Analysis of Safety Measures in Old Government Schools Building for Multi Hazards. A Case Study of Hashtnagri, District Peshawar

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Abstract

Natural disasters are all always sudden and fluctuating processes that remain a risk to sustainable socio-economic development around the world. Safety measures play crucial role in coping with disasters therefore, safety management in schools is essential because it guarantees the safety of students, teachers and other staff and stuff of the schools. School play an important role in socioeconomic development of the nation. Therefore, to analyze the safety measures different government high schools were surveyed at district Peshawar, Khyber Pakhtunkhwa. After surveying different government high schools, two schools i-e Shaheed Hasnain Sharif No.1 and Shaheed Osama Zafar Centennial Model High School No.2 were selected for analysis because of high vulnerability to multi hazards. The leading objectives of this qualitative study were to conduct multi hazard risk assessment of the government schools building using UN-Habitat Tool, secondly to assess the impacts of hazards on school buildings and finally to identify the necessary actions to strengthen the schools building capacity. Based on this study, it was found that, due to weak architectural design and non-structural elements the school buildings are vulnerable to both fire and seismic hazard. The study revealed that facilities and equipment were not fully protected and majority of the unit's lack fire extinguisher equipment. There was no emergency response team and no evacuation centers were properly identified to cope with sudden event like an earthquake and explosion. The fire and earthquake will cause extreme damages to building and loss of lives if occurred therefore, the School buildings need preventive measures against the fire and seismic actions. In addition, teacher staff and students had not received any training about disaster or seismic management and fire emergency management and were unaware of the use of fire extinguishers.

Keywords: Seismic performance, disaster management, UN-habitat tool kit, Schools, Hazard, Fire safety, Risk assessment, non-structural elements

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Introduction

Globally, disasters are dynamic in nature, which effects every aspect of a community (Rehman et al., 2019). Disasters like earthquake, floods, tsunami, and fire had caused a severe damage to social, physical, economic and environment sectors (Zevenbergen, 2012). The primary effect of earthquake is physical destruction of buildings like schools, hospitals, and other infrastructures. School buildings are important structures that shall provide resistance during earthquake and fire hazards (Arya, 2011). However, due to improper methods of planning, structural, non-structural elements and architectural design enhance the vulnerability of school buildings for natural and anthropogenic hazards. Similarly, inadequate maintenance of aged school buildings had caused severe economic and human loss (Zevenbergen, 2012). Twentieth Century's last decade caused many damages to public buildings due to earthquake proved to be more dangerous than that one occurred to the private buildings (El-Arab, 2017).

Earthquakes are uncertain and can happen suddenly, destructively at any time round the year (Mohamed, 1998). Annually, about 70 – 50 destructive earthquakes happened throughout the World (Sullivan et al., 2007). The disastrous earthquake that hit Nepal on 25, April 2015 had caused far reaching affliction to the education buildings, containing college of Nepal's main university (Ghimire. 2015). In 2004 fire accident occurred in a school in Kumbakonam town in Thanjavur district in the Indian state of Tamil Nadu. About 94 students were burnt to death in their classroom as the roof caught fire on 16 July 2004.

In the previous two decades, Pakistan has been devastated by a series of natural disasters (Fahad & Jing, 2018). Pakistan is divulged to both intentional and unintentional hazards. The diversity of natural hazards, comprised of natural disasters like floods, earthquakes, droughts, landslides and human induced including technological hazards, terrorism and fire hazard (Himayatullah et al., 2008). On October 8, 2005 earthquake had caused destructive and unpleasant influence on education system as over 18,000 students and 900 teachers lost their lives [NDMA, 2017]. About 7489 schools were destroyed in the 2005 Kashmir earthquake resulting in the deaths of 1700 school-aged children (Shah et al., 2018; Wisner, 2006). In the middle of 2007, Pakistan experienced intense storms and a major cyclone causing severe flooding, displacing over 300,000 people and affecting more than 2.5 million. Khyber- Pakhtunkhwa (KP) province of Pakistan is the highly prone to natural and anthropogenic hazards and is most affected among the other provinces of Pakistan. High number of educational institutions have not the capacity to cope hazard (such as earthquake, flooding, landslides and associated disasters) because

of poor architectural and structural designs, deficiencies of preparedness and response plans [UNDRR, 2013].

Fire is becoming arising hazards in the urban settlements of district Peshawar, main city of KP. In recent decade many fire events occurred in houses, industrial units, markets, hospitals and schools (especially the privately-owned ones). In 2013, about sixteen students of a school agonized with burn injuries when a fire blows up inside a school building in Nothia, the overcrowded area of the Peshawar city (PDMA, 2008). In seismic risk concept, the assessment of ground motion intensity for future earthquakes plays significant role (Muhammad, et al., 2018). Therefore, Risk Assessment is requirement of the day for every workplace. Even a minor risk could have fetal consequences and will have serious financial implication for any business. The mission of creating well off and a standardized tool kit for the safety assessment in schools and hospitals for multi hazards in Asia was initiated by UN-Habitat, in collaboration with United Nation International office for risk disaster reduction (UNISDR), Asia Pacific Secretariat and the South Asian Association for Regional Cooperation Disaster Management Centre (SDMC) in 2011 (Chadia et al., 2017). The basic framework for Risk and vulnerability assessment in schools and hospitals was adopted from the SDMC template and were deployed in those areas of Asia that are prone to multi hazards like flood, earthquake, tsunami and fire etc.

Study Area

Peshawar district is more vulnerable to earthquakes because of the four faults (Manki Fault, Garhi Chendan Fault, Hissartang Fault and Hassan Khel Fault) crossing Peshawar district as shown in the Fig. 1 [NDMA, 2017]. The study area selected for this research work was Hashtnagri, which is located on both sides of Grand Trunk (GT) Road Peshawar in Peshawar city of Khyber Pakhtunkhwa. There are three government schools in Hashtnagri i-e Government Shaheed Hasnain Sharif Higher Secondary School, Government Shaheed Osama Zafar Centennial High School and Government Girls Middle School **(**Khurram,2016).

Survey and Data collection

An investigation survey was conducted in Peshawar to select the most vulnerable schools to multi hazards that include fire, flood, wind, and seismic hazard as to find out which school is more vulnerable or more exposed to all these hazards. Among them the most vulnerable and highly exposed schools to multi hazards were selected for risk assessment.

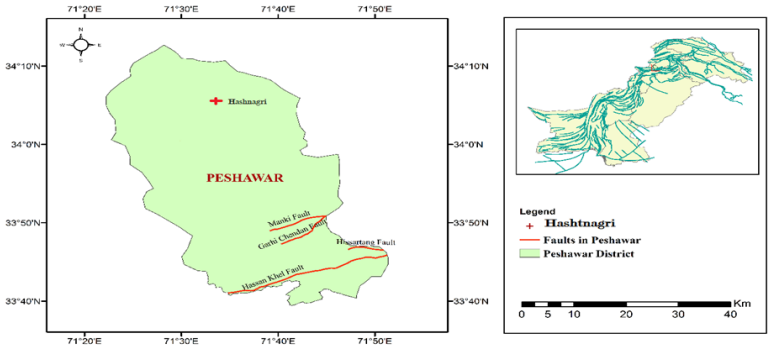


Fig. 1. Fault Map Lines Passing through District Peshawar

Two government schools i-e Govt. Shaheed Hasnain Sharif Higher Secondary School No.1 and Govt. Shaheed Osama Zafar Centennial Model High School No. 2 were selected during the reconnaissance survey because of its highly vulnerable condition among other schools. Depending on the nature of the required information, both primary and secondary data were collected from the appropriate sources. UN-HABITAT tool for multi hazard risk assessment have been used to gather data from target population i.e. Semi Structure Interviews, field observations and other secondary sources such as internet, books, journals, articles, relevant offices etc.

Data Analysis

Generally, the UN-Habitat tool is used for Multi Hazard Risk Assessment covers four types of hazards i-e Seismic, Fire, Wind and Flood. In this case, only two hazards have been covered that is Seismic and Fire. Flood and Wind hazards were ignored in this case study because the School buildings are in safe location from flood and wind. Flow chart of the overall process is shown in Fig. 2.

Data Analysis for Government Shaheed Hasnain Sharif Higher Schools No.1

Existence of Seismic Hazards:

For the better assessment of school building the seismic and fire hazard analysis are further classified into four categories. These include planning issues, architectural design, structural and non-structural elements of the building. The data was collected for each element of both seismic and fire hazards and analyzed through the UN-HABITAT tool which gave the results in the form of tables and bar graphs. Each category

in seismic and fire hazard has values that are compared with the consultant range of values. The compliance and consultant range values are given in Table 1.

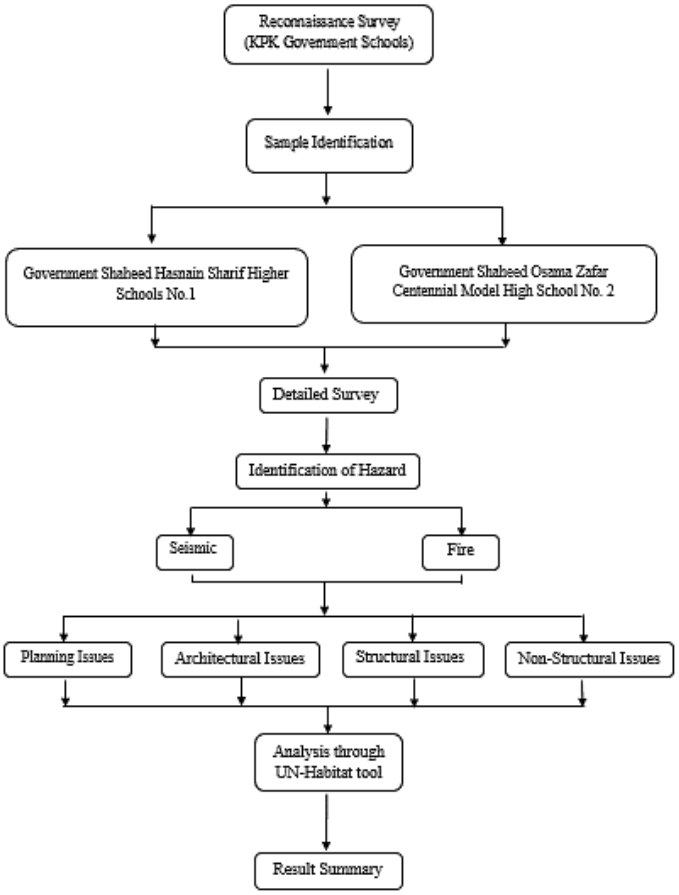


Fig. 2. Data Collection and Analysis Flow Chart

Table 1: Consultants Compliance

0	Not Addressed
0.25	Low
0.5	Medium
0.75	High
1	Completely Addressed
NA	Not Applicable

Planning Issues

According to UN-HABITAT Tool there are six questions in the Planning category that needs to be answered appropriately according to the situation, location and access to the school building. These six questions are represented by P1, P2, P3, P4, P5 and P6. The selected school building has only one main road that can be used for the access and movement of fire engine during emergency. Access to the school building under study is shown in Fig. 3. Table 2 shows the planning analysis in seismic hazard assessment of the school building.

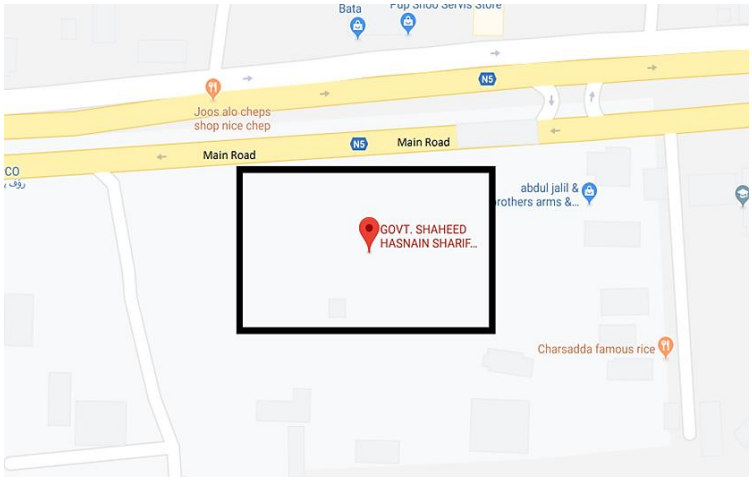


Fig. 3. Single Road Access To The School Building

Table 2: Planning Issues in Seismic Hazard

SEISMIC HAZARD		
	Planning Issues	**Seismic Compliance**
P1	The distance between study area and fault line is greater than 1000m	0.75
P2	One access road would be suitable during emergency	0.75
P3	The road wideness is enough and other buildings are away from the school building.	1
P4	In schools building the alternate sources of water are present for 24-48 hrs.	1
P5	Enough gap has been provided to avert pounding effect.	1
P6	The School building have not suitable space for gathering during emergency	0.5

Architecture issues

According to UN-HABITAT tool, architectural issues in seismic hazard are related to structural configurations i-e irregularity and non-uniformity, vertical irregularity, provisions for physically challenged-friendly access to the buildings and functional areas, provision for emergency exit in the building plan, fixity of glass and other panels door openings, fixity of tiles on walls, securely attachment of parapet walls to the building structure, Length/breath ratio and Height/width ratio of the building and provision of walls and/or columns in grid lines. Architecture issues are denoted by A1, A2, A3 upto A9. Based on the questions asked in UN-HABITAT tool, it was concluded that the building of Government Shaheed Hasnain Sharif Higher Schools No.1 consists of both irregular and non-uniform shape without structural separation (pounding effect) while the parapet walls are eroded and not restrained to the building at all as shown in Fig. 4. Building design of the selected school is not suitable for physically challenged people. According to the data collected, seismic compliance for the architectural issues are given in Table 3.

Table 3: Architecture Issues in Seismic Hazard

SEISMIC HAZARD		
	Architectural Issues	Seismic Compliance
A1	The Shapes are asymmetrical, and structure is having no joints	0.05
A2	The story elevation is alike (i.e., but contrast by < 5%); irregular elements are not present	1
A3	The school building is not suitable for disabled people	0.1
A4	There are exit passageways which has a width less than 2.4 m but more than 1.2m, and are well lit, not so difficult to identify and to use during emergency	0.75
A5	Windows are provided without glasses	NA
A6	Wall have no tiles at all	NA
A7	Parapets walls are weakly attached	0.05
A8	There is Moderated level of difference of length/ breadth/ height ratio from safe limit	0.5
A9	All walls and columns of the building are constructed in a network & some (<15%) not in network in other direction	0.75

Fig. 4. (a) Irregular Shape (b) Rectangular Shape (c) Eroded and Non-Restrained Parapet Walls

Structural issues

The structural issues for seismic hazard consist of ten questions related to microzoning, bearing capacity of soil, liquefaction, load path, provision of reinforcement per code, seismic load and short column effect. Structural issues in UN-HABITAT tool is represented by S1, S2 up to S10. After investigation it was found that micro zonation has not been considered in the school building and the effect of seismic load has not been taken in the design of building. The Seismic compliance value for each structural issue is given in Table 4.

Non-Structural issues

Non-Structural issues are denoted by NS. In non-structural issues, plumbing lines, fire protection piping, connection of gas pipelines in labs, suspended lighting fixtures, fixation of emergency generator and fire alarm equipment's are addressed.

In non-structural point of view, the school building was having no fire alarm, no fire protection piping and no emergency generator. Seismic compliance of non-structural issues is given in Tables 5.

Existence of Fire Hazards in Government Shaheed Hasnain Sharif Higher Secondary School No.1

A fire is a chemical reaction. There are many variables that can affect a fire. Effective fire safety management programs control the

variables that can affect a fire. Therefore, it is imperative to understand the variables. A fire requires three variables to initiate: a fuel, oxygen, and heat.

Table 4: Structural Issues

SEISMIC HAZARD		
	Structural issues	**Seismic Compliance**
S1	The building is constructed without considering micro-zonation recommendations for site	0.25
S2	Structural system is not considered according to the soil condition.	0.25
S3	They have not mentioned any source of information neither you have considered liquefaction effect in the building during construction	0.25
S4	There is a slight eccentricity from the load path	0.75
S5	Merely corner reinforcements have been provided	0.25
S6	Building is constructed without ductility detailing	NA
S7	The seismic load has not been taken into account in the design	0.25
S8	There are no Short-Columns in the building	NA
S9	The distance between Doors, windows and wall corner are less than 600mm and the distance between two openings are than 600m	0.25
S10	Plumbing lines & rooftop/above water tank are satisfactorily strengthened & safe	1

Table 5: Non-Structural Issues

SEISMIC HAZARD		
	Non-structural Issues	**Seismic compliance**
NS1	Roof top water tank and pipes system are properly anchored	1
NS2	Fire protection piping does not exist	NA
NS3	There is no lab.	NA
NS4	The suspended lighting fixtures do not exist	NA
NS5	Emergency generator does not exist	NA
NS6	There is no fire alarm equipment	NA
NS7	Communication components on rooftop have not been provided	NA

Planning issues

The type of access road and safe entry for the school with reference to the exterior of the school building, rate the building's vulnerability to external fires is a significant part of building safety. Is

there any open place in the school where students can assemble during a fire?

There is one main road that is enough for fire vehicles to operate during fire emergency. Wood materials are used in the roof and windows of the building which make it vulnerable for fire hazard as shown in the Fig. 5. Fire compliance related to other issues are given in Table 6.

Fig. 5. Roof With Wooden Materials

Table 6: Planning Issues in Fire Hazard

FIRE HAZARD		
	Planning Issues	**Fire Compliance**
P1	There is one main road that is enough to provide services and perform all functions during emergency	1
P2	There is medium (school's exposure to external fire)	0.5
P3	Open space in school building is not enough for gathering during emergency	0.5

Architectural issues

According to architectural point of view, every room in a building must be provided with one main escape route, the main meter box should be in safe location, the main switch should be in the entrance lobby and whether the existing staircase is protected for safe evacuation during fire or not?

Majority of the stairs in the school can cause further damages during fire emergency because the stairs are not enough wide to support

more than two students during evacuation as shown in Fig. 6. Fire compliance for architectural issues are given in the Table 7.

Table 7: Architectural Issues in Fire Hazard

FIRE HAZARD		
	Architectural Issues	**Fire compliance**
A1	Every room is provided with one main escape route	0.05
A2	The main meter box is in safe location	1
A3	The main switch is in the entrance lobby	0.05
A4	The existing staircase is not protected for safe evacuation during fire	0.25
A5	There is no fire escape stair	0.15
A6	There is lack of water source to use during emergency	0
A7	Sprinklers have not been planned for	0.25
A8	The doors open inside	0.05
A9	Kitchen is at a safe distance from wardrooms	1

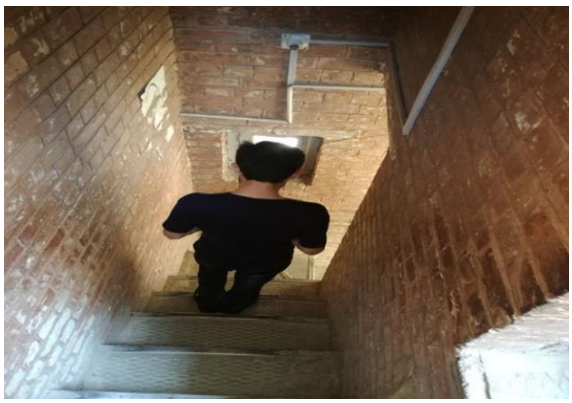


Fig. 6. Stairs with Small Wideness

Structural issues

In structural issues of a building it must be kept in mind that the structural members must be insulated in order to get safe from fire. In the school under study, fire prone material like wood was used in the building which can increase the building vulnerability to fire hazard as shown Fig. 5. Fire compliance for structural issues are given in Tables 8.

Non-Structural Issues

Non-Structural issues in a building in terms of fire is related to quality of electricity wiring, emergency batteries, fire alarms and fire extinguishers etc. The quality of wiring in Government Shaheed Hasnain

Sharif Higher Schools No.1 was very old which can cause damages in future due to short circuiting. The school building has not been provided with lightening arrester and no earth system was founded. Non-Structure issues are given in Tables 9.

Table 8: Structural Issues in Fire Hazard

FIRE HAZARD		
	Structural Issues	Fire Compliance
S1	Structural members that aren't insulated and/or the building's materials are exposed to fire	**0.25**

Table 9: Non-Structural Issue in Fire Hazard

FIRE HAZARD		
	NON-STRUCTURAL ISSUES	Fire compliance
NS1	The quality of wiring is not founded	0.25
NS2	Earthen has not been provided	0
NS3	Lightning arrester has not been provided in the building	NA
NS4	Emergency batteries is present near the lobby of the schools building	0.25
NS5	No fire extinguisher is present in the building, especially in Chemistry lab	NA
NS6	Fire alarm system is not provided in the building	0.25

Data Analysis for Government Shaheed Osama Zafar Centennial Model High School No. 2

Existence of Seismic Hazards:

In this section planning issues, architectural design, structural and non-structural elements of Government Shaheed Osama Zafar Centennial Model High School No. 2 are addressed using UN-HABITAT tool.

Planning issues

The school building can access by one main road and two streets during the emergency situations as shown in Fig. 7. Other issues related to planning are given in Table 10.

Architectural issues

School building under the study was W-shape with irregular structure. Parapet walls were eroded and not restrained at all. Story heights

were not the same as shown in Fig. 8, 9 and 10. Architectural issues are given in Tables 11.

Fig. 7. One Main Road and Two Streets Access to School Building

Table 10: Planning Issues in Seismic Hazard

SEISMIC HAZARD		
	Planning Issues	**Seismic Compliance**
P1	A large distance between fault lines and the study site which are more than 1000m	0.75
P2	One main access road and two streets appropriate for fire engine access & other movement	1
P3	The road is sufficiently wide, and surrounding structures are unlikely to fall after an earthquake.	1
P4	The building is not provided with internal water system that can be used during emergency for 24-48 hours.	0.25
P5	Enough gap has been provided to elude pounding effect	1
P6	There is enough open space for gathering	1

Fig. 8. W-Shape School Building

Fig. 9. Irregular Story Heights of the Building

Table 11: Architectural Issues in Seismic Hazard

	SEISMIC HAZARD **Architectural issues**	**Seismic Compliance**
A1	Shapes are unbalanced and structure is not uniform	0.05
A2	Difference between two Story heights are alike (they differ by > 5% but <20%) and the irregularity of elements is very low	0.5
A3	The design is not suitable for evacuation during emergency for disabled people	0.1
A4	The wideness of the emergency corridor is less than 2.4m and higher than 1.2m are present in the building which are properly lit, not hard to recognize and use for evacuation in crisis	0.75
A5	Have not detailed glass in openings for drift of the structure	0.05
A6	Wall have no tiles at all	NA
A7	Parapets are not restrained at all	0.05
A8	There is average level of dissimilarity of length/ breadth/ height ratio from safe limit	0.5
A9	Totally walls &/or columns was constructed in a way that were in safe network& some (<15%) not in network or grid in other direction	0.75

Fig. 10. Parapet Walls Not Restrained to the Roof and Fallen on the Left Side

Structural issues

Veranda and other walls of the buildings as shown in the Fig. 11 and 12. Issues are explained in the Table 12.

The material used in the construction has been eroded. There are many cracks in the walls of the building.

Table 12: Structure Issues in Seismic Hazard

SEISMIC HAZARD		
	Structural Issues	**Seismic Compliance**
S1	There is no micro zonation recommendations for the site	0.25
S2	The building is not constructed on structural system according to soil condition	0.25
S3	It is found that liquefaction is not considered	NA
S4	There is a slight deviancy from the load path	0.75
S5	No horizontal band and vertical and horizontal bands are provided	0.05
S6	The code-required reinforcing detail to ensure the structure's manipulability was not completed.	NA
S7	The design is constructed without the concept of seismic load in the building	0.25
S8	There is no short column effect in the building	NA
S9	The distance between doors and windows are less than 600mmfrom wall curve and similarly the distance between two opening is less than 600mm	0.25
S10	The entire width of door and window in a wall are less than from its wall length	0.25

Fig. 11. Eroded Wall of Building Room

Fig. 12. Wide Crack Between Veranda and Building Room

Non-Structure Elements issues

Fire protection alarm had fire extinguisher are not installed in the building. Emergency generator is not present in the building and other issues has shown the Table 13.

Existence of Fire Hazards:

Planning issues

Because of wooden materials, wiring system and painting of the building enhance its vulnerability to fire hazard as shown in the Tables 14.

Table 13: Non-Structure Issues in Seismic Hazard

SEISMIC HAZARD		
	Non-Structural Issues	**Seismic Compliance**
NS1	Sanitation lines & rooftop/overhead water tank are satisfactorily sustained & protected or there is a hand pump	1
NS2	Fire protection piping does not exist	NA
NS3	There are no flexible joints, and the lines aren't fastened in the right places	0.05
NS4	There are no suspended lightening fixtures	NA
NS5	Emergency generator is not present	NA
NS6	Fire alarm system is not installed	NA
NS7	There is no communication equipment on the rooftop	NA

Table 14: Planning Issues in Fire Hazard

FIRE HAZARD		
	Planning Issues	**Fire Compliance**
P1	Only one access road is found to the building	0.75
P2	School's proneness to external fire are high	0.05
P3	There is adequate open space for gathering	1

Architectural issues in Government Shaheed Osama Zafar Centennial Model High School No. 2

The building is provided with only escape route. The kitchen is located near classrooms. Others issues are showing in the Tables 15.

Table 15: Architectural Issues in Fire Hazard

FIRE HAZARD		
	Architectural Issues	**Fire Compliance**
A1	Only one escape route in each room are founded	0.05
A2	The main meter box is founded in safe location	1
A3	Main switch is in the entrance lobby	0.05
A4	The staircase is not suitable for safe evacuation during fire	NA
A5	There is no fire escape stair	NA
A6	Water tank for fire emergency is not provided	0
A7	Sprinklers have not been planned for	0.25
A8	The doors open inside	0.05
A9	Kitchen is located in danger zone as it is near the classrooms	0.05

Structural issues in Government Shaheed Osama Zafar Centennial Model High School No. 2

Structure of the building is little prone to fire hazards but the material used inside the building are increasing the vulnerability of the building as given in the Tables 16.

Table 16: Structural Issue in Fire Hazard

FIRE HAZARD		
	Structural Issue	**Fire compliance**
S1	Structural members are not insulated and/or building's materials are founded prone to fire hazard	0.25

Non-Structural issues in Government Shaheed Osama Zafar Centennial Model High School No. 2

The Non-Structural Issues are given in Table 17. There is no lightning arrester in the building. Emergency batteries are present in the entrance lobby of the building.

Table 17: Non-Structure Issue in Fire Hazard

FIRE HAZARD		
	Non-Structural Issues	**Fire Compliance**
NS1	It is not found about quality of wires used in the building	0.25
NS2	Earthen has not been done	0
NS3	Lightning arrester not been fixed	0
NS4	Emergency batteries such as Inverter situated in the entrance lobby of the building	0.25
NS5	The building lacks a fire extinguisher, particularly in the Chemistry lab	0.25
NS6	There is no setting up for fire alarm	0.25

Result and Discussion

After data analysis the following result has been obtained as shown in the following graph and tables.

Summary of all Categories for the Govt. Shaheed Hasnain Sharif Higher Secondary School No. 2

This Bar Chart is showing the entire range of compliance for structural, non-structural, architectural and planning issues in the school building. The overall multi-hazard compliance hazard was 0.24 as shown

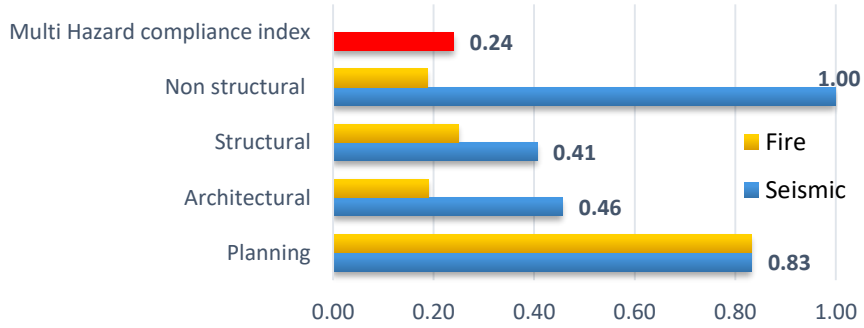
in the Table 19. This shows the very poor design of building and there is need for retrofitting in the schools building as soon as possible to prevent damages due to earthquake and fire hazards in future.

Table 18: Range of Compliance for Result

Consultant to use These	Range
0	Not Addressed
0.25	Low
0.5	Medium
0.75	High
1	Completely Addressed
NA	Not Applicable

Table 19: Matrix Table

is this hazard → applicable at your site?	Applicable	Applicable	Applicable	Applicable
	MULTI HAZARD WEIGHTED COMPLIANCE			
	Seismic	**Wind**	**Flood**	**Fire**
Planning	0.83	NA	NA	0.83
Architectural	0.46	NA	NA	0.19
Structural	0.41	NA	NA	0.25
Nonstructural	1.00	NA	NA	0.19
Multi Hazard compliance index	**0.24**			
Overall CI	0.63	NA	NA	0.34

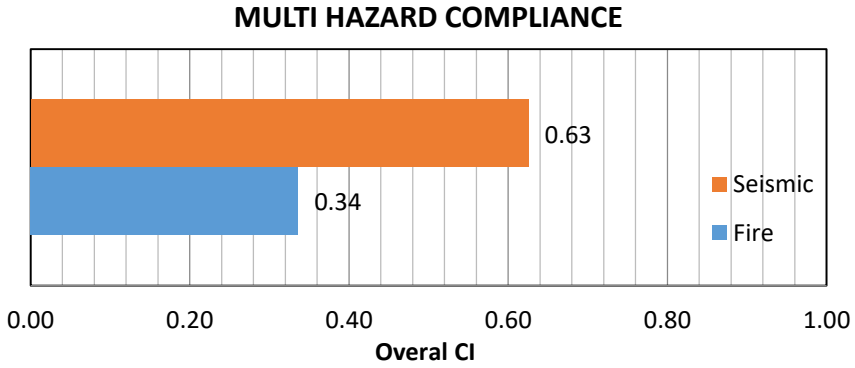


Bar Graph 1: Summary of Compliance for the Top Level Management

Bar Graph 1 shows hazard safety compliance throughout different phases which includes planning compliance that is 83% for seismic and 83% for fire. Similarly, architectural compliance 46% for seismic and 19% for fire. Also, the graph shows compliance for structural and non-structural members of the building. The compliance of seismic safety for structural members is 41% and 25% for fire while for Non-structural the compliance for seismic safety resulted 100% while 19% fire safety.

Overall Seismic and Fire Hazard Bar Graph Shaheed Hasnain School

The overall seismic and fire hazard performance of the school building is shown in Bar Graph 2.



Bar Graph 2. Overall Seismic and Fire Hazard Bar Graph

The assessment of the building for fire and seismic vulnerability indicated that it is 0.34% vulnerable to fire and showing only 63% vulnerability to seismic forces for which the building needs preventive measures against the fire and seismic actions.

From the above given graph, it is clearly observed that the Govt. Shaheed Hasnain Sharif School No.1 building has to be on emergency based addressed for the fire risk, and fire extinguishing equipment should be provided throughout the building. However, the building is also highly vulnerable to seismic activity at the same time. Therefore, a regular maintenance is required throughout the building for long lasting time and to prevent risk in future.

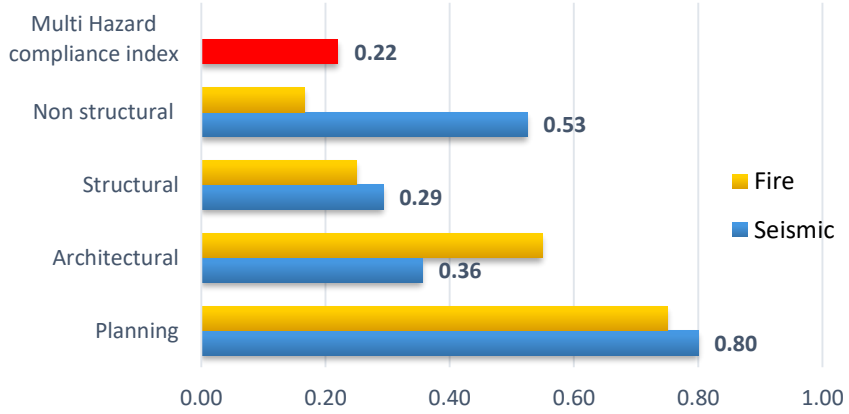
Summary of all Categories for the Govt. Shaheed Osama Zafar Centennial Model High School No.2

This Bar Chart is showing the entire range of compliance for structural, non-structural, architectural and planning issues in the school building. The overall multi-hazard compliance hazard become 0.24 as

shown in the Bar Graph 3. This shows the very poor design of building and there is need for retrofitting in the schools building as soon as possible to prevent damages due to earthquake and fire hazards in future. The Multi Hazard Matrix for Govt. Shaheed Osama Zafar Centennial Model High School No.2 is given in Table 20.

Table 20: Multi Hazard Matrix Table

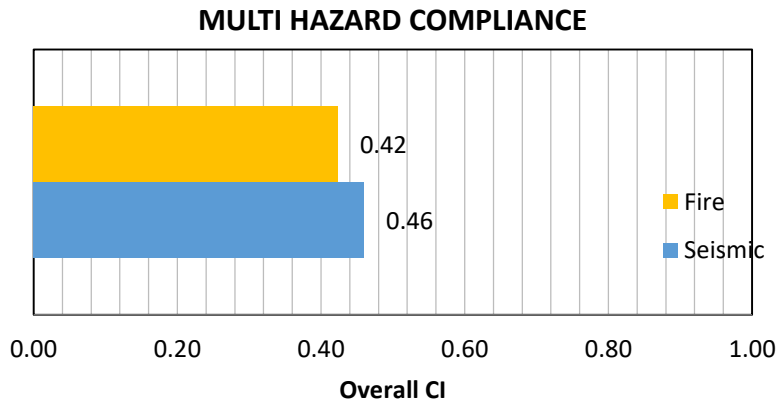
is this hazard → applicable at your site?	Applicable	Applicable	Applicable	Applicable
	MULTI HAZARD WEIGHTED COMPLIANCE			
	Seismic	**Wind**	**Flood**	**Fire**
Planning	0.80	NA	NA	0.75
Architectural	0.36	NA	NA	0.55
Structural	0.29	NA	NA	0.25
Non-structural	0.53	NA	NA	0.17
Multi Hazard Compliance Index (CI)	**0.22**			
Overall CI	0.46	NA	NA	0.42



Bar Graph 3: Summary of Compliance for the Top Level Management

Graph showing hazard safety compliance throughout different phases which includes planning compliance that is 80% for seismic and 75% for fire. Similarly, architectural compliance 36% for seismic and 55% for fire. Also, the graph is showing compliance for structural and non-

structural members of the building. The compliance of seismic safety for structural members is 29% and 25% for fire while for Non-structural the compliance for seismic safety resulted 53% while 17% fire safety.



Bar Graph 4: Overall Seismic and Fire Hazard Bar Graph

Bar graph 4 shows the overall seismic and fire hazard bar graph. Assessment of the building for fire and seismic vulnerability indicated that it is 0.42% vulnerable to fire and 0.46% vulnerable to seismic forces for which the building needs preventive measures against the fire and seismic actions. From the above given graph, it is clearly observed that the Govt. Shaheed Osama Zafar Centennial Model High School No. 2 building has to be on emergency based addressed for the fire risk, and fire extinguishing equipment should be provided throughout the building. However, the building is also highly vulnerable to seismic activity at the same time. Therefore, a regular maintenance is required throughout the building for long lasting time and to prevent seismic risk in future.

Conclusion

- The study conducted on fire and seismic risk assessment of Government Shaheed Hasnain Sharif higher secondary school No.1 and Government Osama Shaheed centennial high school No.2 buildings in Hashtnagri, Peshawar-Pakistan concluded that both Schools are highly vulnerable to fire hazard and earthquake hazard, but the risk of fire hazard is more as compared to the earthquake. It was noticed from the assessment that fire hazard risk is more active in the non-structure elements and in architectural design of the building. On the other hand, seismic hazard risk is more active in architectural and structural design of the buildings.

- The Hazard safety compliance for Government Shaheed Hasnain Sharif Secondary High school No.1 was 83% for seismic and 83% for fire, similarly architectural compliance was 46% for seismic and 19% for fire. The compliance of seismic safety for structural members was 41% and for fire it was 25%, for Non-structural the compliance for seismic safety resulted 98% while 19% for fire safety. The assessment of Hasnain Shaheed school building for fire and seismic vulnerability showed that the building is 66% vulnerable to fire and 37% vulnerable to seismic forces for which the building needs preventive measures against the fire and seismic actions.
- In Hazard safety compliance for Government Osama Shaheed high school No.2 the planning compliance was 80% for seismic and 75% for fire, similarly architectural compliance was 36% for seismic and 55% for fire. Similarly, the compliance of seismic safety for structural members was 29% and for fire it was 25% while for Non-structural the compliance for seismic safety resulted 53% while 17% for fire safety. From the overall result for Osama Shaheed School it was concluded that the building is 58% vulnerable to fire and 54% to seismic forces for which the building needs preventive measures against the fire and seismic actions.
- Both the schools lack facilities, training and proper installation of firefighting equipment's. Furthermore, there were no permanent staff for firefighting emergency management as some of the staff received training for firefighting and at some place's equipment were installed but they were not on right places. Besides the equipment's are less in numbers and were never checked after installation and were in miserable condition.
- There was no emergency response team and no evacuation centers were properly identified to cope with sudden event like an earthquake, it means that students and teachers are at extreme level of risk because evacuation is even more difficult job during an emergency. The fire and earthquake will cause extreme damages to building and loss of lives if it occurs.

References

Arya, A. S. (2011). *Rapid structural and non-structural assessment of school and hospital buildings in SAARC countries*. SAARC Disaster Management Centre, New Delhi.

El-Arab, I. M. E. (2017). *Seismic Risk Assessment of Existing School Buildings in Egypt*. International Journal of Advanced Engineering Research and Science, 4(4), 237117.

E, Sullivan. (2007). *Disaster Response Coordination Positions Bypass FEMA.*

Fahad, S., & Jing, W. (2018). Evaluation of Pakistani farmers' willingness to pay for crop insurance using contingent valuation method: The case of Khyber Pakhtunkhwa province. Land use policy, 72, 570-577.

G, Binod. (2015). *Earthquake destroys university and school buildings*".

Hamdache, M. (1998). *Seismic hazard estimation in northern Algeria*. Natural hazards, 18(2), 119-144.

Khan, H., & Khan, A. (2008). *Natural hazards and disaster management in Pakistan.*

Khurram S. M (2016). *Footprints: A gurdwara opens its doors*.

National Disaster Management Authority, (2017) Annual Report. PDMA, (2008) "*Monsoon contingency plan Khyber Pakhtunkhwa*".

Rehman, K., Khan, M. Y., Turab, S. A., & Wajid, A. (2019). *Strain energy release-based seismic hazard of Pakistan and its surrounding areas*. Journal of Himalayan Earth Sciences, 52(1), 51.

Shah, A. A., Ye, J., Pan, L., Ullah, R., Shah, S. I. A., Fahad, S., & Naz, S. (2018). Schools' flood Emergency preparedness in Khyber Pakhtunkhwa Province, Pakistan. International Journal of Disaster Risk Science, 9(2), 181-194

UNDRR. (2013) *Plan of Action for Safe School and Educational Buildings in FATA.*

Wannous, C., & Velasquez, G. (2017). *United Nations office for disaster risk reduction (UNISDR) unisdr's contribution to science and technology for disaster risk reduction and the role of the international consortium on landslides (icl)*. In Workshop on World Landslide Forum (pp. 109-115). Springer, Cham.

Waseem, M., Mushtaq, Y., Khan, S., Ahmed, W., Pasha, A. R., & Khan, A. (2018). *Ground Motion Prediction Equations (GMPEs) for Pakistan: Preliminary Results*. Journal of Himalayan Earth Science, 51(2).

Wisner, B. (2006). A review of the role of education and knowledge in disaster risk reduction.

Zevenbergen, J. A. (2012). *Handling land: Innovative Tools for Land Governance and Secure Tenure*: e-book.