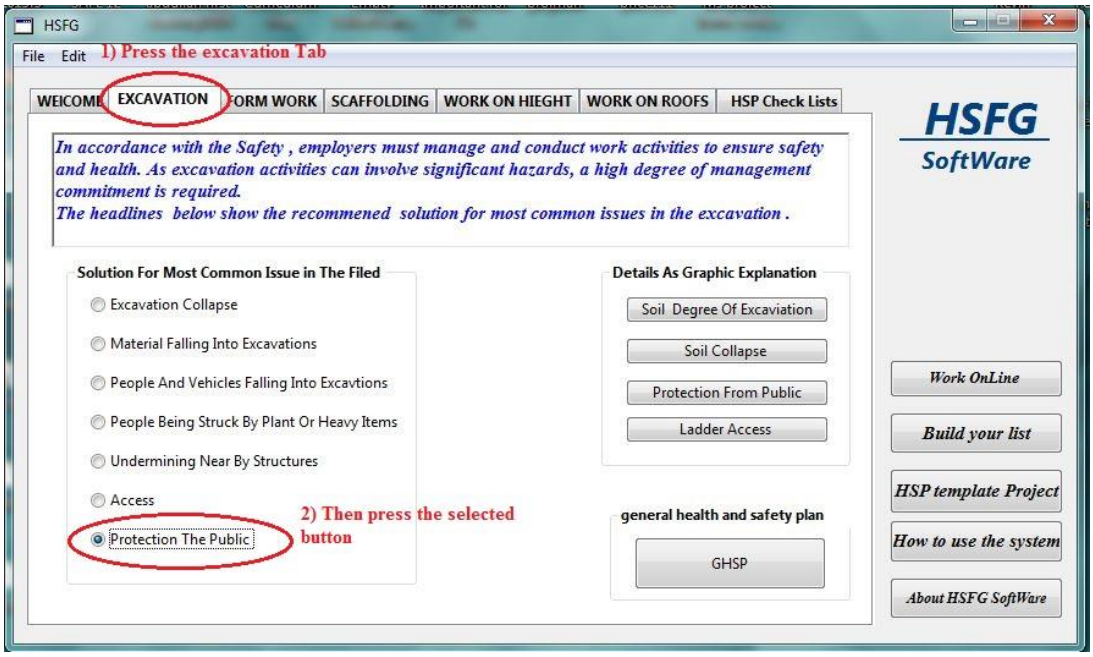


Figure 22 :The location of protection the public in excavation tab

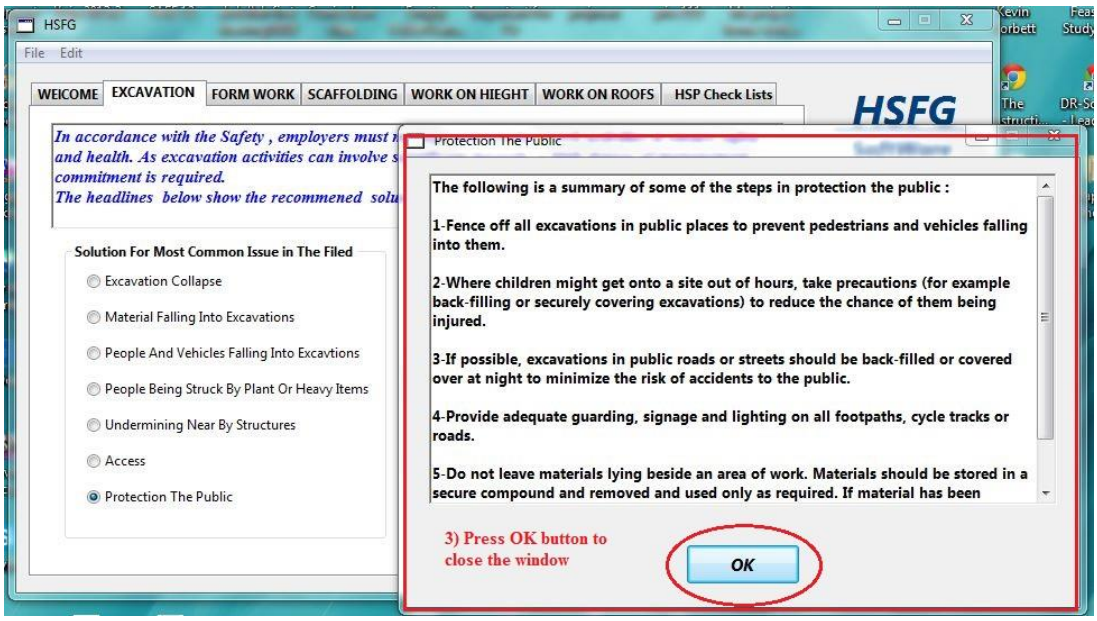


Figure 23: The solution of the problem of protection the public

3.5.2 Formwork

Permanent structures, in whole or in part can be supported by temporary ones such as false work and formwork. When components are joined and fully assembled a temporary structure can be put-in place or make them assembled. However, it is sometimes necessary to keep the false works and form work alongside the permanent structure. Both false and form works are known as structure work. They remain part of the construction, the maintenance or the design (SWA, 2012; WHS, 2006).

Figure 24 shows how to shift from the Excavation tab to Formwork tab into in HSFG program and what has been described previously is the introduction content of the tab after the selection.

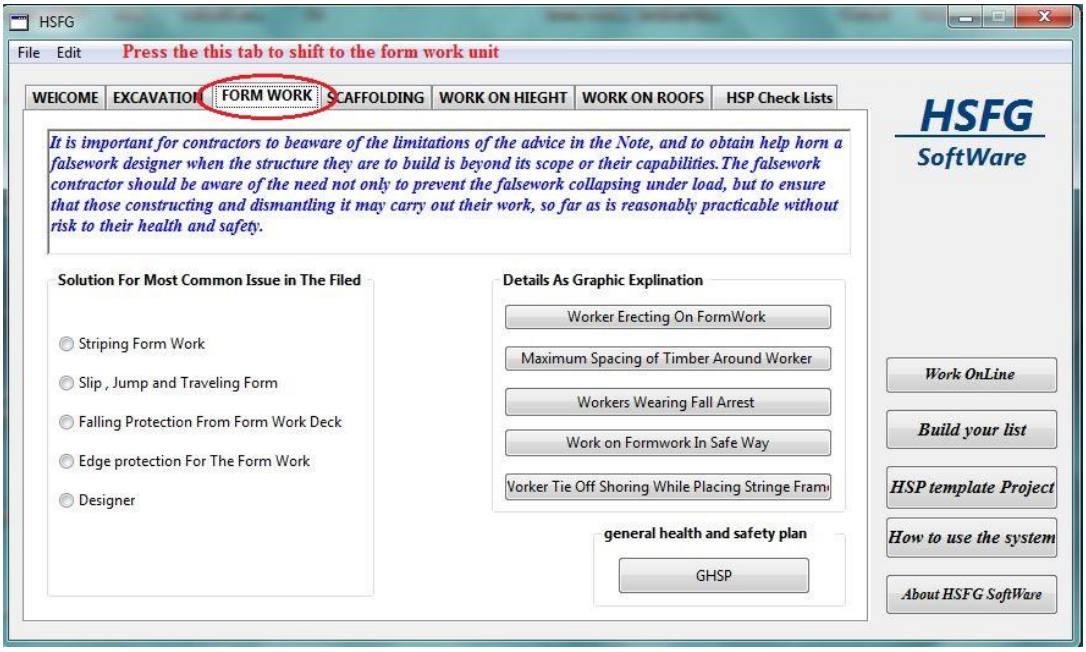


Figure 24: Location and how to shift to another tab which is formwork tab

3.5.2.1 Stripping formwork

The following should be taken into consideration:

1) The number of workers in each group.
2) The order in the work of stripping giving details regarding how materials or items will be removed.
3) To remove completely or lower partially the support system before the formwork is removed or allow to remain under the form ply.
4) Fixing items like nails should be removed before the components are stacked.
5) Reduce the percentage of damage in relation to the components.
6) In arranging the objects of the formwork, all efforts should be made not to block either the access routes or the areas of work. Parts of the formwork should not be discarded by throwing them from a structure or building. The ends of bearers are not supported by flatheads (Safe Work, 2012; SWA, 2012).

Figure 25 and Figure 26 show how to reach the recommendation of stripping formwork issue in the HSFG program and what has been described previously is the content of the tab after the selection.

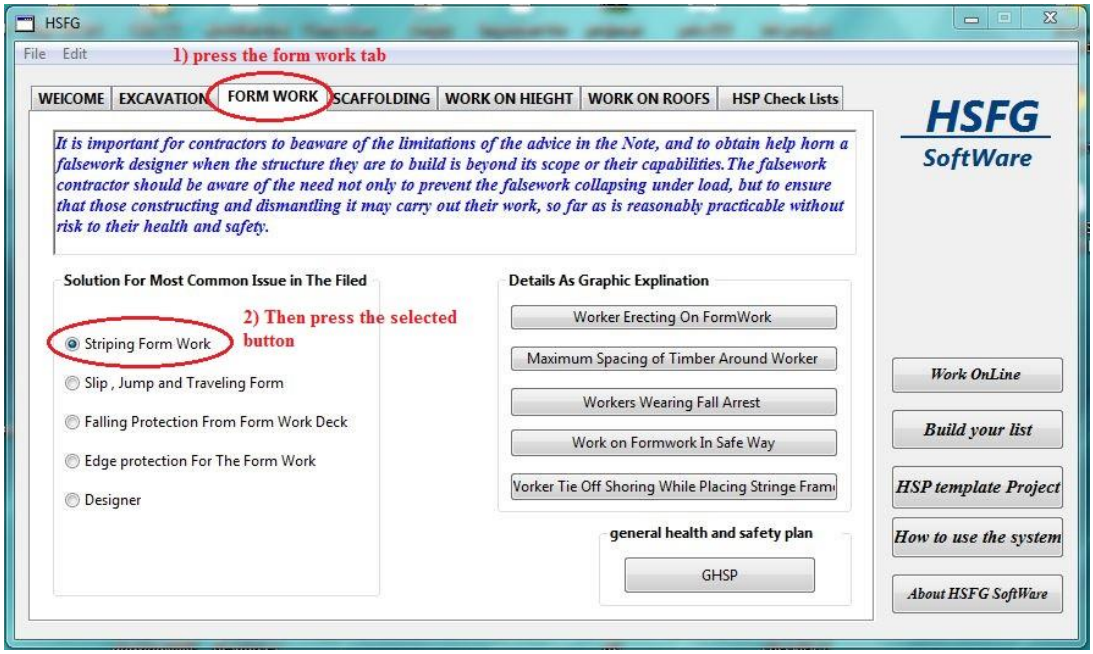


Figure 25: Location of stripping formwork

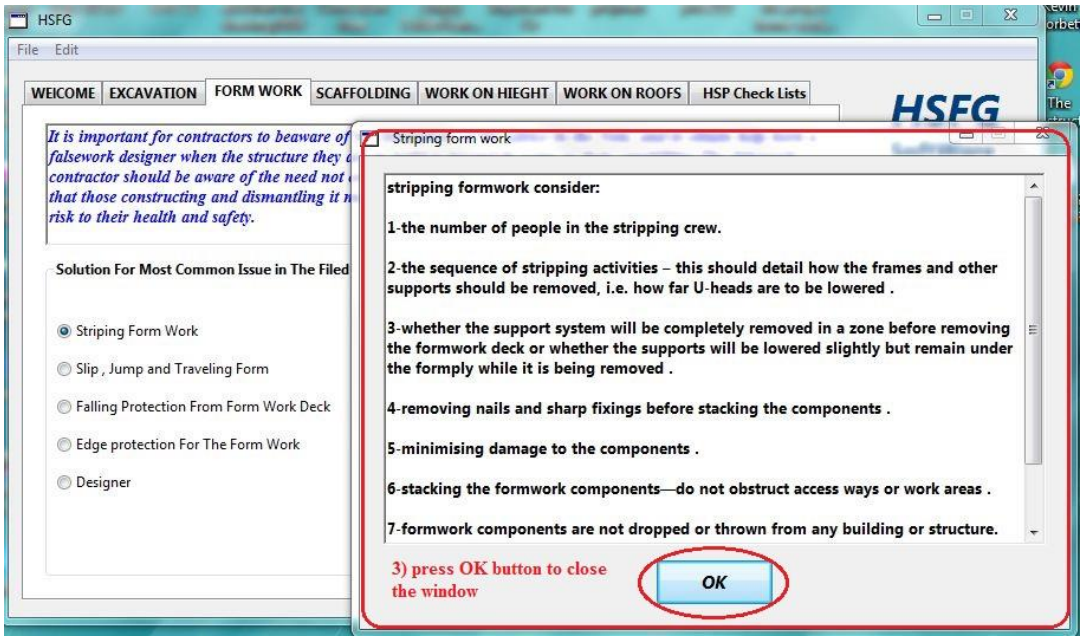


Figure 26: Solution for the stripping formwork problem

3.5.2.2 Slip, jump and traveling form

In slip, jumping and traveling form, some steps should be followed:

1) All areas of work should be provided by safe entries. It is recommended that emergency entry and stair access entry be included.
2) Working areas at a height are always a potential risk and should be carefully controlled.
3) Enough space for work should be provided.
4) Shutters and other parts need to be handled properly, so appropriate methods should be specified and safe entry for people should be provided.
5) Bringing back to the work area, the person who is injured without affecting on his life can return to the work or disabled (SWA, 2012).

Figure 27 and Figure 28 show how to reach the recommendation of traveling form and slip or jump issue in the HSFG program and what has been described previously is the content of the button after the selection.

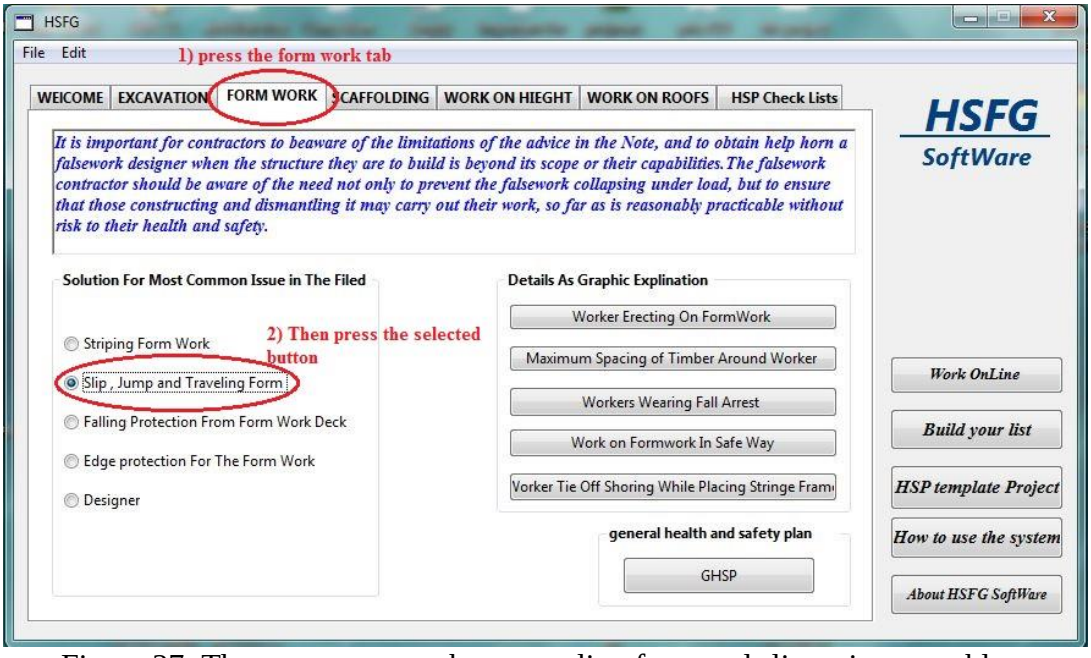


Figure 27: The process to reach on traveling form and slip or jump problem

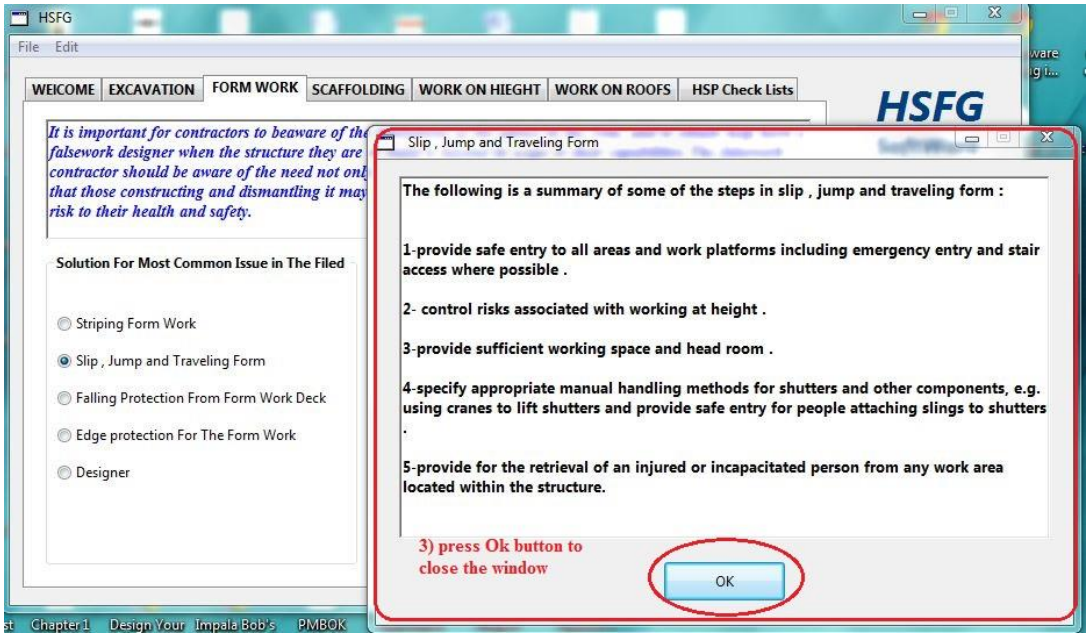


Figure 28: The solution of the slip, jump and traveling on formwork tab

3.5.2.3 Falling protection from work deck

1) Modeling the measures of fall protection is a necessary step as there are continuous changes throughout the construction formwork.
2) Fall protection should be provided solely to the leading edge. As far as the other edges should be equipped with appropriate safety apparatus.
3) It should be made clear that it is difficult to put in place and ensure fall protection if all parts of the deck are not at the same level or there are too many leading edges.
4) Keeping in mind the difficulties in maintaining a uniform deck level and with consideration of the varying number of leading edges, building designers should provide floor slabs with the same thickness (SWA, 2012).

Figure 29 and Figure 30 show how to reach the recommendation of falling protection in formwork issue in the HSFG program and what has been described previously is the content of the button after the selection.

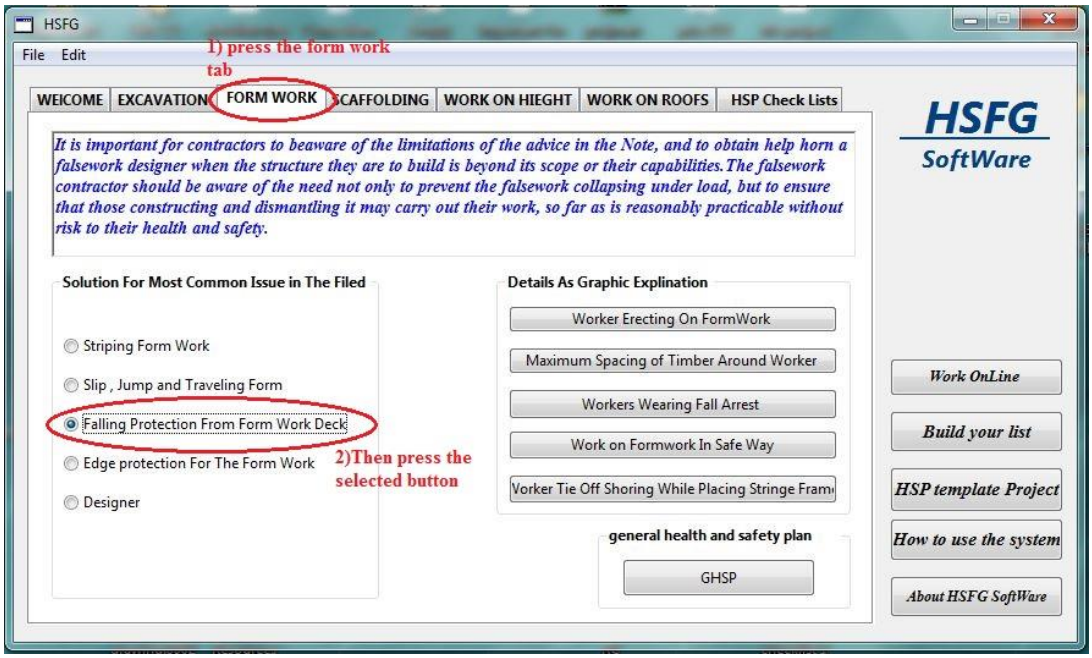


Figure 29: The location of the falling protection in formwork tab

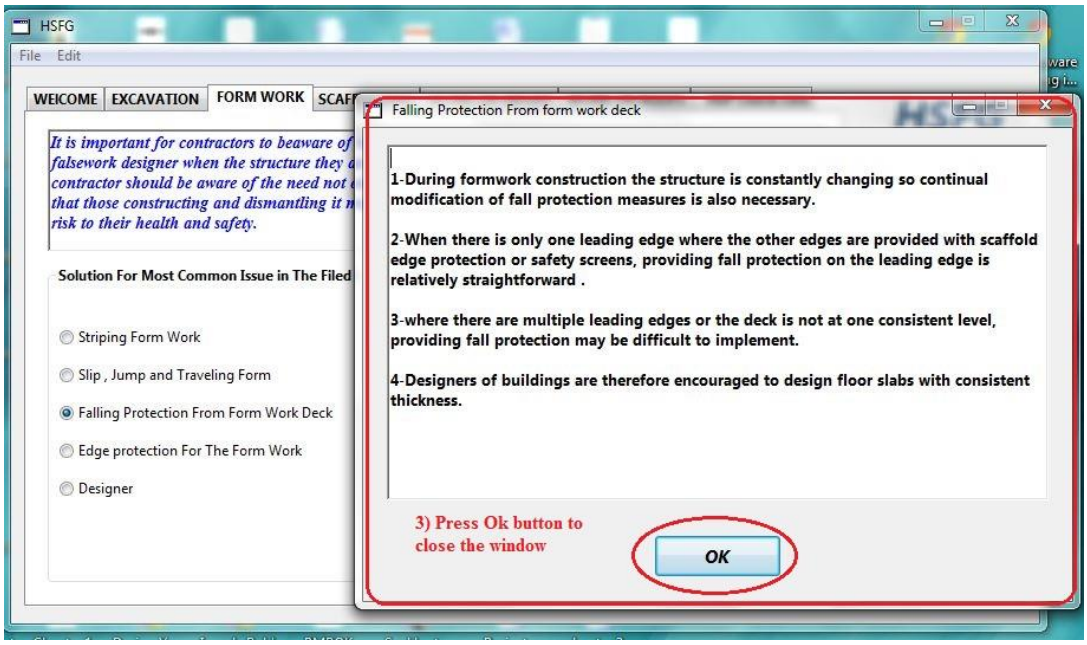


Figure 30: The solution of the falling protection in formwork tab

3.5.2.4 Edge protection formwork

1) When constructing a deck with variations in height, consideration should be given to the supporting places, beams and the thickness of the supporting material.
2) Special attention should be taken and care given when there are unblocked or unsigned form decks and there is a need of non-workers to go onto the deck.
3) Open stairwells or lift shafts should be well-signposted and safety measures taken to minimize the risk of injury to persons (Safe Work, 2012).

Figure 31 and Figure 32 show how to reach the recommendation of edge protection in formwork issue in the HSFG program and what has been described previously is the content of the button after the selection.

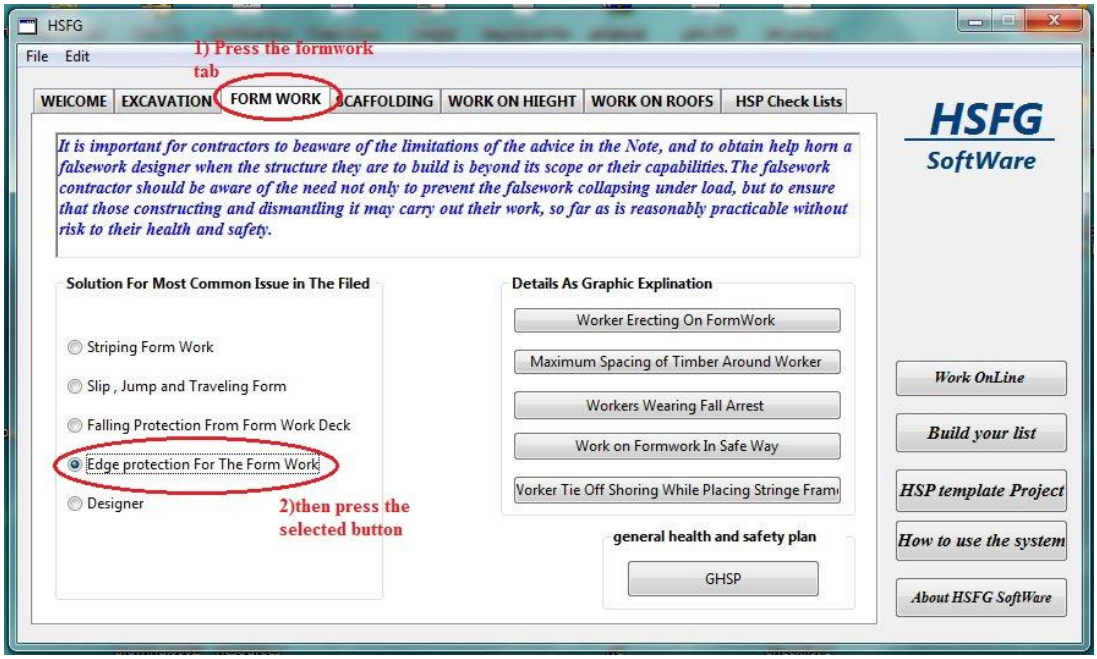


Figure 31: The location of edge protection in formwork tab

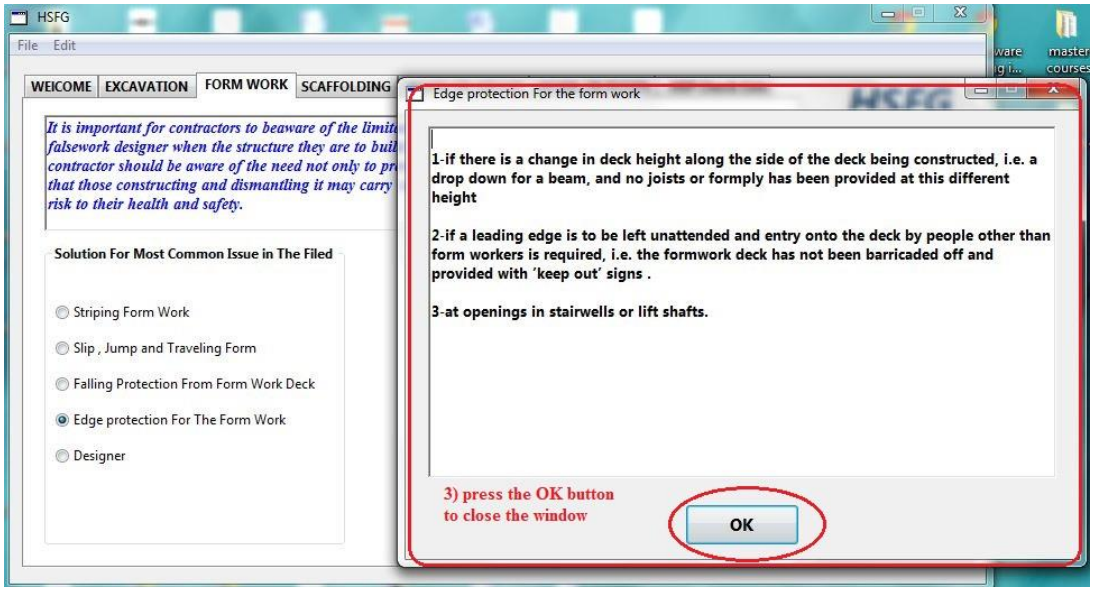


Figure 32: The solution of edge protection in formwork tab

3.5.2.5 Designer

1) The minimum required strength of the concrete before climbing.
2) The amount and strength of loads like wind loads or dynamic ones.
3) The amount of loads from work activity and workers's use.
4) The amount and effect of added loads as when materials are being lifted.
5) The amount of-unusual loads that may be added as a requirement of the form during the process of building the form.
6) It is advisable to calculate the possibility of the form being off level (maximum degree) due to the amount of loads. It is also recommended to envisage the procedures to be adopted to limit this possibility as well as the actions to be taken when the form is off level. Fire protection should be provided.
7) Electrical connections should be appropriate.
8) In situations of extreme heat, workers should have safe areas provided for them.

9) In designing the form, provisions should be made for situations when there is the need for a rescue operation. These should include designated entry and exit gates to best facilitate the operation (SWA, 2012; Safe Work, 2012).

Figure 33 and Figure 34 show how to reach the recommendation of designer problem in form work issue in the HSFG program and what has been described previously is the content of the button after the selection.

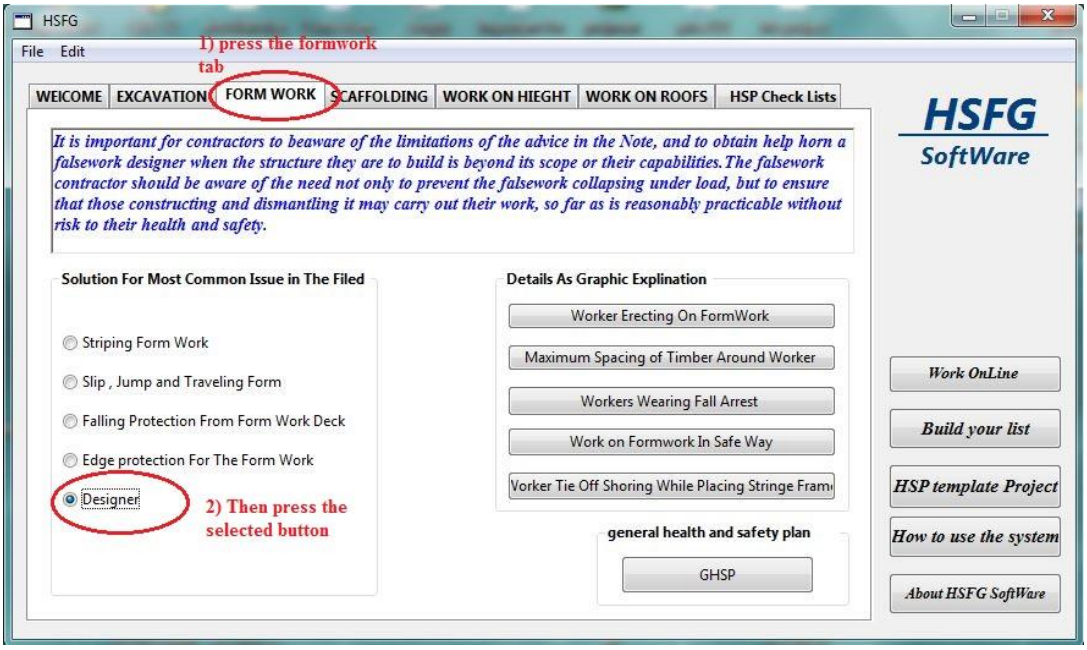


Figure 33: The location of designer problem in formwork tab

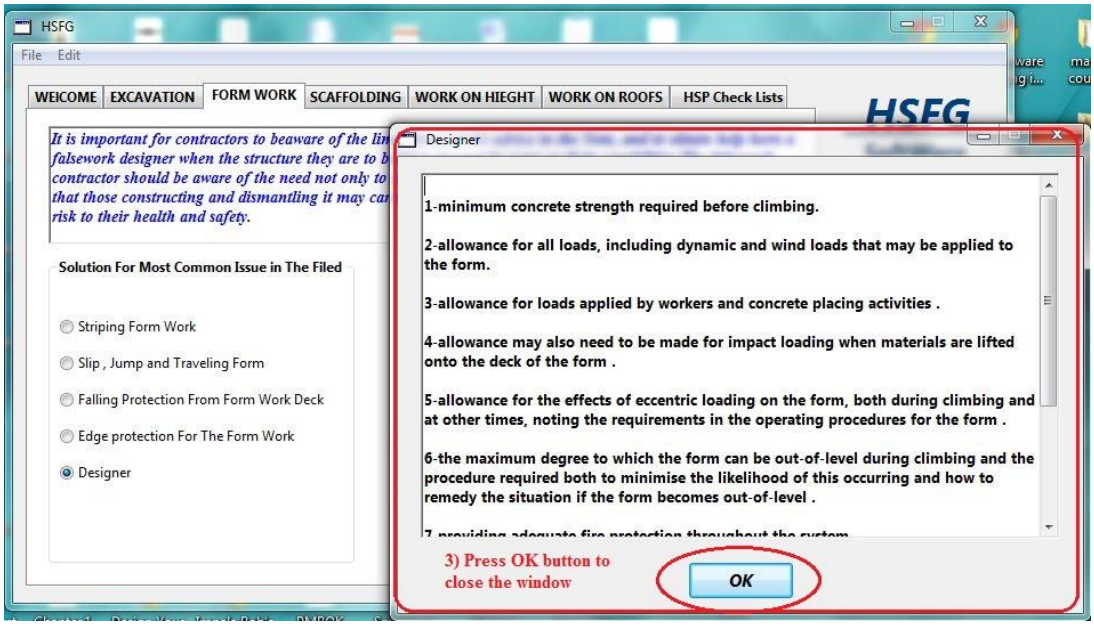


Figure 34: The recommended solution for the designer in formwork tab

3.5.3 Scaffolding

In construction work it is essential that metal scaffolding is used as the supporting factor in a false work system.

There are many causes to explain the collapse of a false work system. Included among these is insufficient strength to withstand the loads imposed on it, the weaknesses in the original design which have resulted in serious or fatal injury to those working on such defective scaffolds. The fall or collapse of such structures can be prevented by good practices highlighted by the code of practice (OCSH, 2011).

Principles of engineering should be taken into consideration, as well as national or international standards. These principles and standards are wed to justify the strength and stability of scaffolds. This is because the required standards of health and safety in the work of scaffolding need to be attained (OCSH, 2011).

Figure 35 shows how to shift from the Formwork tab to Scaffolding tab into in HSFG program and what has been described previously is the introduction content of the tab after the selection.

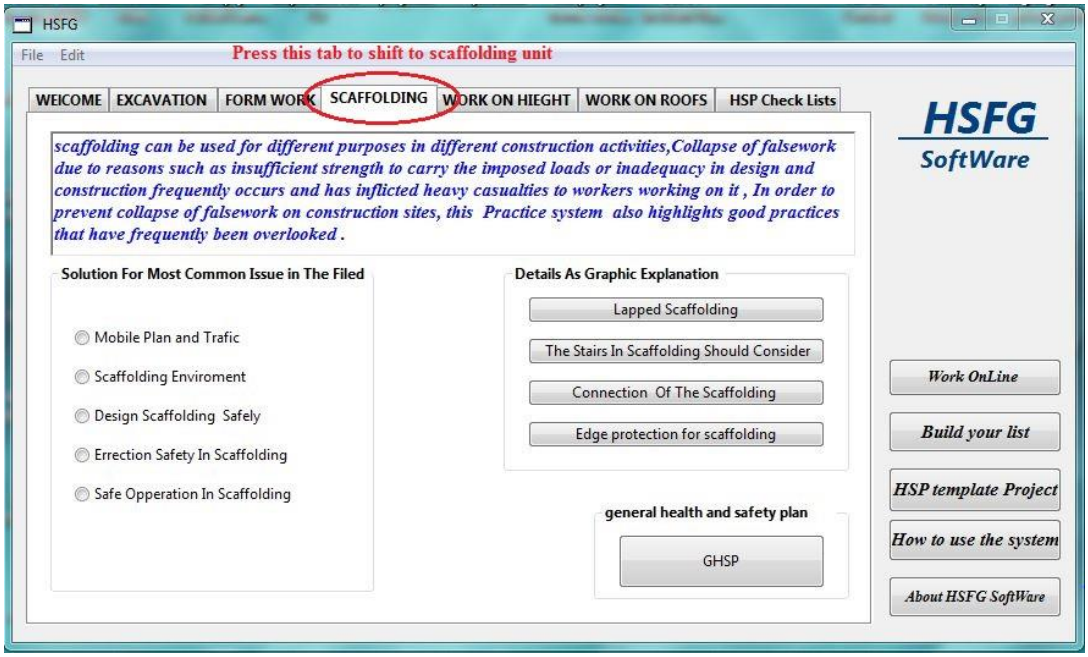


Figure 35: Shift to scaffolding tab and it location in the software

3.5.3.1 Mobile plant and traffic

Measures of control that can be carried out in the case of movable scaffolding are the following:

1) If not otherwise instructed by the designer or manufacturer, the scaffold should not exceed in height the base dimensions multiplied by a factor of three.
2) Only 5 degrees of surface slope is allowable if scaffolds with wheels are being used.
3) When getting on or off a scaffold, a ladder with an opening for security should always be used.

4) For scaffolding on wheels the total mass of loads should be estimated when determining the capacity and size of the wheels. The castors to be used should be marked clearly with the limit of the working load.
5) It is advisable to lack the castors after fixing them to a certain level before continuing with the assembling of the scaffolding.
6) It is advisable to use the kind of castors that have adjustable legs in order to keep the level of the platform constant especially when the scaffolding is being erected at different heights.
7) In order to have stability, the base of scaffolds should have braces.
8) When the mobile scaffold needs to be moved to another place, it should be observed that:
    a. There are no obstructing power lines.
    b. The ground level is checked.
    c. No person is on the scaffold.
    d. No materials or equipment from the platform is forced from its position.
    e. There is no obstruction that might cause the scaffold to overturn scaffold.
    f. Leads from electrical tools should not become entangled. (OCSH, 2011), (Department of justice and attoney, 2009).

Figure 36 and Figure 37 show how to reach the recommendation of mobile plant and traffic in scaffolding issue in the HSFG program and what has been described previously is the content of the button after the selection.

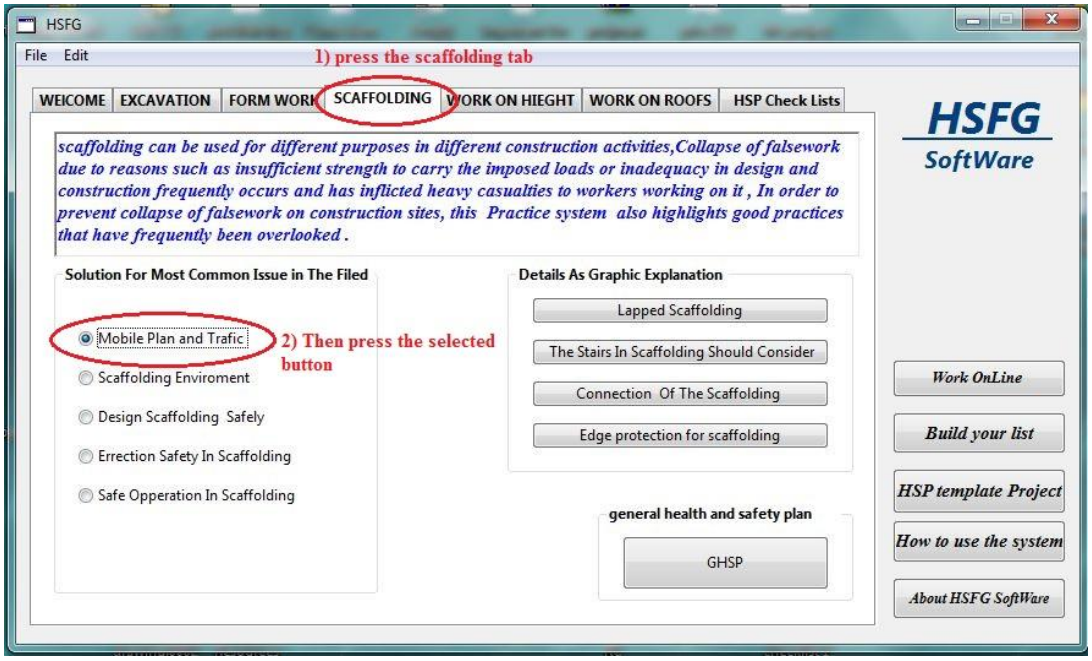


Figure 36: The first issue in scaffolding and how to reach it

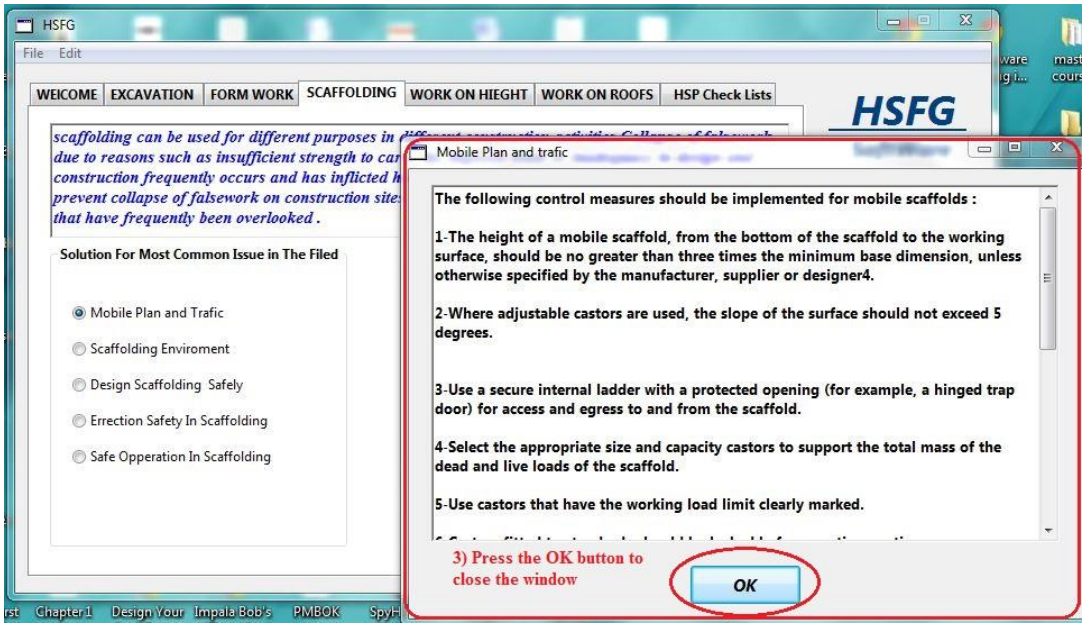


Figure 37: The solution of the first issue mobile plan in scaffolding tab

3.5.3.2 Scaffolding environment

1) Special controls and protection should be provided when a scaffold is erected over a public place or property. For example, it is necessary to have blocking materials, boards or fences.

2) Special controls like boards or platforms are also needed when workers are beneath suspended scaffolds.
3) Suspension parts such as raps should not come close to any power lines. The minimum space allowed is 4.6m. Many problems are caused by power lines being too close to scaffolding parts.
4) Workers should assume that all power lines are live if not otherwise informed by their employers. Given times should be given by the employer showing the distribution of power.
5) The risk factor and hazard potential of places or areas should be calculated against the kind of machines that are likely to be used in the work. This is in order to protect workers against the possibility of accident or injury. By way of example, dusty areas run the risk of explosion when electrical equipment is being used (OCSH, 2011; Department of justice and attoney, 2009).

Figure 38 and Figure 39 show how to reach the recommendation of scaffolding environment issue in the HSFG program and what has been described previously is the content of the button after the selection.

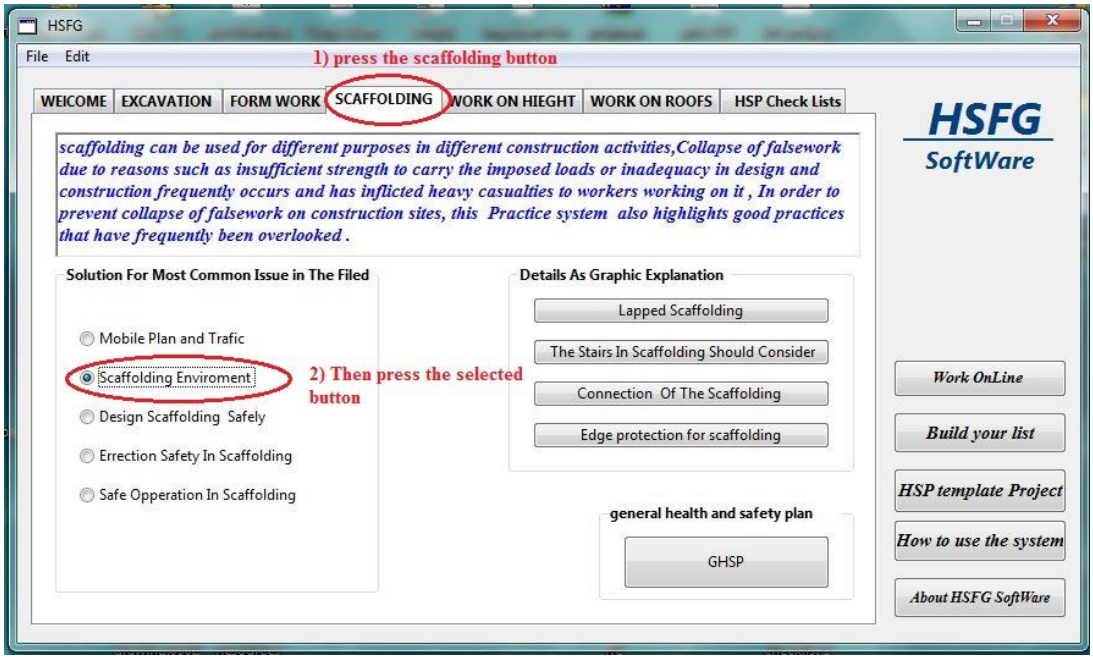


Figure 38: The location of scaffolding environment

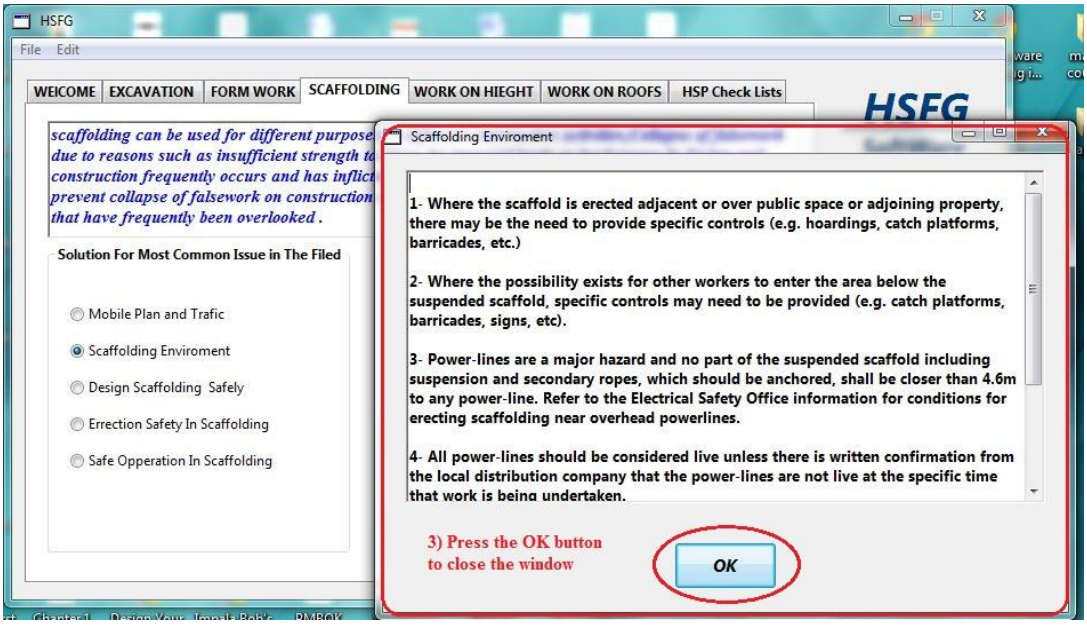


Figure 39: The scaffolding environment solution

3.5.3.3 Design scaffolding safely

1) Before fixing the scaffolding, it should be assured that the structure to which the scaffold is to be fixed is liable to hold different kinds of loads. This should be provided in a written assessment by the required authority.

2) A full description of the plan designed for each scaffold especially the suspended ones should be prepared. In this design, the specifications for each scaffold and the support structure, including its limiting factors, should be considered, The plan and design should be exact in its specifications, even to the expected speed of wind or any other force likely during the fixing or operating of the scaffold.
3) In the case of having to change the structure of the scaffold, the required changes should be carefully documented in a new plan.
4) Before using the scaffold, the changes made should be approved and reviewed many times by the designer or any other person on behalf of the designer.
5) Measures of protection should be undertaken in a place when and where certain activities are being conducted in the construction sites. Welding or water blasting are typical of the kind of work activity where care and the protection of the workers and sites are of utmost importance.
6) Because of Wind or particular work procedures are often the cause of instability in relation to the platform. In such conditions it may be necessary to secure the work area with wire ropes or other stabilizing equipment. These should be removed when the work situation does not require them (OCSH, 2011; Department of justice and attoney, 2009).

Figure 40 and Figure 41 show how to reach the recommendation of design scaffolding safely issue in the HSFG program and what has been described previously is the content of the button after the selection.

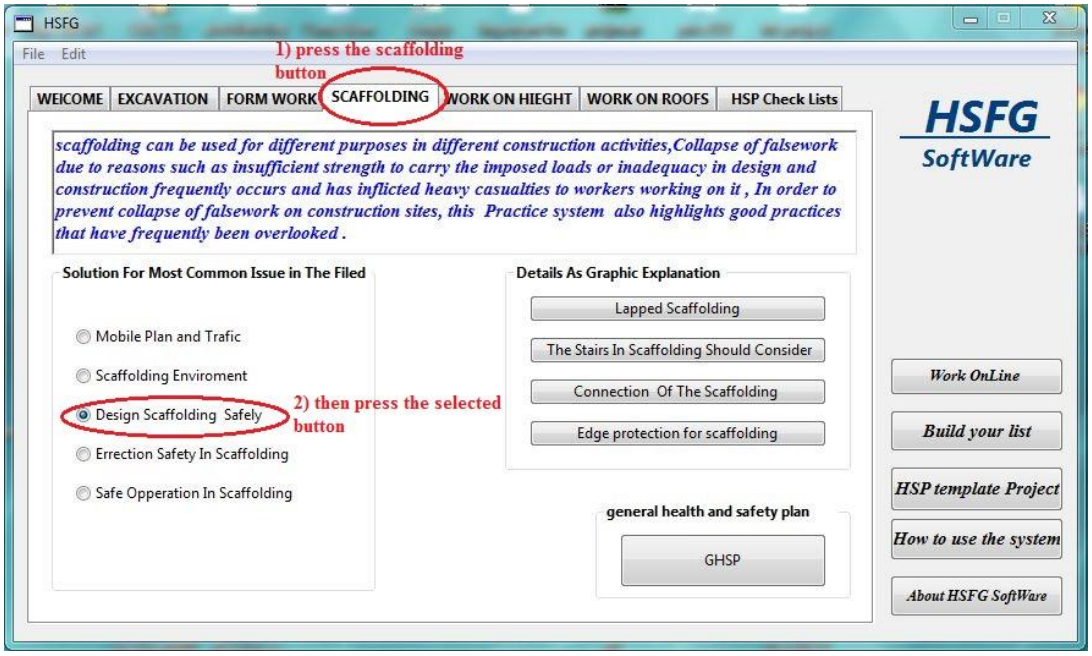


Figure 40: The location of the third issue in scaffolding tab

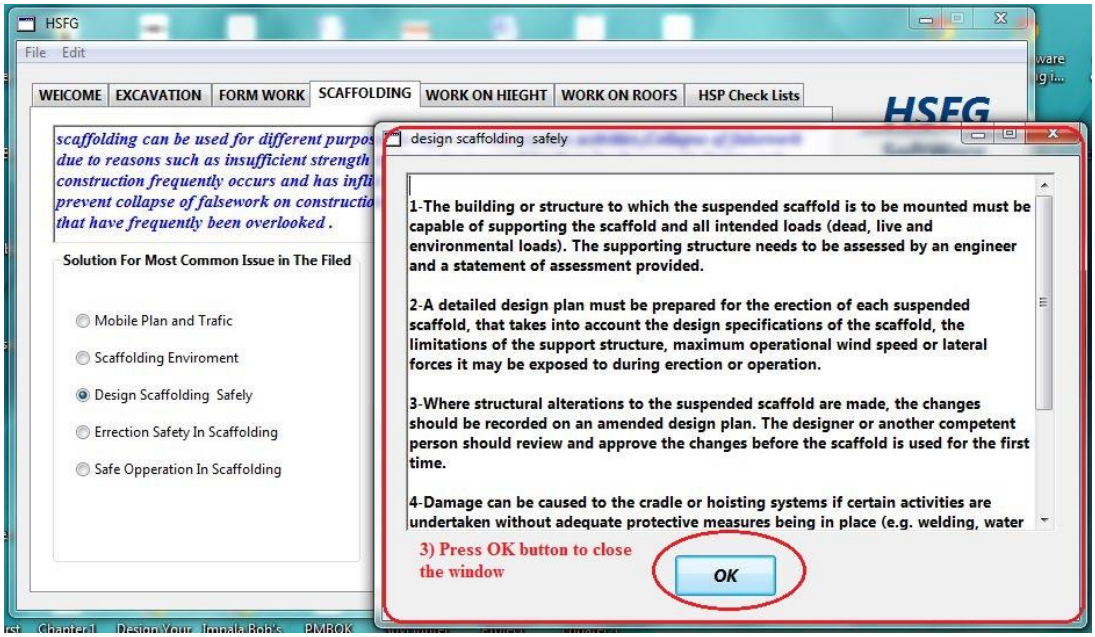


Figure 41: Design scaffolding safety recommended solution

3.5.3.4 Safety in the erection of scaffolding

1) The person assigned to erect or supervise the erection or disassembling of the scaffold should hold an advanced certificate in relation to rigging or scaffolding.
2) The design plan should be in the hands of the supervisor of the work. This design plan should show the requirements in relation to rigging such as the counter weight's position, the size and number before erecting the scaffold.
3) The workers should be aware and confident of the position of the fall protection in relation to the building edge. They should also be sure that the scaffold has fastening equipment for their safety especially for work that requires positioning near an exposed edge. The area designated for the supporting rigs should be used only by the workers who are responsible for climbing the scaffold.
4) There should be a barricaded area directly below the scaffolding which prevents access to anyone and so secure the area in case of falling cables, rigging or tools.
5) In cases where it is impossible to block the area below the scaffold physically, a guard should be placed to keep the area free of people and so prevent any injury from objects falling from above (OCSH, 2011; HSE, 1996).

Figure 42 and Figure 43 show how to reach the recommendation of safety in the erection of scaffolding issue in the HSFG program and what has been described previously is the content of the button after the selection.

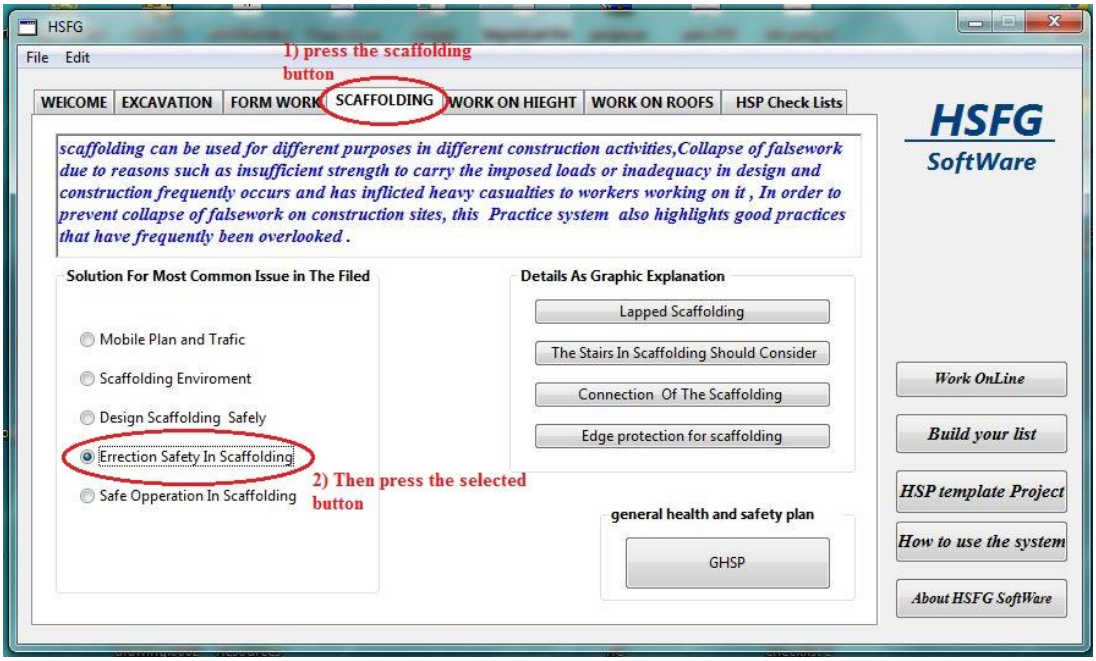


Figure 42: The location of erecting safety in scaffolding

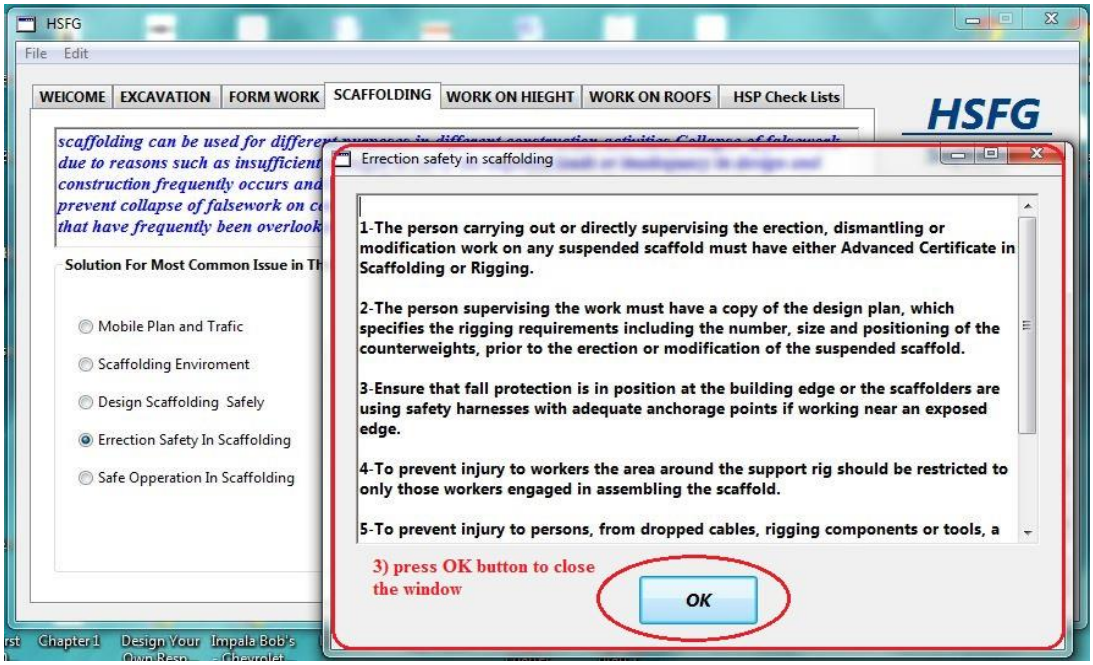


Figure 43: The recommended solution of erecting safety in scaffolding

3.5.3.5 Safe operation in scaffolding

1) The safe completion of the scaffold should be confirmed for the record on an official document. The writer should hold the required qualifications and the scaffold should not be used before the document has been notarized.

2) The supplier of the scaffold must present the instructions relating to health and safety and operation as well as the check list of health and safety every day.
3) After work on a suspended platform is completed, a procedural exit plan must be provided. In cases of emergency, a crane work box in the construction site can be used as the rescue or fire services may not always be immediately at hand.
4) Measures should be in place to guard against injury to workers from the falling of garbage from the scaffold.
5) Fastening materials are needed when there is a likelihood of movement in the scaffold from wind forces through procedures of work.
6) It is a must that the cradle platform be in good condition .The entire platform should be free of obstruction in relation to access to it.
7) The safe limits should not be exceeded in relation to the suspended scaffold and the liability of loads.
8) When there is a break in work and there is wind, damage can be prevented by securing the platform to the structure and disconnecting power from the main board or from the hoists (OCSH, 2011; HSE, 2000).

Figure 44 and Figure 45 show how to reach the recommendation of Safe operation in scaffolding issue in the HSFG program and what has been described previously is the content of the button after the selection.

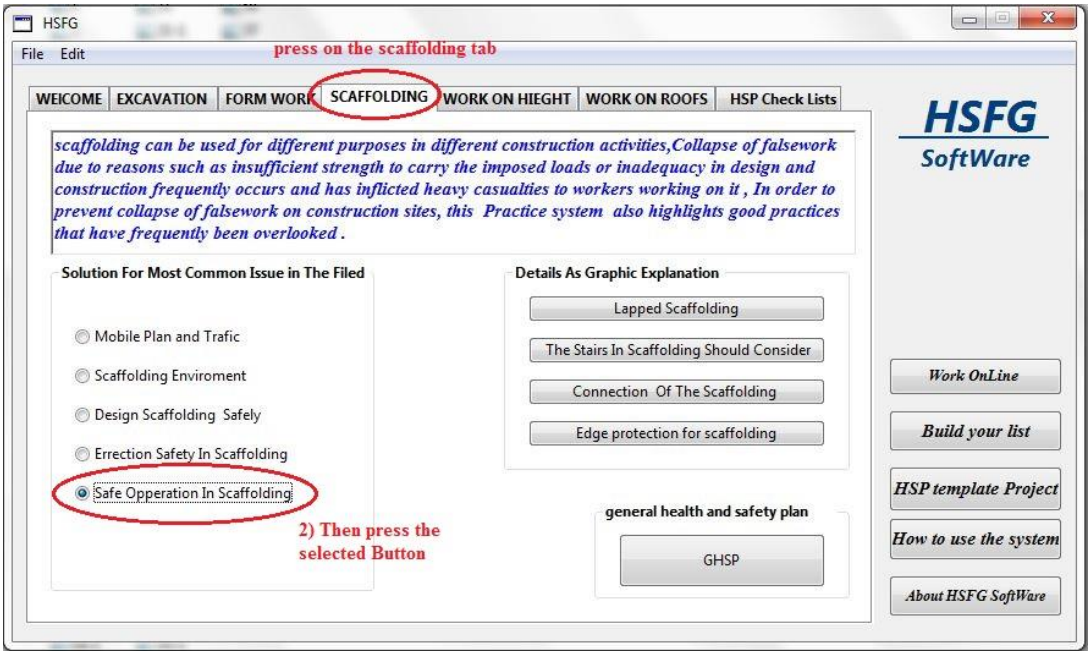


Figure 44: The safe operation in scaffolding problem in scaffolding

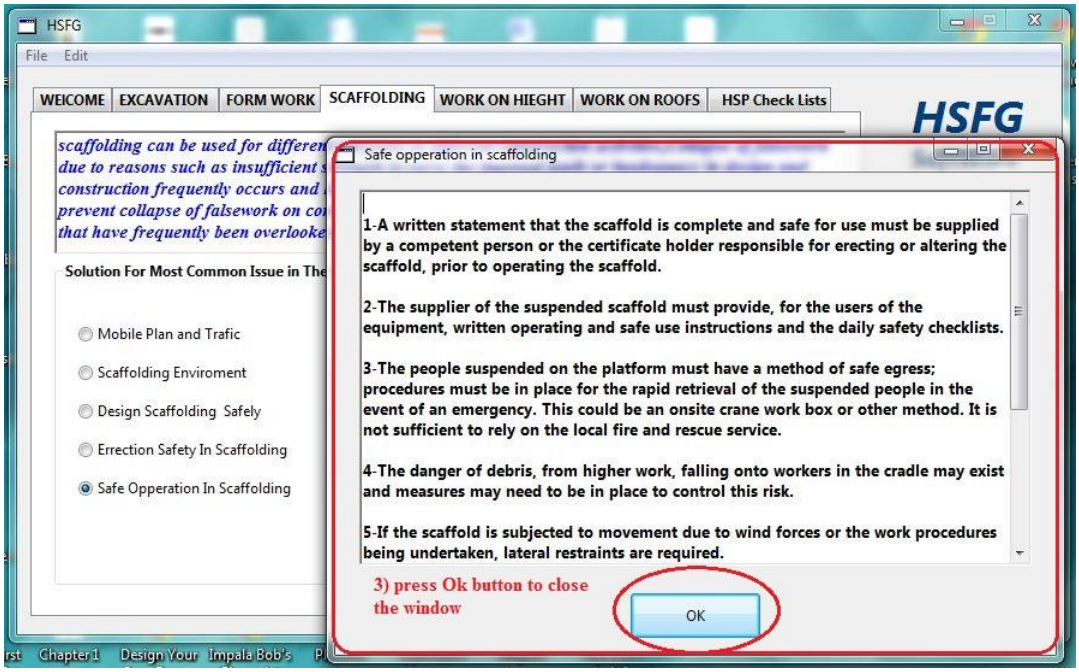


Figure 45: The safe operation recommended solution

3.5.4 Working at height

Working at a height is one of the biggest problems in the construction sites .Its importance comes from its result as it causes death or injury to workers. Each injury or death means seriously affects the community and the victim's family. It is not only

the inexperienced or young workers who faces this problem. It is a concern facing even the most experienced workers. To maintain or create an environment that is safe for workers, practical solutions and information should be provided (WSH council, 2009).

Figure 46 shows how to shift from the Scaffolding tab to Work on height tab into in HSFG program and what has been described previously is the introduction content of the tab after the selection.

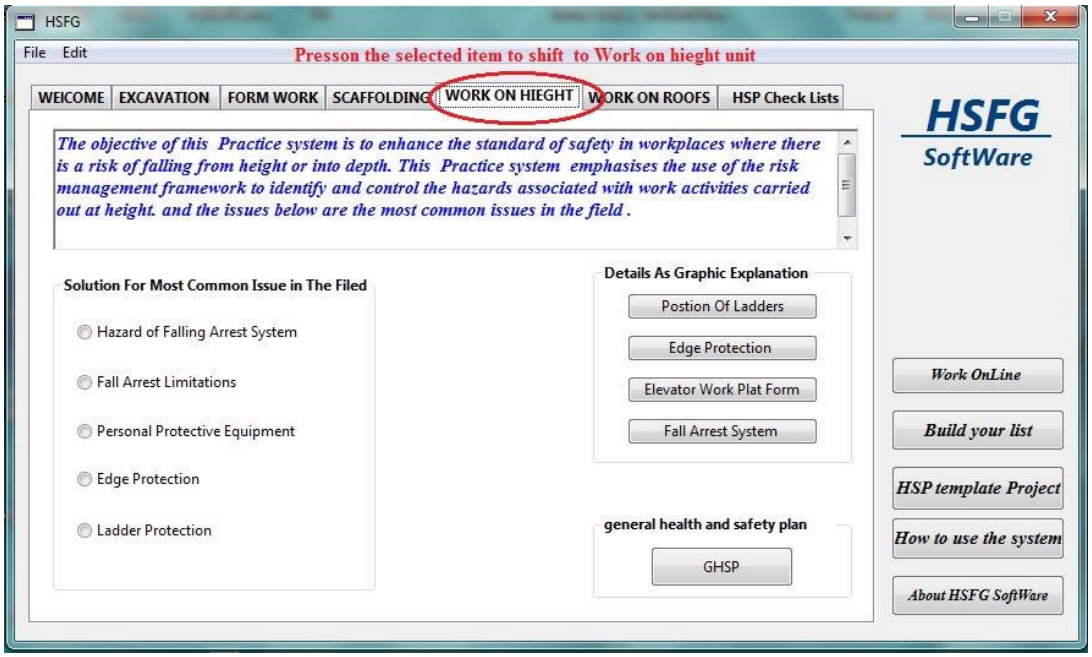


Figure 46: Shift to work on height unit in the program

3.5.4.1 Hazard falling arrest system

1) Swinging back or down is one of the problems that takes place when a person falls far away from the edge. It is said that this problem is the result of not using the system of fall arrest.
2) 'Swing back' is the case of falling from an edge that is perpendicular. There is the possibility of swinging back against the structure of the building and

hence, a collision with any object in the way. Such situations can be overcome by using a system of fall arrest.

3) In the case of swinging down, the arrest line stretches in a diagonal way towards the roof's outside edge. If there is a case of fall, the arrest line will go along the outside aspect until it shapes a right angle in relation to the roofs edge. There is also the possibility of dropping and hitting the ground if the line is long or broken after hitting the roof (WSH council, 2009; NOHSC, 2004).

Figure 47 and Figure 48 show how to reach the recommendation of Hazard falling arrest system issue in the HSFG program and what has been described previously is the content of the button after the selection.

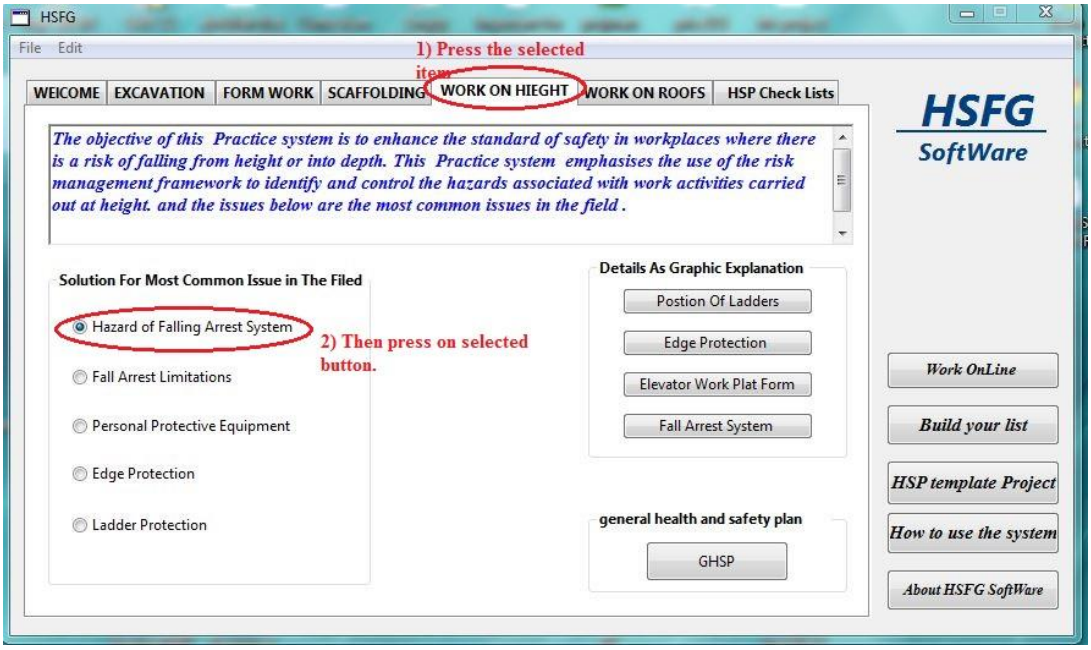


Figure 47: The first issue of the work on height in work on height tab

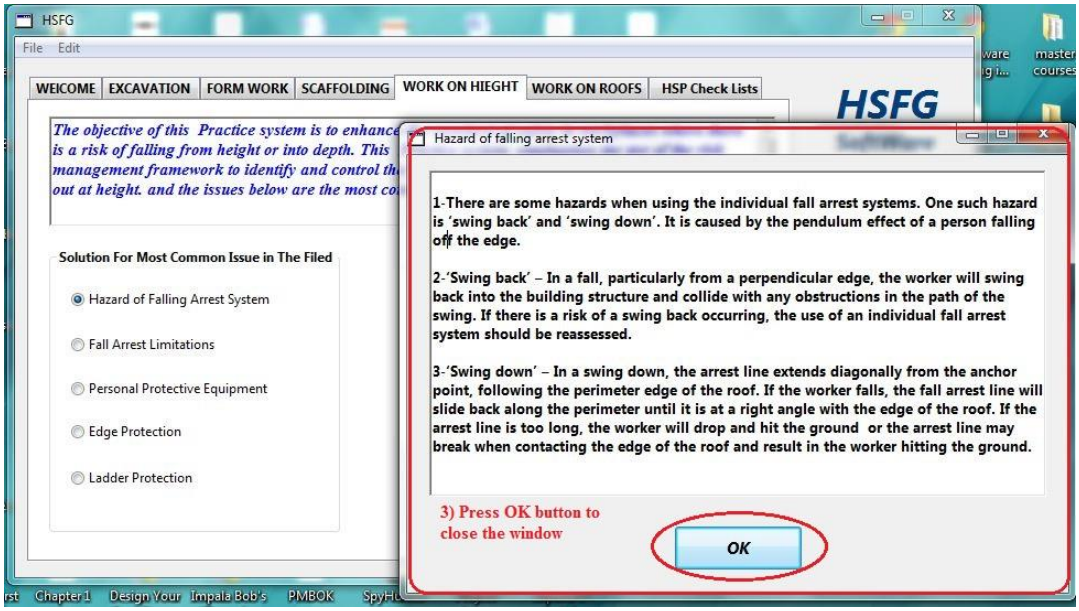


Figure 48: The recommended solution for the hazard of falling arrest system

3.5.4.2 Falling arrest limitation

1) In the prevention of falls where no practical measure of controlling risk is available, the use of an individual fall arrest system is applicable. Such a system needs skills to be used in a safe way as it may sometimes injure the user.
2) The system has the limitation of height clearance. In height falling, the total length of lanyard combined with the hanging down of life lines and with the absorber of shock might be 5m or more. This length is sometimes more than the real fall height.
3) We should take into consideration the block of fall arrest, which is retractable especially when it is possible to fall over distances that are short (HSE, 2005; WSH council, 2009).

Figure 49 and Figure 50 show how to reach the recommendation falling arrest limitation issue in the HSFG program and what has been described previously is the content of the button after the selection.

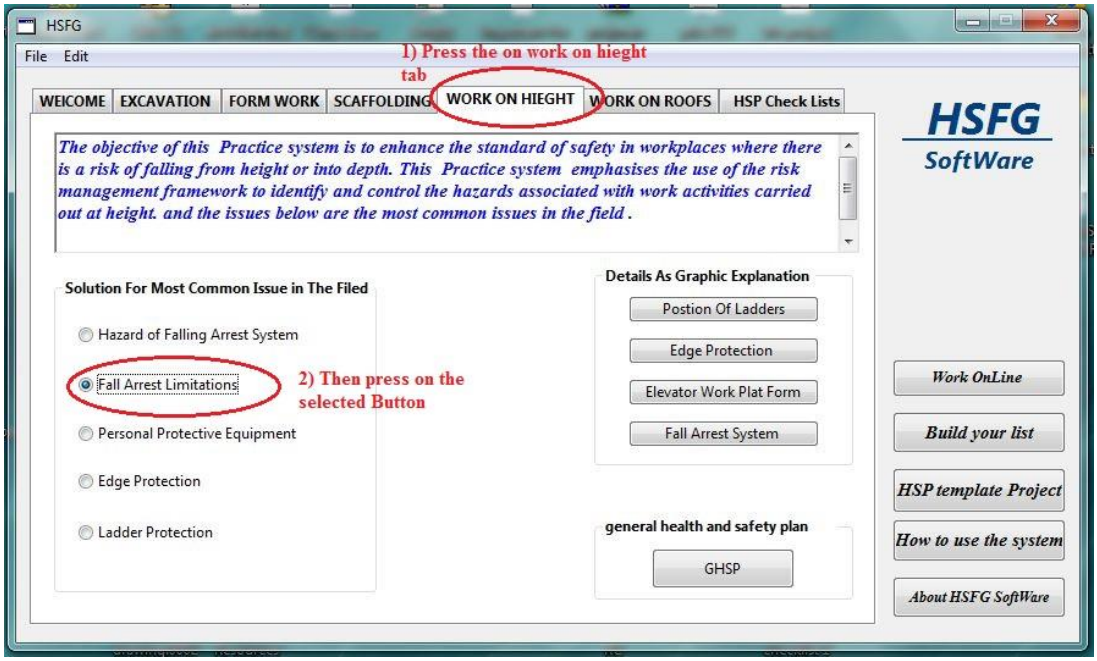


Figure 49: The location of fall arrest limitation in work on height tab

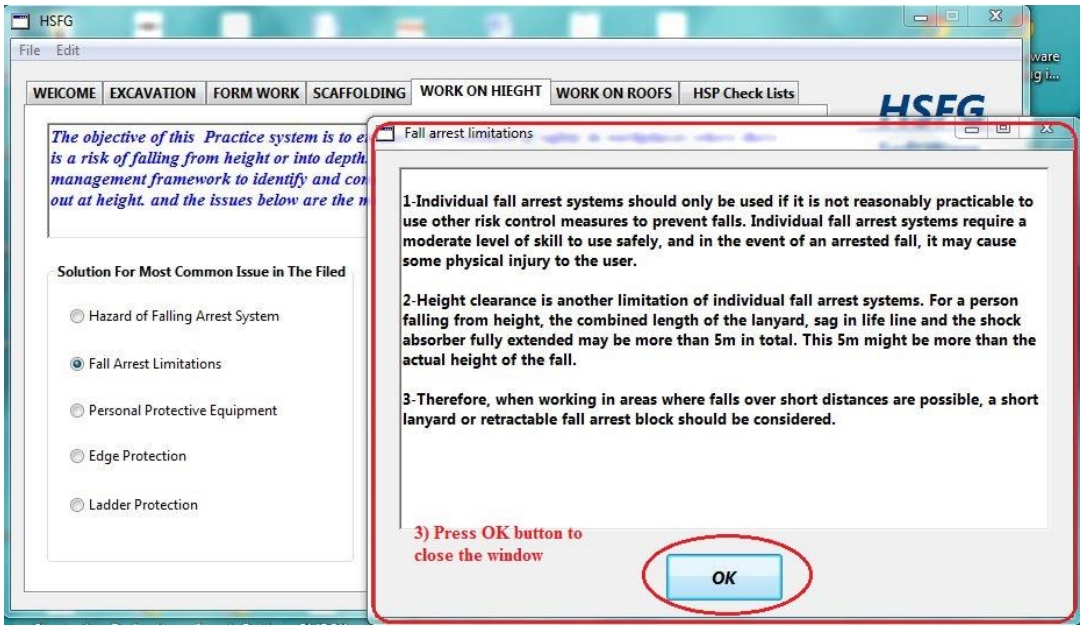


Figure 50: The recommended solution for the falling arrest limitation

3.5.4.3 Personal protective equipment

The guidelines that follow should be observed in arresting falls.

1) It is good to minimize the distance of the fall so the impact of the arrest can be reduced.

2) Protective equipment should be checked regularly.

3) It is preferable not use the fall arrest system after it has been used once.

4) Whenever possible the fixing of lanyards to crash barriers should be avoided. if not, the crash barrier is designed to stand up to the force caused by the falling person, about 22.2 kN per person attached. However, once should tight properly the part that is to be anchored to crash barrier when necessary. Here, it is recommended to use the vertical and not the horizontal pieces in the anchorage.

Figure 51 and Figure 52 show how to reach the recommendation personal protective equipment issue in the HSFG program and what has been described previously is the content of the button after the selection.

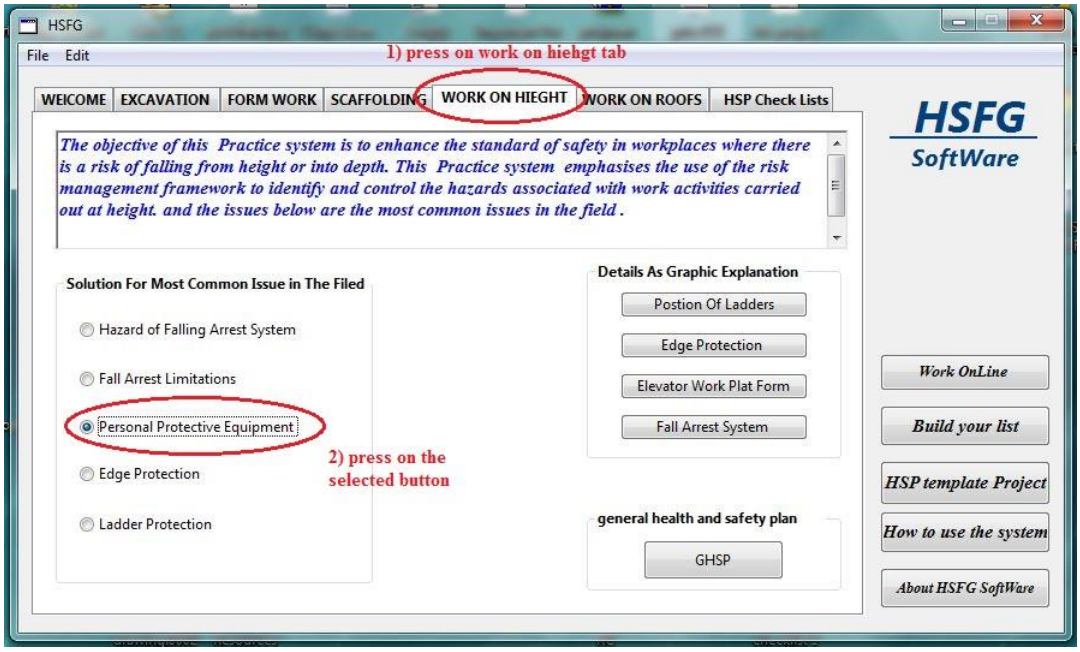


Figure 51: The location of personal protective equipment

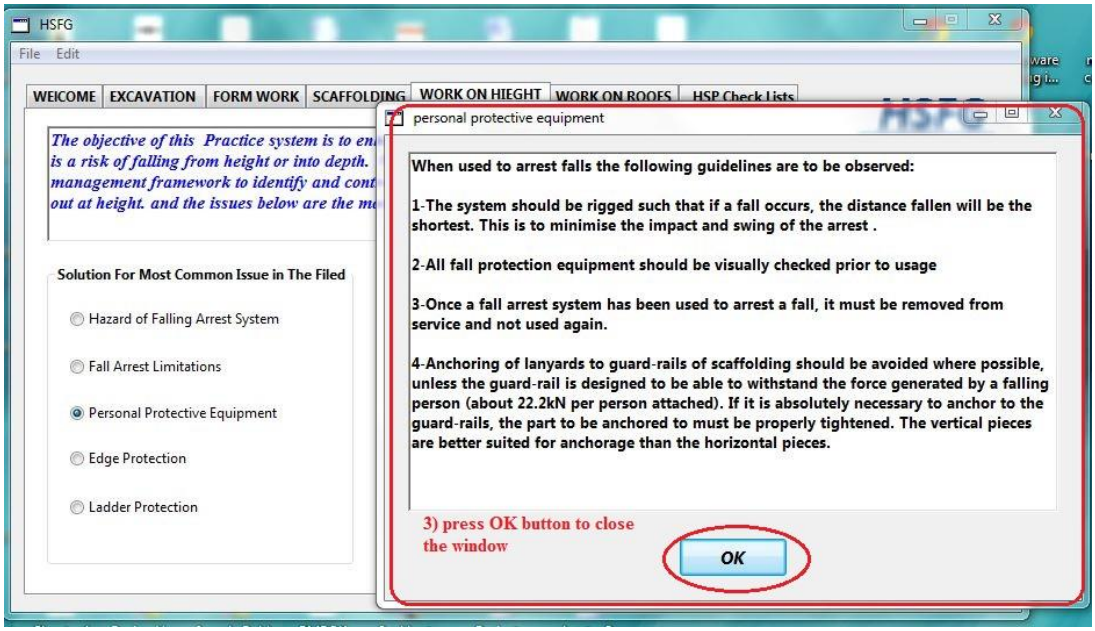


Figure 52: Recommended solution for personal protective equipment

3.5.4.4 Edge protection

1) In fixing the scaffold guards should be as an additional protection for the scaffold fixer and minimize the risk of falling. This is always a safe possibility if the level of the scaffold is exposed or unsecured.
2) The system of guardrails should be able to withstand the persons weight at any point and it should be of the highest quality.
3) Top bars should be 1 meter above the working surface.
4) It is advisable to provide mid bars and toe boards but wire mesh can be used in place of mid bars if it is filling the specific panels.
5) For harsh roof slopes, a bottom bar (rail) above the toe board can be provided. Sliding off the roof in relation to persons and objects can be prevented by the use of a mid-rail and infill mesh panel.
6) Gates, chains can be used in order to protect the falling of a person when we are in need of access points which should be covered if not used.

7) In order to minimize the problem of falling of a person from one level to another, the builders and designers should join the guard rails and fixings to the structures. This can be seen in steel structures where systems of guard rails are used.

8) Using scaffolding as a way of falling structure where systems of guard rails are used. This is done by including into the scaffold the guard rails as edge protection (HSE, 2005; OSHA Regulations, 2000).

Figure 53 and Figure 54 show how to reach the recommendation edge protection issue in the HSFG program and what has been described previously is the content of the button after the selection

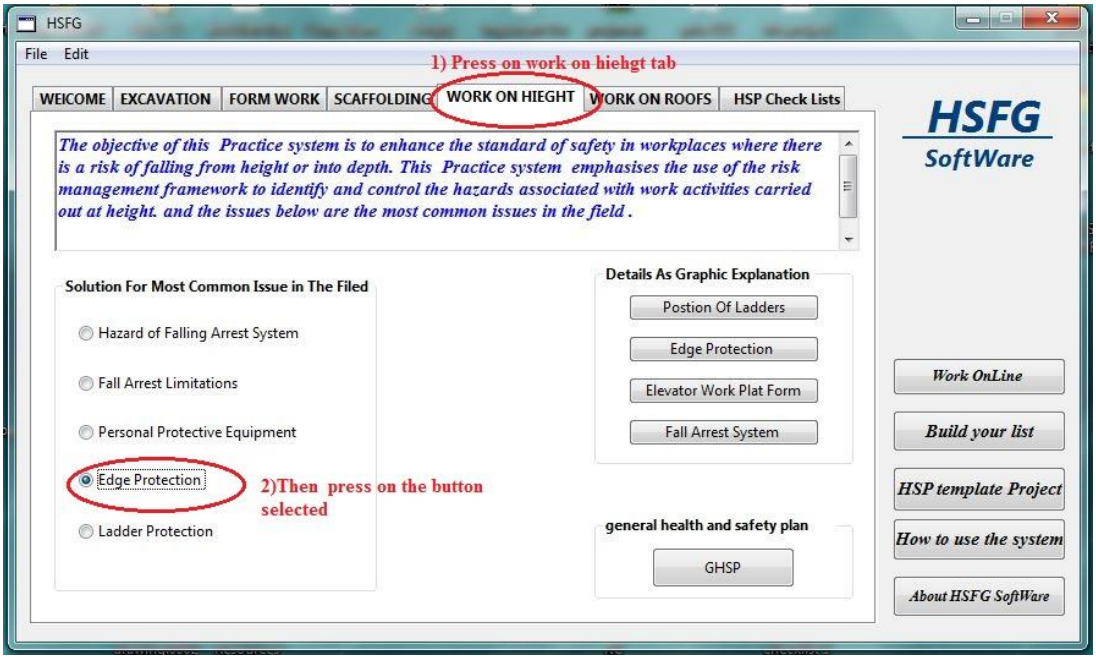


Figure 53: The edge protection in work on height

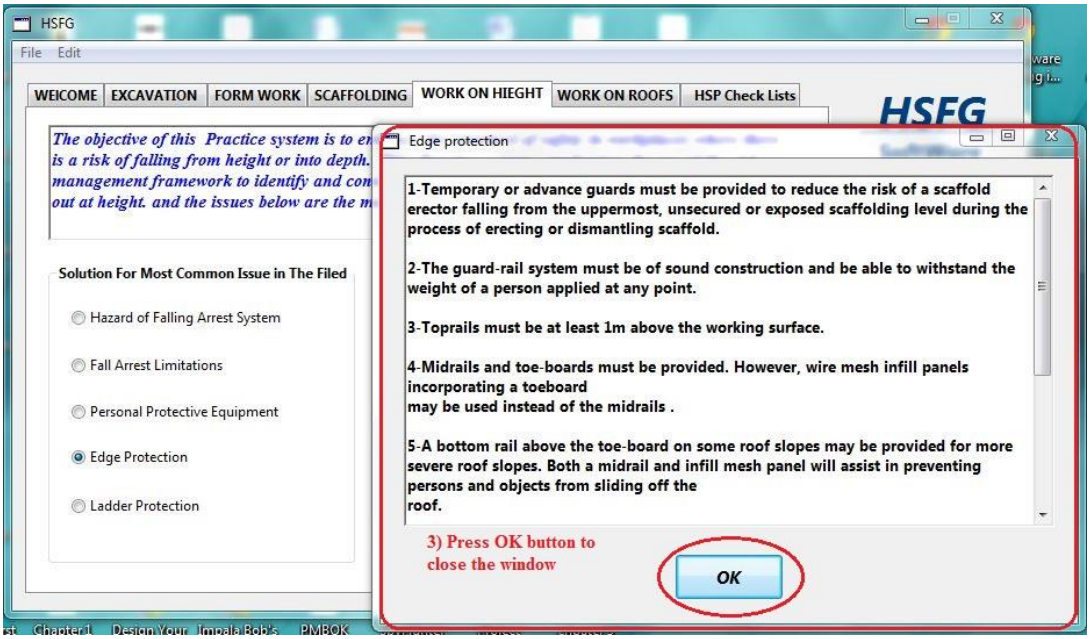


Figure 54: Edge protection recommended solution

3.5.4.5 Ladder protection

1) Two persons are needed in order to change the place of ladders of more than 2m in height or to carry similar ladders from one place to another.
2) All ladders should be checked before use.
3) Ladders should not be painted or coated as it prevents spotting.
4) Ladders should not be used or touched if there is possibility of electrical contact where power lines are present. Metal ladders should not be used in the vicinity of of electricity.
5) Ladders should not be left where they might obstruct the passage of a person or vehicle.
6) A step-up ladder should not be used to gain extra height for none use, if when the work is near to a floor or on a scaffolding too. In both cases there is always the danger of a worker losing balance and falling. In this case, there is possibility of the fall of the worker.

7) Ascending or descending a ladder, materials or tools should not be carried by hand. Materials that cannot be attached to the belt of the worker must be lifted or moved to the construction sites independently.
8) The recommended time for using the ladder is 10 to 15 minutes. It is not advisable to continue work on a ladder for long periods longer than that.
9) The use of ladders in heavy work is not advisable.
10) Workers should be warned against the danger of overreaching when working on ladders.
11) A ladder should be secured when a side loading is imposed and if not secured no work should be done.
12) Work on a ladder should not be done in the work area of others.
13) No more than one person should be on a ladder at one time (WSH council, 2009; HSE, 2005).

Figure 55 and Figure 56 show how to reach the recommendation ladder protection issue in the HSFG program and what has been described previously is the content of the button after the selection.

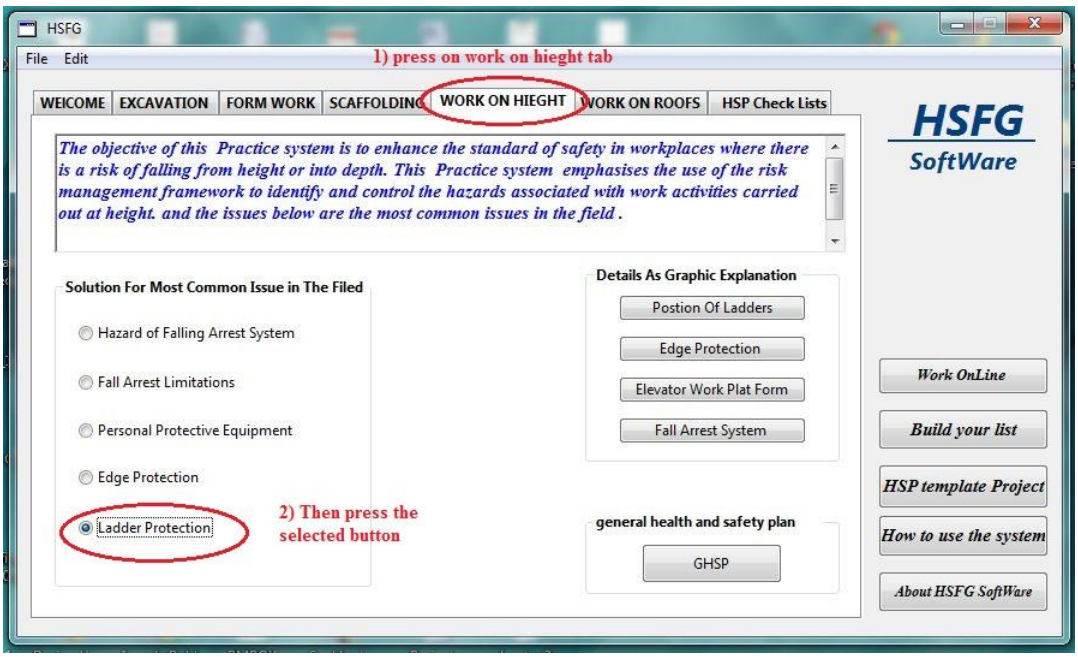


Figure 55: Ladder protection in the work on height tab

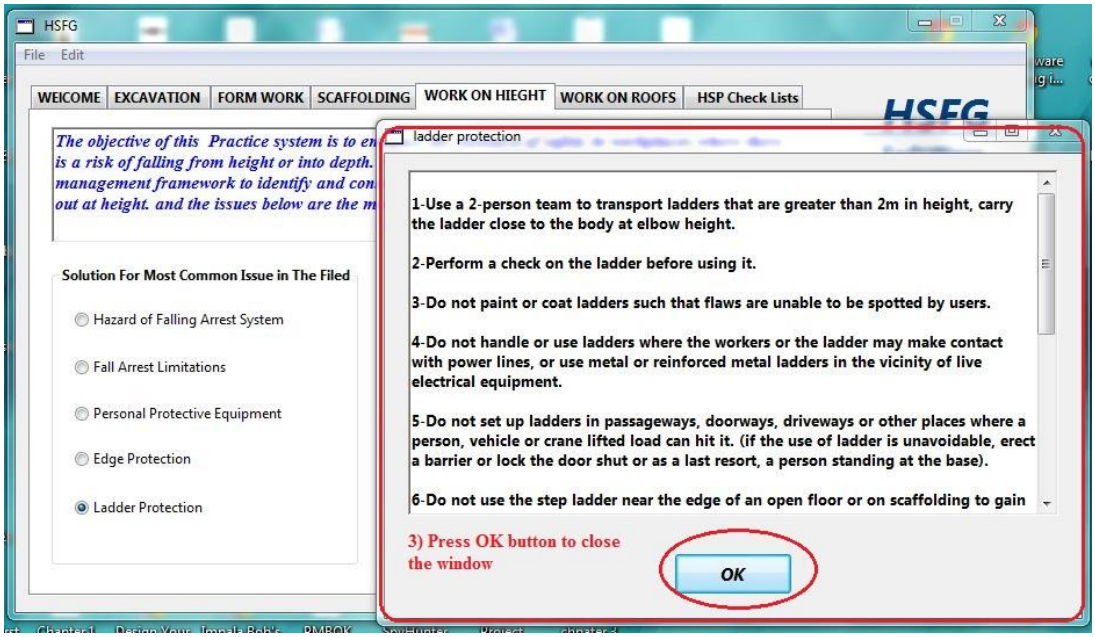


Figure 56: Ladder protection recommended solution for the issue

3.5.5 Work on roofs

Serious injury or worse may be the result of a fall while working on a roof whether the work is for a short time or over an extended period there is always a continuous risk.

In terms of accidents, it not only the builders of risks who run the risk of injury but also those employed to clean, maintain or even demolish roofs are working in the same hazardous environment. The risks affect all and so it is important to insist on certain standards of safety.

The standards, warnings or even the precautions needed may change depending on the kind of work being carried out. However, there are common precautions needed in all kinds of work on roofs and specific strategies of safety required for different kinds of roofs (HSE, 2008).

Figure 57 shows how to shift from the work on height tab to work on roofs tab into in HSFG program and what has been described previously is the introduction content of the tab after the selection.

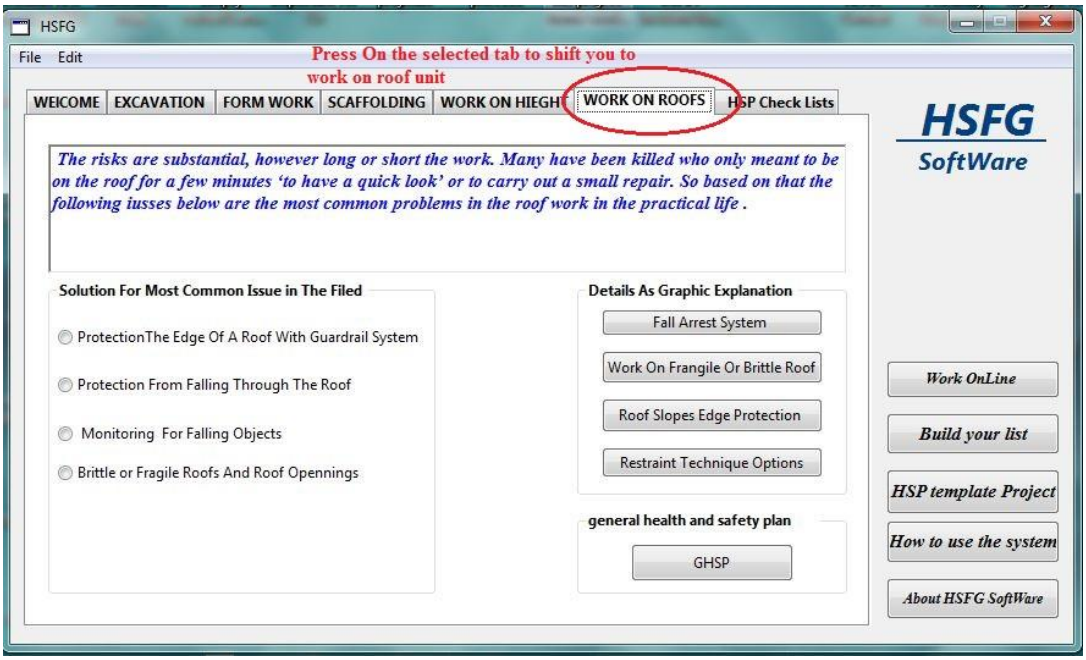


Figure 57: The location how to shift to work on roofs tab in the program

3.5.5.1 Protecting the edge of a roof with guardrail system

1) Before a crash barrier is placed at a roof's edge, its suitability for that roof should be ensured. The supporting members members should hold in position the load of a person falling towards the rails. The engineer who designed the roof should be consulted in order to get information about the capacity of the roof in relation to different crash barriers systems.
2) It should be made certain that the guard rail system can be fixed in order to follow the profile of the roof. There should be no gaps that might allow for the fall of a person on the roof. An additional risk may be posed if work is being done on buildings that are unusual in relation to roof construction or plan profiles. If there is nothing to secure the edge, the gaps should be in-filled. Those are between the guardrail system and the roof, on site.
3) A guardrail system ought to be in place and not to be moved away till the completion of work .In removing the guardrails, entering or leaving should be prevented on that section of the roof.
4) A method must be developed by which the guardrail system can be fixed or taken apart safely. Sometimes a temporary platform is needed when scaffolds are not involved (HSE, 2005; HSE, 2008).

Figure 58 and Figure 59 show how to reach the recommendation protection the edge of a roof with guardrail system issue in the HSFG program and what has been described previously is the content of the button after the selection.

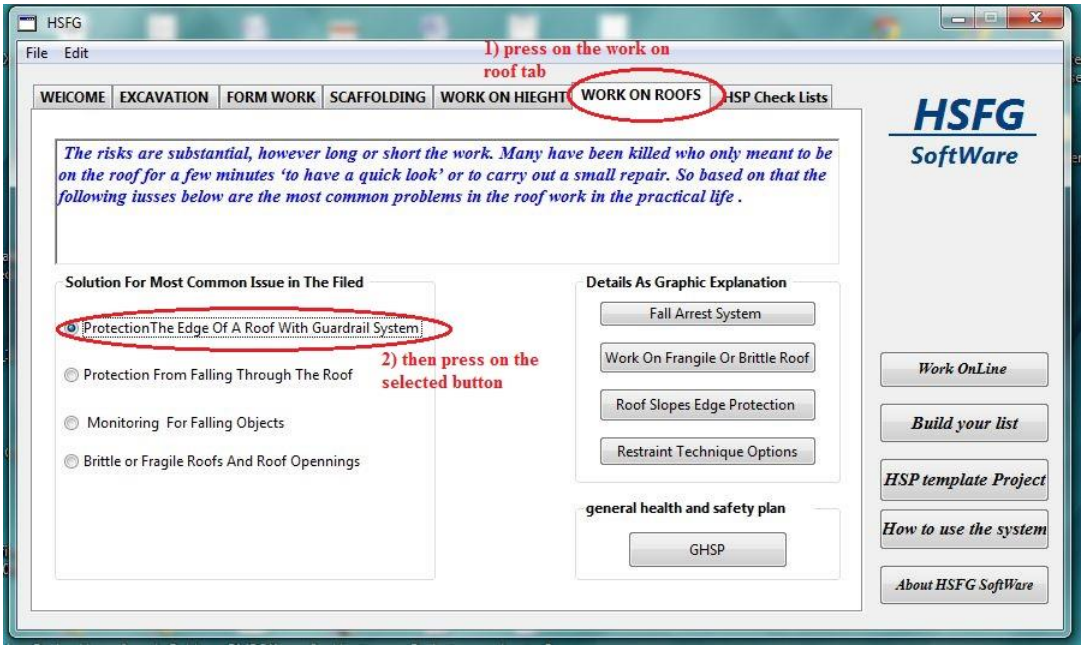


Figure 58: The first issue in working on roofs tab

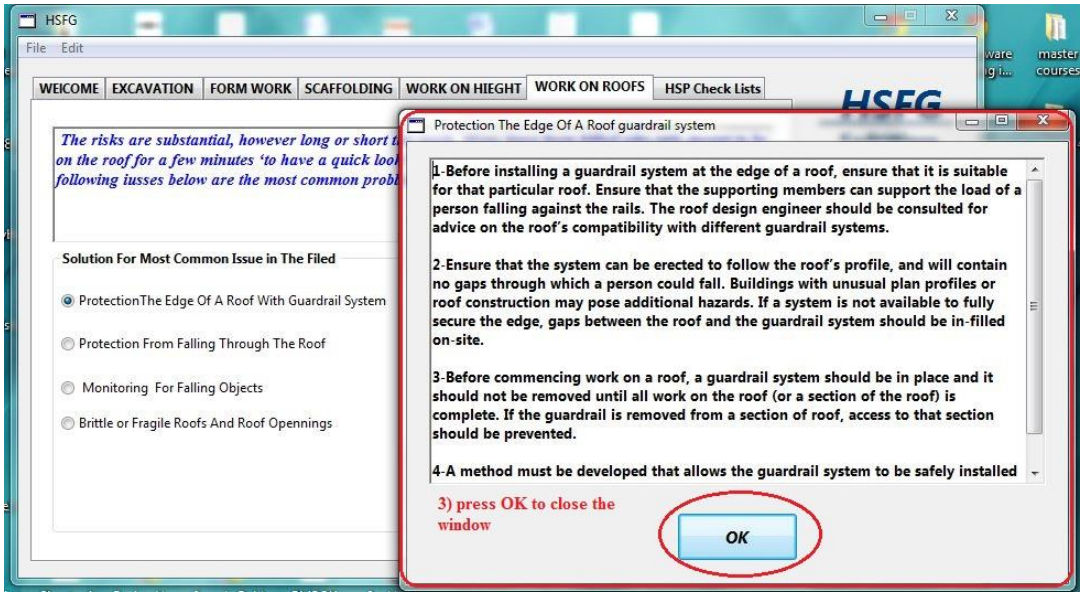


Figure 59: The recommended solution for protection of the edge of the roof

3.5.5.2 Protection from falling from the roof

1) Between the structure of the roof and the cladding, there is the installation of a safety mesh, In this case the person responsible for installing the cladding at the roofs leading edge is protected as well as the person responsible for maintaining work on the roof.

2) Walking on the safety mesh is not allowed unless the design of the mesh permits it.
3) Make sure it should also be ensure that the mesh is suitable for the roof in relation to its truss span length or pitch.
4) The instructions of the manufacturer should be followed and applied carefully in order to install the mesh safely.
5) The unity of the mesh must be examined by the person responsible before maintaining or removing the roof (HSE, 2008; WSH council, 2009).

Figure 60 and Figure 61 show how to reach the recommendation for protection from falling from the roof issue in the HSFG program and what has been described previously is the content of the button after the selection.

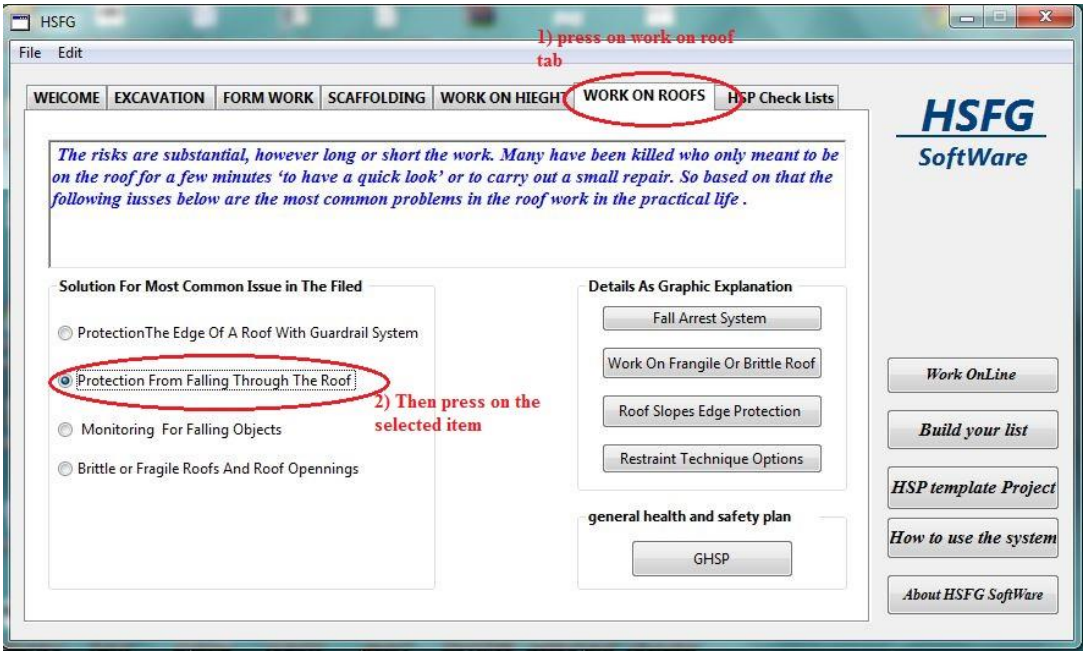


Figure 60: The location protection from falling through the roof

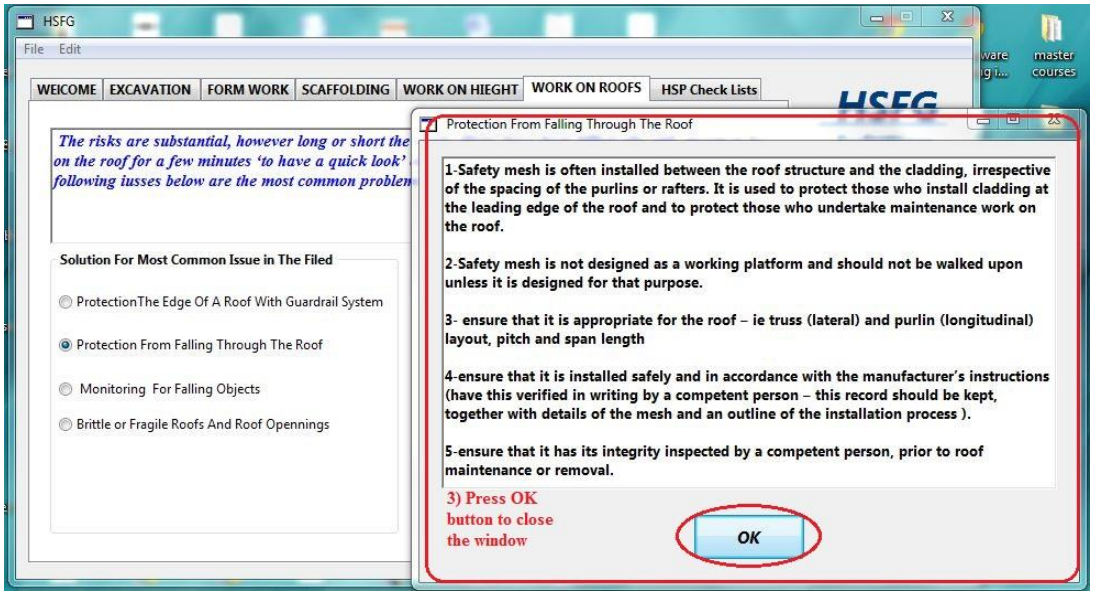


Figure 61: Recommended solution for protection from falling through the roof

3.5.5.3 Monitoring for falling objects

To control the fall of objects we can use the following:

1) The construction sites should allow for the raising or lowering of plant and materials safely.
2) In the construction site, the falling of objects from the building should be safeguarded by using a safe barrier.
3) If a secure barriers are provided, certain contingency measures should be introduced so the path of falling objects can be arrested.
4) Controlling falling objects can be achieved by working from height structures. This can be done by using platforms, scaffolding or ladders.
5) Working above others is prohibited.
6) By using screens walkways are protected.
7) Dangerous areas should be isolated by putting up the sign 'NO-GO'
8) Training should be provided (NOHSC, 2004; WSH council, 2009).

Figure 62 and Figure 63 show how to reach the recommendation monitoring for falling objects issue in the HSFG program and what has been described previously is the content of the button after the selection.

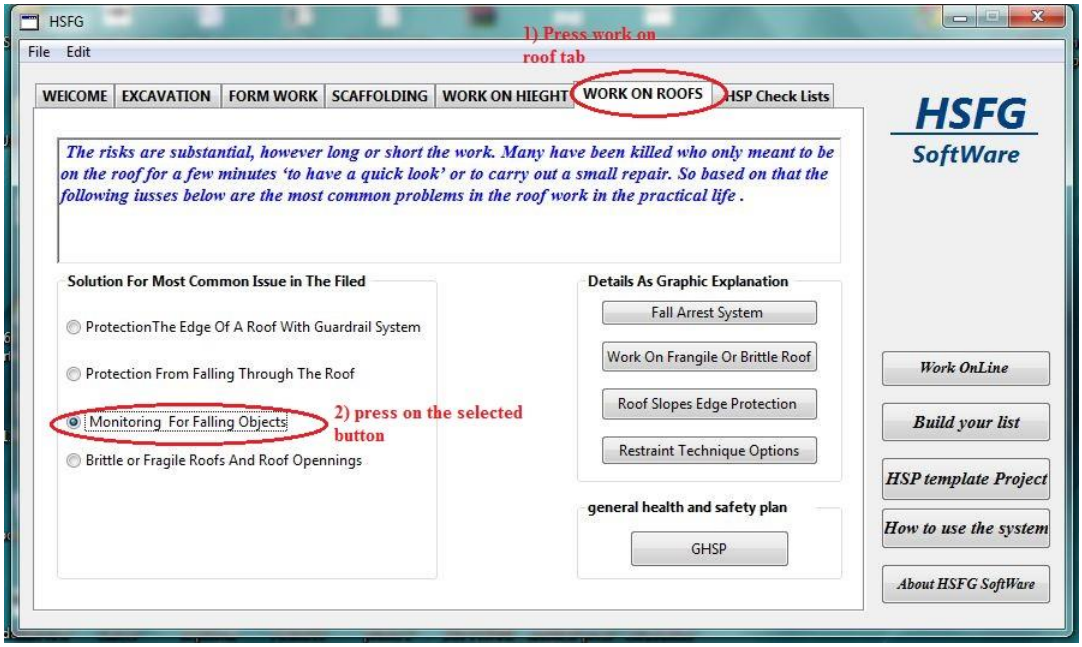


Figure 62: Monitoring for falling objects issue in the work on roofs

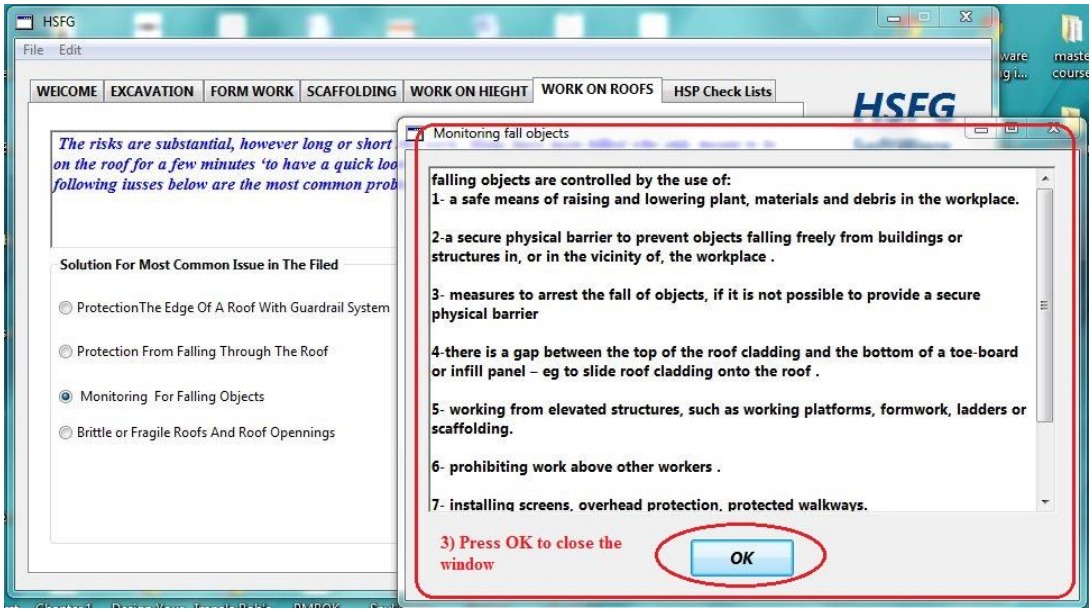


Figure 63: Recommended solution for the monitoring for falling object

3.5.5.4 Brittle and fragile roofs and roofs operation

1) An assessment of risk should be performed before doing any work in relation to roofs. This is done in order to know whether there is any roof that is fragile or opening in roofs or skylights. If there is such a thing, the area must be marked as a risk area or with a 'No-Go' area sign.
2) Information about such areas should be given to the workers in the work place. Such cases should be identified, and the information written on the site induction or any other notice.
3) After being identified, the 'No-Go' places or openings must be barricaded, or a system put in place to control and monitor the flow of people through or within such areas.
4) if workers need to be close to such areas, a certain measures should be taken, like the system of fall arrest anchorage points and safety harness.
5) The responsible on the work site should follow the regulations as well as the safety rules, such as put up warning signs. Danger of brittle roofs are among the warnings that should be fixed almost everywhere. Also the roof's curve, the slope or the places from where a person can reach the roof (HSE, 1996; NOHSC, 2004).

Figure 64 and Figure 65 show how to reach the recommendation brittle and fragile roofs and roofs operation issue in the HSFG program and what has been described previously is the content of the button after the selection

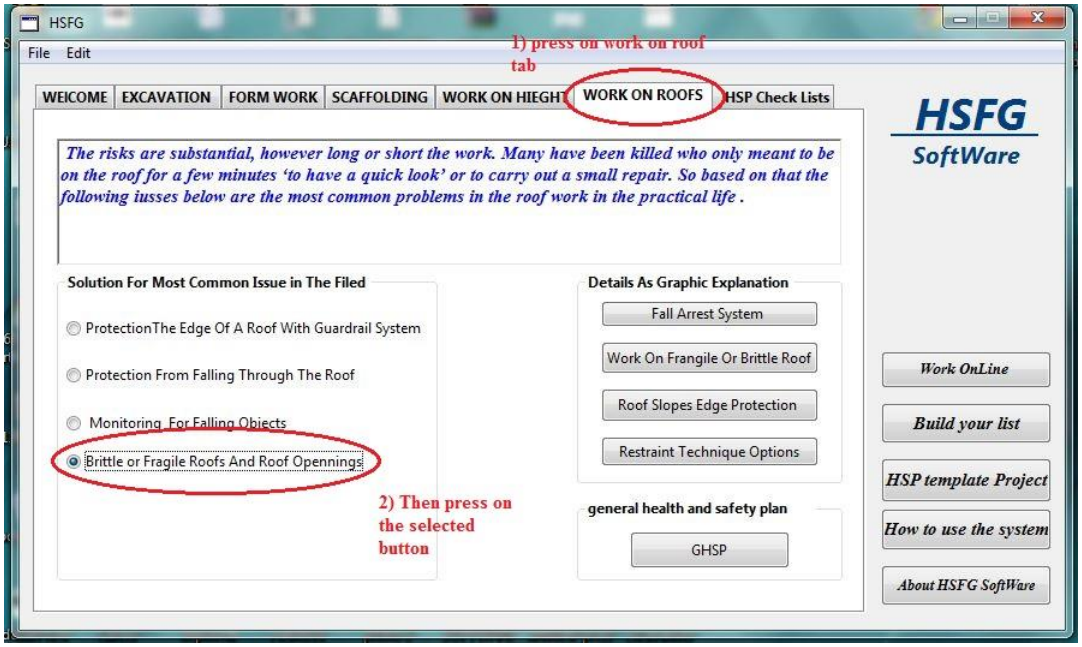


Figure 64: Brittle roofs issue in the program in work on roofs

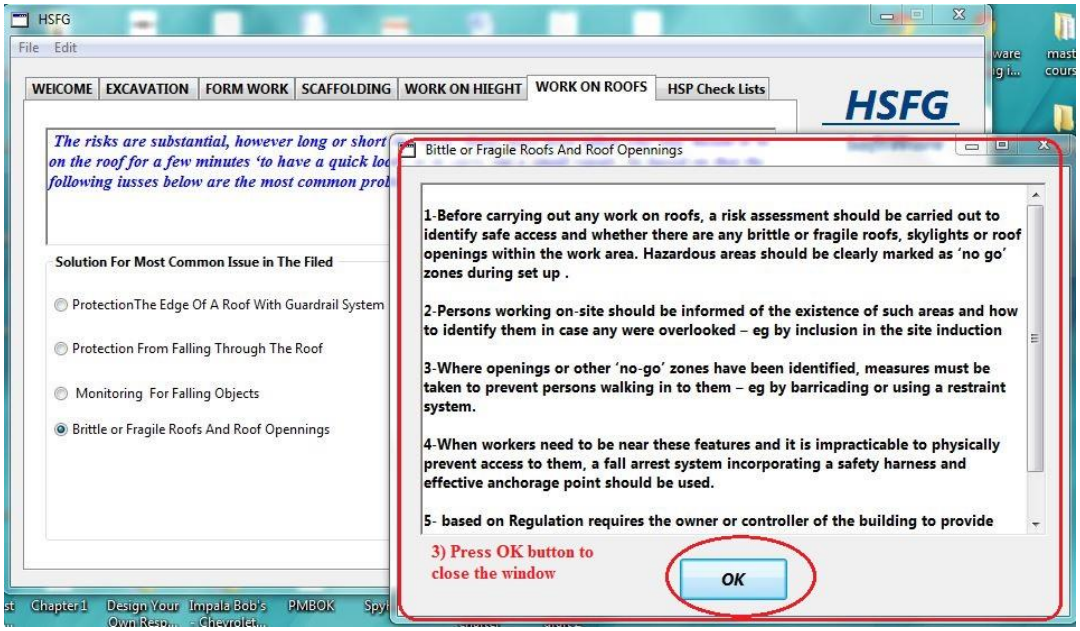


Figure 65: The recommended solution of the brittle roofs openings

3.6 General Health and Safety Plan on Construction sites

The following criteria describe the main activities on the construction site related to health and safety on construction site and figure 67 shows the location of the general health and safety plan (GHSP) in HSFG software.

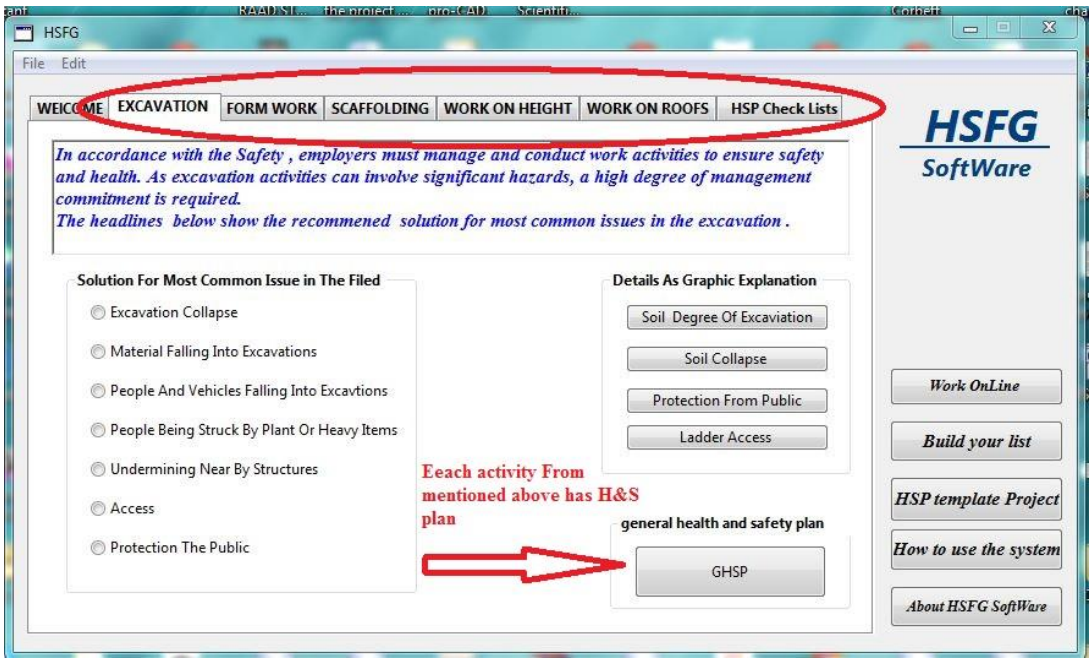


Figure 66: Mentioned activities in program tabs have it own health and safety plan

3.6.1 General health and safety plan in excavation

In this field the factors that play a role in the safety plan are:

1) Finding out all the locations in relation to underground services.
2) Small and enclosed places must be taken into consideration in relation to atmosphere potential.
3) Soil should be dealt with by using a good protection system. In relation to people, they should be provided with equipment and clothing that is protective.
4) The composition and kinds of soil should be determined.
5) It should be determined if the is surface or subsurface.
6) It should be established how long the excavation is to be kept open and what the depth of it will be.
7) What system of rescue is to be used in case of emergency.

8) Thorough understanding and application of safety programs should be done. This should go with the applicable standards; for example, there is the excavation and trenching safety program (HSE, 2005; HSA, 2004).

3.6.2 General health and safety plan in formwork

1) The designer should specify the maximum weight in relation to paint loadings.
2) It is not accepted to put loads or deck on the structures that are temporary and especially if the designer specifically prohibits it.
3) People who are working on cranes should be given information about the suitable time to lift or place safely a material load. This is also true in relation to temporary structures or decks.
4) If there is no identified zone for landing, i.e., a place designed for such a purpose, the workers on the crane should not lift materials connected to temporary decks or structures.
5) Only identified areas should permit the placing of loads of persons.
6) A plan should be settled upon concerning the moving of materials. It should be clearly stated and understood that lifting loads to workplaces where there is unsafe or incomplete temporary decks or structures is impermissible
7) Materials should be kept safe during the operation of work on site. This is to prevent the wind loads moving the materials (WHS, 2006; Safe Work, 2012).

3.6.3 General health and safety plan in scaffolding

1) It is advisable to have a good, solid footing for scaffolds. Hence, it is not recommended to use unstable objects to support the scaffold, like concrete blocks, boxes or barrels.

2) Health and safety control personnel are the only persons permitted to supervise the conduct of any activity either erect, alter or move scaffolds.
3) The load capacity of scaffolds should be four times the estimated intended load in order to protect against failure or collapse.
4) In the case of the scaffold being weakened or damaged, it should be immediately replaced by another one or undergo repair. This includes even the accessories, such as the trusses, screw legs, ladders, brackets and braces.
5) It is advisable to provide an access ladder or any other safe access.
6) The parts of the scaffold such as the legs, uprights or poles should strongly the entire structure and is therefore solid and prevents movement. Workers exposed to overhead dangers on scaffolds should be provided with material and clothing protection.
7) Conditions that might allow for slipping on scaffolds should be rectified immediately.
8) Protected fiber or artificial ropes should be used in works where we have corrosion, so fastening, burning or welding won't be performed by means of untreated fiber or artificial ropes.
9) Workers should maintain a safe distance from power lines.
10) In order to lift material, fastening lines should be used in order to prevent contact.
11) If the weather is stormy or windy, scaffolds should not be used (WSH council, 2009; HSE, 1994).

3.6.4 General health and safety plan for working at height and working on roofs

1) To control construction site, it is advisable to follow the instructions given in a systematic way in order to ensure Safe Working Procedures (SWPs).The information shows how to carry out work in a safe way. Due to risk assessment, we should develop different activities that reduce the hazards of fall from high places.
2) The instructions provided by the Safe Work Procedure (SWP) relates to different aspects of the working environment. There are the jobs that workers ought to perform, There are also the persons who are going to do the jobs, the precautions as safety procedures that should be known and the training of those who are to perform the jobs.
3) Everyone in the workplace should be involved in SWP and everyone should know their responsibility or roles. The SWP must take into consideration not only workers on site but even those who might be indirectly affected by such work.
4) Supervising the application of SWP is necessary. In this way, we can be sure that the workers are following the procedures of safety in the construction site. Also, they have to see whether the procedures are effective or not and this is done through reviewing SWP regularly.
5) Organizing the work will help in decreasing the risk of fall. This is done by putting jobs in sequence. So, they will not have jobs done at the same time and workers are not below or above each other.
6) Make sure that the following risks are not present:
    a. Surfaces of height level such as inclines (slopes).
    b. Surfaces that are slips because of being dusty, oily or wet.

c. Surfaces that are not flat or level like broken ground.
d. Surfaces that do have enough space.
e. Surfaces that are untidy because of materials, rubbish or tools.
f. Working in bad conditions where the weather is is cold, hot, humid, rainy or windy.
g. Working where the edges that are not protected.
h. Materials that should not be carried manually.
i. Platform overload which can lead to collapse.
j. The possibility of being hit by equipment or objects such as when lifting loads (WSH council, 2009; HSE, 2005).

3.7 HSFG Health and Safety Checklist

HSFG checklist helps the users such as control engineers in the specific activities on construction site that mentioned in the software, to check wither the workers are following the Health and Safety plan. The check list in HSFG program are two types, as shown in figure 67 the first is Changeable check list, which allow the user to fill the question in the list directly inside the program and report it by clicking on print button. The second type is Fixed check list, which allow the user to print the list and use it on the construction site by filling the table.

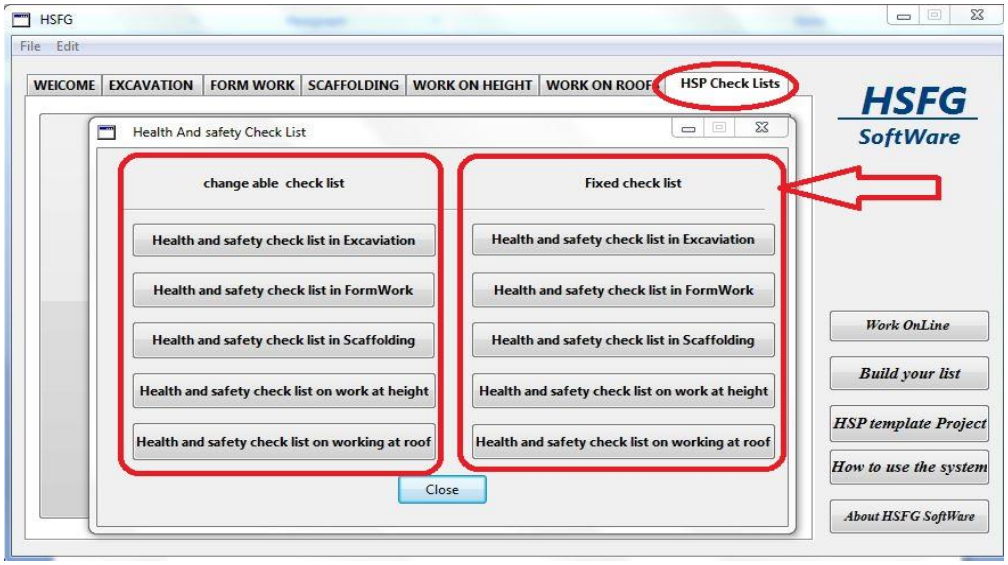


Figure 67: Health and safety practice checklist

3.8 HSFG build your list and HSP template

HSFG "build your list" button allow the users to write their own Health and Safety plan with high flexibility in add or delete the texts. The users also able to print their Health and safety plan in order to save it with necessary project documents. Furthermore, the HSP ("Health and safety practice template"), is a ready template allow the users have and idea about the Health and Safety plan by filling the empty area in the template. This also can be printed in order to save it as document or reported to the responsible on the construction site. And figure 68 shows the location of those buttons in HSFG software.

Figure 68: Build your list in HSFG software

Chapter 4

EVALUATION OF HSFG SOFTWARE

4.1 Introduction

Evaluation can be seen as a task with an outcome. Also, it can be considered an aid related to planning and goals to be achieved or as a means of choosing the best alternative from a set of results.

Generally, evaluation is founded on sound scientific and theoretical knowledge and a set of standards that are methodologically acceptable (Dzida, 1994). In relation to software, evaluation has been used and applied to for many years with a constant regard for the change in "human computer interaction". So, software can be evaluated from a variety of perspectives and with a concern for different aspects such as portability, efficiency, reliability, maintainability, usability or functionality (Desurvire, 1992).

Software evaluation in past years came to be at the last stage of the progressing phase. Experimental designs and statistical analysis were used. Nowadays, evaluation is used as an information tool that is gathered within the design. As well, experts nowadays agree that they can develop a useable software by an organized system (Scriven, 1967).

Consideration must be given to the aspects of usability within the model of the life cycle. In relation to the aspect of usability, the important section is the prototype's evaluation. It is advisable to use techniques of evaluation that are suitable so the weaknesses or errors of the software can be found from the beginning (Scriven,1967).

4.2 Evaluation Goals for HSFG

The evaluation goals in the field of software programming can have one or more of the following characteristics:

- "To choose what is better" means that the aim of the evaluation is a comparison of software systems. To that end the most suitable software tool for an application is chosen, deciding between different prototypes, or comparing different versions of a software system.
- The other goal is simply to make an evaluation on the quality of an individual system and whether or not it meets the requirements needed. In other words, simply asking how good it is. Evaluating the specific system in relation to usability is one of the aspects of this goal.
- An evaluation of a system aims to demonstrate the reasons that indicate its weaknesses as well as its strengths. Signifying the weakness of a system means that it requires further development. A good example of this aspect is the use of the re-engineering of an available system or prototype (Gould, 1997).

The first two points can be included within a general approach called "summative evaluation". The third point is as example of the concept of "formative evaluation".

Generally, "summative evaluation" deals with the development of the software related to global aspects. It doesn't give information for making a different design in a direct way. When the system's development is performed, this evaluation comes to be present. Also, this evaluation is used in prototypes simply if there is a need to control the changes between the different versions of the system.

Software improvement and the supporting aspects of design are the goals of the third point, formative evaluation. This is the important part of software evaluation. It plays a great role in repeated system development and, as in every cycle of development, it is the result of formative evaluation. Quantitative and qualitative data are analyzed: the quantitative describes the progress in realizing goals of usability and the qualitative detects the problems of usability in the system (Gould, 1997).

The data resulted from this evaluation can be categorized in the following way objective, subjective, quantitative and qualitative. The first kind of data is observable as it is the behavior of the user when using the interface or applying the system. The second kind of data is related to opinions, taking in to consideration the interface usability. The quantitative deals with the data and the result is numerical. For example, it tabulates the ratings of performance of the user. The qualitative, on the other hand, deals with the data that is non- numerical; for example, various difficulties that might be encountered when using the program and suggestions for improving the design (Gould, 1997).

4.3 Evaluation Criteria

Evaluation criteria is always a contentious issue. According to Dzida (1994), for example criteria could mean the qualities of an evaluation or design that are measurable.

Looking to the literature on software evaluation, numerous and varying opinions will be found on how best to settle on an acceptable evaluation criteria but usability as a concept is generally regarded as a commonly accepted criterion when evaluating a software system and is widely used in the determination of how good or bad a system is.

The international guideline "ISO 924" is considered the methodological foundation of standard and refers to usability as the extent to which and how easily the program facilitates the user in being able to achieve certain goals and how efficient and effective the program is in doing this. However, some factors should be taken into consideration by every evaluation:

a) The user's background characteristics in terms of age, experience, etc.
b) The kind of activity to be undertaken.
c) The study environment.
d) Generally, there are four approaches in relation to the criteria's derivation.
e) The consecutive division of rules into a hierarchical aspect so one can measure from top-down or down top the program by using clear procedures.
f) The consecutive division of hierarchical rules until the program process can not be divided any more.

g) The principles operational that takes into consideration, also the demands and the qualities related to the direct operationalization (Scriven, 1967).

However, it is advisable to refer once again to the literature of software evaluation. This is to say that there has been a growing interest in systems of information over the last years. Such systems are available to control, monitor or support business processes. Examples of such systems are:

Enterprise Resource Planning (ERP) systems, Work Flow Management Systems (WFMS), Customer Relationship Management (CRM) systems.

Also, experts have created a set of support languages as an invaluable tool in the whole process of web services which includes Business Process Modeling Language (BPML) and Business Process Execution Language (BPEL) for specifying actions within business processes with web services or Web Services Description Language (WSDL) which is used to describe the functionality described by a web service (WSDL).

4.3.1 Smith's evaluation criteria

First of all, to define when examining–methodologies related to comparison and evaluation of "internet based software products" the consumer faces a problem of sometimes conflicting information. One way to resolve this is by collecting a group of criteria that govern all methodologies for "internet based information resources". The important aspects of these applied methodologies are:

A. Product aims or scope

This is to represent an introduction connected to information and the scope refers to the items included in the software. They are:

- **Time:** How long does it take to find the information required
- **Breadth:** How much information in terms of subjects covered is available in the program.
- **Format:** Are there any resources otherwise available on the internet excluded, such as PDF or FTP
- **Depth:** How much resource detail is available connected the subject.

B. Content

According to Smith's criteria, the information is either opinion or factual. The product of software is either an important one or an integrated one. The features of the content are:

- **Accuracy:** The internet is a main tool for advertising and marketing. This raises a question related to the motives of those who put information on the net. Supporting a certain point of view will be the answer.
- **Authority:** When evaluating the product and the producer it is of fundamental importance to establish the sources of the information provided.
- **Uniqueness:** It speaks to the availability of the product in other form (e.g. CD-Rom, Print). Extra features are to be given if the information in the product is derived from an original format.
- **Links made to other sources:** This should be valid, factual, and appropriate. The external resource as a reference should be shown clearly.
- **Quality of writing:** This is important for communication in the sense that the text is well written (Gould, 1997).

C. Graphic and multimedia design

If the design of the product is poor, this decreases the interest in the product even if it is otherwise good. The visual impact can affect the success of the product as can the use of audio or video demonstrating the main features of the product.

D. Purpose

The products purpose should be stated clearly.

- **Audience:** the product's evaluation should state what market the product is intended for, whether it is students, architects.

E. Reviews

The evaluator should be familiar with the weaknesses or strengths that have been reported in media reviews of the product.

F. Workability

This refers to product's effectiveness, and this should include:

- **User friendliness:** This refers to features that allow for ease of use including readability, clear commands, and useful design.
- **Required computing environment:** This relates to the environment of the software product, if or not standard or special software is necessary for its functioning or if it needs to be supported by additional software.
- **Browsing ability and organization:** This relates to how well the software is organized, if the organization is logical and what format does that organization take. organizing the functionality of the product.
- **Searching:** This relates to how effectively can information be retrieved, in what ways, what operators or ranking features are available and if the product provides a useful search engine.

- **Interactivity:** This relates to whether or not interactive features are provided, if they work and if they enhance the programme in any way.
- **Connectivity:** It refers to accessing the products with standard software or equipment or with network environment and if the resource is reliable.

4.3.2 Belyk's and Feist's software evaluation criteria

This is another software evaluation in relation to network with the following characteristics.

- **Product selection criteria.**

In order to evaluate online tools in relation to delivery, development and administration, there are suggested criteria as follows:

- Requirements of the systems to operate the product, e.g. platform.
- Bandwidth for network use, (e.g. ADSL. Modem).
- Soft/hardware requirements of the user.
- The complexity of technical support; whether or not it has an online or offline support system, use-manuals or frequently asked questions. Another measure is if it has tools that an collaborate such as email or conferencing.
- Controls which also contain the privacy of the data, password protection, firewalls, encryption and personalization.
- Clarity which contains the size of the software and the layout.
- Technical framework such as platform, protocols, integration, files sharing.
- Features which include tools of administration and registration.

4.3.3 Alternative software evaluation criteria.

It should be emphasized that all measuring items of any criteria cannot be applied to all software programs. This is because of the kind of program under evaluation differs. In this sense, only the appropriate criteria will be used with the specific kind

of software program. The non-appropriate items within the criteria should not be used (Dzida, 1994).

However, certain criteria are quality standards and any software program should meet such standards. For example, the control of making decisions by the user. The language that is non-discriminatory, the technical assistance availability, the information that is current and valid and the reliability of the program. Such quality standards should be applied when evaluating and rating any program because they are common to all. There are features of a program that should be evaluated utilizing the following classes of criteria.

A. Information in the program

Certain features are covered by information standards such as the organization of the information, the connection to the audience, the quality of the information and the suitability of the language. Thus the information should be clear, covers all relevant subjects in the specific field and with no reference to race or ethnicity. In terms of language, it should be free of grammatical mistakes, the information should be up-to-date and there should be a clear differentiation between language that is factual and language that offers and opinion or advice (Scriven, 1967).

B. Career development process

The following points assess the ability of the specific program to be in accord with required career development. The program should stimulate the individual, enhance the career plans, and develop skills. Goals and values widen the awareness of the individual and help to obtain alternative information or routes to decision making (Gould, 1997).

C. User interaction

This deals with the interrelation between the user and the program. It addresses the program's purpose. Its organization should be effective, the language should be clear and materials would be easily accessible, the guidelines fully comprehensive and the program should allow for independent operation with an acknowledgment of user input.

The technical features of the program should be coupled with how effective its user interaction is. So the equipment used in the system and its capability in relation to graphics should be considered. Basic information about the program should be available, updating the system is easy and security is available.

D. Support

Here there is a reference to cost, written materials, service and training. Also, the process and content of updating are explained through the program coordinator.

The effective use of the program is explained through computer materials and training is available if needed. A communication system between the user and the developer is available. An online assistance is always available. Moreover, there is a reference to the standard costs charged when serving clients (Gould, 1997).

4.4 Evaluation Techniques

Evaluation can be classified into categories: organizational (expert techniques) and behavioral where the former adopts a descriptive approach and the latter a predictive one.

4.4.1 Expert technique

The views of experts descriptive evaluation techniques are the approaches used and on what the user himself does. Reliability and objectivity are the basis of this kind of technique. It also describes the factual problems of the software and can be further sub-divided under the following headings.

4.4.2 Behavior based evaluation technique

It records the behavior of the user when he is working with his system and producing certain data. "Thinking loud protocols" and observational techniques are included in such a field.

4.4.3 Usability testing and predictive evaluation

It combines both the behavior and opinion based procedures with some experimental control.

The predictive evaluation techniques aim to present certain recommendations in order to achieve software development and prevent the error of usability. This is based mainly on experts and on users also in some cases. It should be known that the predictive evaluation techniques are dependent on the "data" introduced by experts. Examples of this kind are the inspection and walkthrough techniques.

Such techniques aim to achieve results beneficial in practice. Hence, these techniques are implemented in ways that are similar to those used in problem solving. However, it is noted that the techniques based on the observational aspects and opinion aspects need a prototype that is sophisticated. On the other hand, the predictive evaluation techniques are not in need of a built system because the experimental methods are changed by experts' contribution or theory (Dzida, 1994).

Hence, the involvement of all users is not essential in the experimental techniques as the user, in this instance, has a passive role. However, the involvement of a user is important in predictive techniques as the user or his representative has the chance to actively influence the process's development (Desurvire, 1992).

4.4.4 Other techniques

A number of techniques have been listed in the previous pages, However there are still other different or combined techniques that have been used in the past years. The "interpretative evaluation technique" is an example of an informal kind of technique relying on sociology and anthropology. The participative evaluation, the cooperative techniques and the contextual inquiry support the complete treatment of evaluation.

There are also the modeling approaches. This describes formally the computer interaction of the human. This has the outcome of a number of developments, such as the yoked state space (YSS), the knowledge analysis of tasks (KAT), the task knowledge structure (TKS), the external task or internal task mapping (ET IT) and the task action grammars (TAG). All of those give true results and they are applied in small-scale comparisons (Scriven, 1967).

4.5 The evaluation technique used and results for HSFG software

The HSFG software has been evaluated based on the expert techniques by sharing the software in front of experts. Those experts are located in different countries. The first member is from Iraq-Mosul city with 30 years experience in the supervision of construction process in different types of projects in Iraq.

The second member is from Iraq-Deyala with 10 years experience working as a branch manager of a governmental construction institute. And the third member is

also from Iraq-Baghdad with 20 years experience in the field of health and safety supervision.

The forth member is general manager of private local company in Libya with 30 years experience in construction management and also worked as instructor in one of the Libyan university.

Finally, from Turkish Republic of North Cyprus an advice presented by expert people in computerizing and programming languages in order to reach the best feature for the HSFG software and follow the design and modeling regulation in the process of programming HSFG software.

The HSFG software presented in front of those experts individually. The experts took four months to revise the HSFG software. Within this time, communication continued several times in order to give their advice and judgments on the weak points in the HSFG software. Throughout the time of communication, weaknesses of the program have been managed and gradually the HSFG program has been developed. The main weak points mentioned by the experts are:

- Location of the information selected in HSFG software and the type of presenting it.
- How the novice will learn from the HSFG software to prepare their own health and safety plan from the information selected.
- Usability of the HSFG software for novice worker and engineers
- The user interface and start up of the HSFG software.

- The presentation of the information in the program has been reformed many times in order to make it easy for primary workers and engineers.

And the techniques used in HSFG software evaluation are based on of the following:

a) **First look:** It deals with the intended audience and the basic content available on the specific software such as HSFG program.
b) **Information quality:** This includes the purpose of the program or the software, the efficiency and organization of the content, and whether or not the information provided is understandable.
c) **Ease of navigation:** Directions how to use the software are clear and avilable, easiness of moving around, and international and external links work properly.
d) **Browser compatibility and objectivity:** This deals with the goals of the software, details, and opinions.
e) **Coverage:** The user shoud be aware of whether viewing information needs specific software. It also should be made clear if getting access to certain information is free or comes with a cost.

The expert used the first look technique among other different methodologies applied on the evaluation of HSFG soft ware. This technique deals with the intended audience and the content of the program. As far as the audience or the user of the program is concerned, the user's satisfaction is very important. This expresses how far the needs of the users are achieved.

On the other hand, the content refers to the information sited on the program. In this sense, the technique can refer to certain features of the content such as the motifs of the author behind placing information into the program.

The experts reached that the program has been successful in relation to first look technique and HSFG software proved that the necessary requirements explained above are achieved and the software obtain it.

The experts also used to check the information quality of HSFG program. The evaluation of the information quality of the HSFG program was based on the purpose of the program, the organization of the content, the understandable information that covers all relevant aspects in the field of health and safety on construction site activities.

As well, the experts used to have comments on the style of the HSFG program as the program has been tested for the first time. They used to modify it several times in order to reach a good quality of presenting the information.

The experts were satisfied by the information itself and the program has succeeded in this part. The experts' judgment was negative concerning reporting the data. The experts suggested adding other tools to be more helpful and to enhance the user with equivalent quality that the HSFG software contain.

After being modified many times, the software finality showed that it has been acceptable to be a reference and a guide software. This is based on the information

and the quality of the program and the tools that are used either from online enhancement or other tools added on the HSFG software.

Ease of navigation is one of the questions raised by experts when they are evaluating the HSFG software. This method being checked has proved that the program has the flexibility in using the tools and commands on the HSFG program. The commands on the program are readable and the result of these commands are clear for the user as judged by the experts.

Generally, the easiness of navigation can be seen in the following aspects: clear language, operating the program independently and individuals can easily start and exit. The experts' judgments on the HSFG software were based on the above techniques that were used. The experts comment that the HSFG programs is fully easy and friendly of use.

Moreover, the browser compatibility of the HSFG software has been tested by the experts. This test is concerned with the effectiveness of the program on the user through using different tabs or browsers in the software. The used tabs will shed light on the scope or the main content of the software.

The comment of the experts on the compatibility of the software was positive effect, because the software shows that it has the scope and solution for the issues on the critical activities on the construction site.

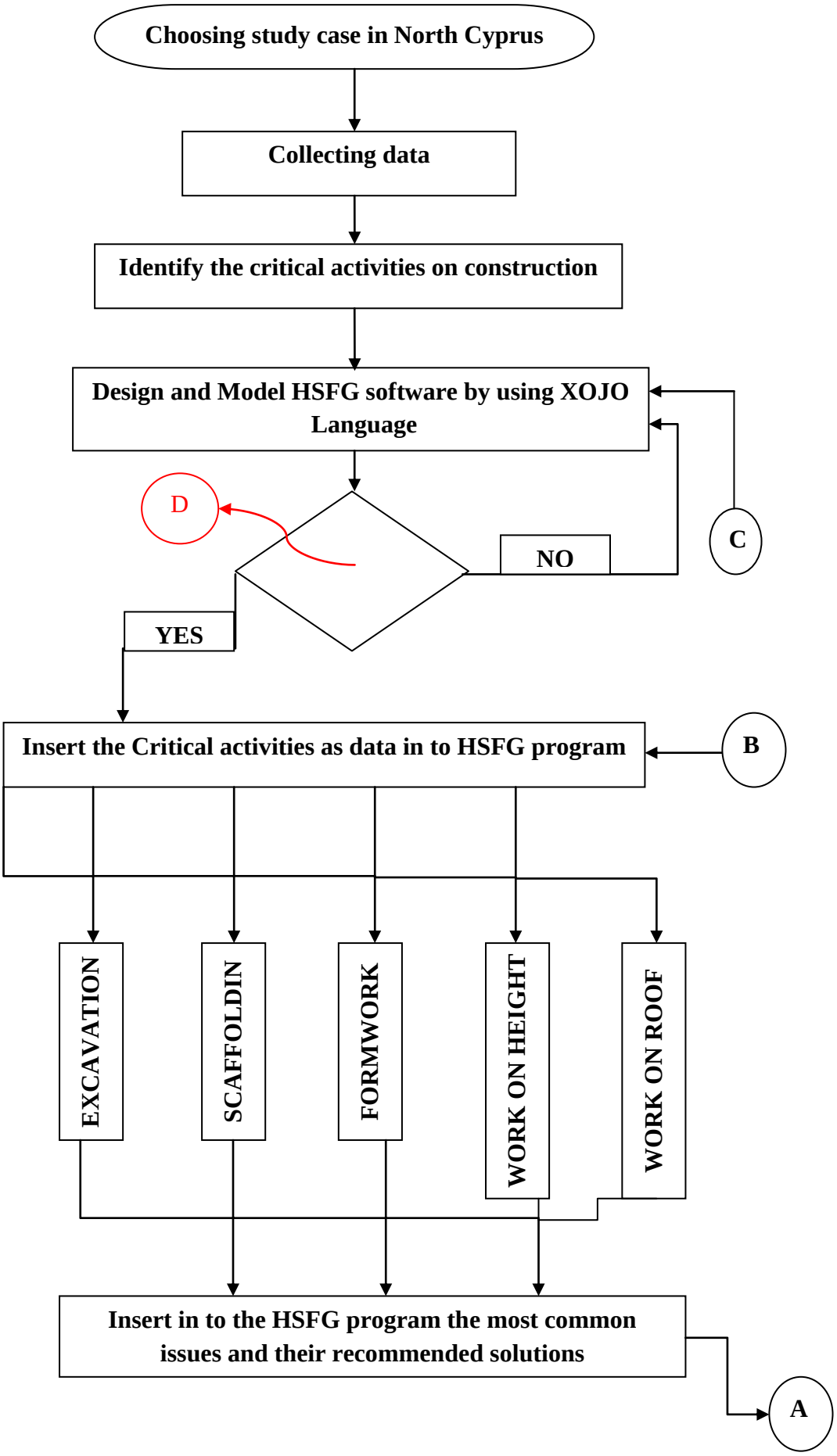
From different favourable comments received from the evaluation, HSFG software has features that are absent in other softwares. And the praise is especially related to

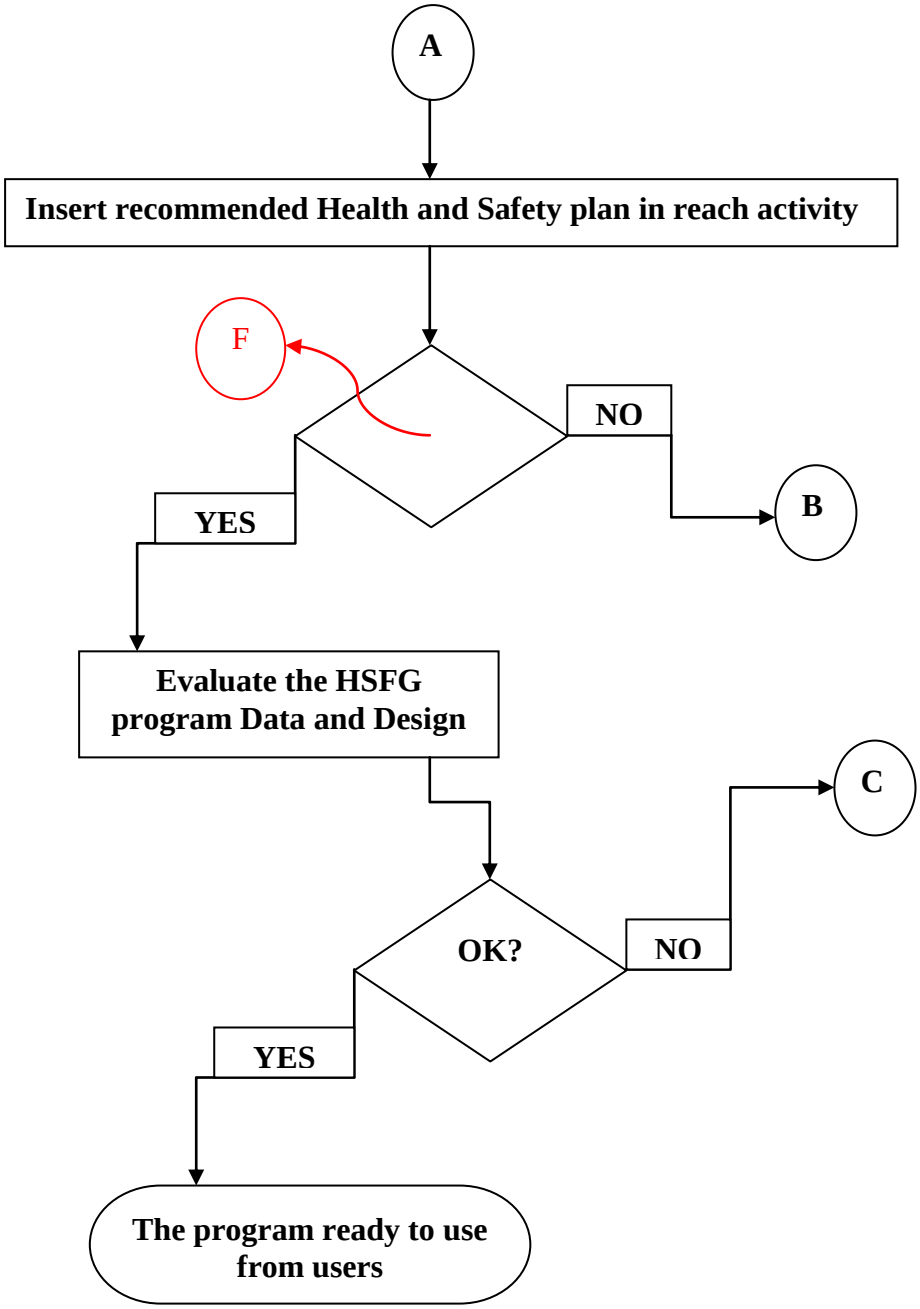
how well it facilitates planning health and safety programmes online and sharing them via the internet. The HSFG software shows its ability to be a very fast guide and helpful for different relevant areas such as an educational guide in the field as well has an enormous helpful for the new generation of engineers and a reference for profisional engineers too.

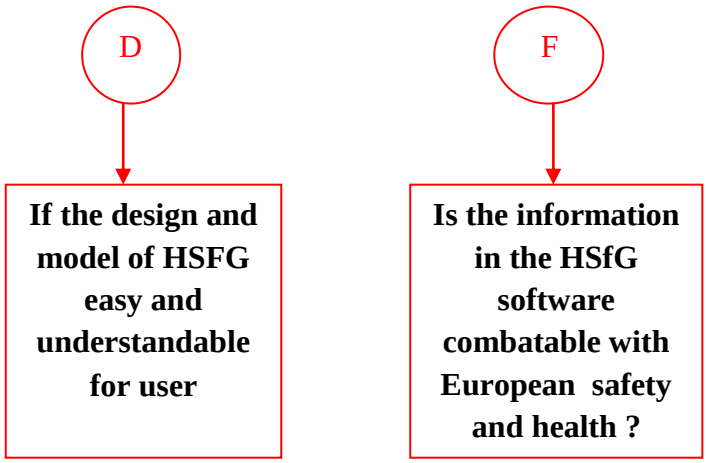
4.6 HSFG evaluation Summary

The application of evaluation techniques on HSFG software has achieved a lot, however, a great effort is needed to develop models that can be used practically. Nowadays, the software evaluation techniques and models are diffrent in relation to effectiveness, cost benefit relations and efficiency. However, in HSFG we had to take into consideration time efficiency, the satisfaction of user and learning suitability. Also, we are in need of further research and applications in order to have well-developed "software evaluation procedures".

In the above pages a general survey of methodologles in the field of software evaluation is introduced. This survey expresses the availability of different approaches and methodologies which have been considered through programing HSFG software in order to assesss software products. Such methodologies present the system of the information operation within a local and global network environment. The flowchart below summerize the process of building the HSFg knowlage system.


Choosing study case in North Cyprus
Collecting data
Identify the critical activities on construction
Design and Model HSFG software by using XOJO Language
D
NO
C
YES
Insert the Critical activities as data in to HSFG program
B
EXCAVATION
SCAFFOLDIN
FORMWORK
WORK ON HEIGHT
WORK ON ROOF
Insert in to the HSFG program the most common issues and their recommended solutions
A


A
Insert recommended Health and Safety plan in reach activity
F
NO
B
YES
Evaluate the HSFG program Data and Design
C
OK?
NO
YES
The program ready to use from users


D
If the design and model of HSFG easy and understandable for user
F
Is the information in the HSfG software combatable with European safety and health ?

Chapter 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Experience has proved that workers and administrative staff are facing health and safety problems on construciton sites.These problems are further exacerbated by the fact that sometimes there is little or no cooperation between those working on construction projects. It is clear that for too long concerns over the well-being of those employed in construction projects have too often been neglected and issues of health and safety need immediate and urgent attention.

In this regard, a program provided by HSFG software should be carried out so that workers and administration can fill a knowledge gap related to health and safety. The intention of this research is to present the best features of a health and safety programme using HSFG software and some safety techniques and tools. The guidance presented is simple but comprehensive and the solutions are straightforward and easy to adopt. In other words, the guideline proposals can provide a handy reference that will meet all the requirements for a comprehensive and workable set of practices in health and safety.

Hence a good management system for the construction activities on construction sites should have powerful health and safety plan. So, the HSFG software shows the health and safety problems mainly the critical activities. Those critical activities are

excavation, formwork, scaffolding, work on height and work on roofs as result of investigation and observation of the selected construction sites. Each activity mentioned, have its own health and safety plan in HSFG software. Also developing such system aimed to be used as training tool in order to educate workers and engineers on construction sites about health and safety issues.

It has been noticed that the governing theme function of the HSFG software is that it not only contains the most critical activities but solutions for those activities with an easy format that gives the flexibility to the user to shift between the tabs in the HSFG software. In this since the specific regulations of each activities can be known.

It has been proved that the HSFG support itself as well as using online tool which give the flexibility to write and make management plan. This can be applied in planning health and safety of a construction site or processing any kind of project management plan.

It has been noticed that the HSFG program can solve the problem of communication between the engineers and sites' directors through the HSFG online tool.

The content of HSFG software and its efficiency can be seen clearly. The HSFG software is characterized by its easy usability format, clear language and its quality information. Hence, the users of the program can easily start or exit.

Based on what is said above, many experts in the construction field have stated that HSFG software will be helpful in promoting greater awareness of health and safety issues and will be an important factor in limiting work-related injuries as well as

enhancing workers's education and knowledge on all matters connected to safety in the workplace.

In general, the study contains a series of proposals offered in a spirit of advice. However, it is how this advice is adopted and turned into positive action that is the more crucial concern for the aim in the short and long term is to reduce as much as possible the incidence of injury, sometimes serious and occasionally fatal, brought about by unsafe practices on construction projects.

5.2 Recommendations

The suggestions and recommendations are based on the survey and the result of the research of this thesis as follows.

5.2.1 Recommendations to the organizations

In order to reduce the losses of work-days because of the absence of workers, address the issue of fatalities or injures in the workplace, and improve the income budget of the country from the construction industry sector, it is suggested to train the workers on the construction site and also the administrators in the field of construction on knowledge based software such as the HSFG program with the purpose of equipping them with the theoretical knowledge and the practical skills in health and safety matters which will allow them to recognize what has gone wrong in the past and so be able to prevent the reoccurrence of similar accidents in the future.

It is also recommended that educational institutes train each new generation of engineers and develop their knowledge base using HSFG software because it is user-friendly and easy to understand.

5.2.2 Recommendations to the companies

It is further suggested that workers be penalized for ignoring or disregarding health and safety regulations on the construction work site. Additionally, it is urged that a special committee be established for private corporations that would regulate, monitor and administer health and safety activities with a view of reducing on worksite related accidents.

5.3 Further work

In order to develop the research, it is suggested that other activities such electrical, mechanical, preconstruction and after construction works be added. Also, it is recommended to create safety strategies for each of the works.

The researcher hopes that this thesis will inspire additional research and the development of further guidelines and proposals to assist practitioners in the field of construction management.

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