

ANCHORING SCHOOL ARCHITECTURE IN SWAT FOR ENHANCED RESILIENCE AGAINST TERRORISM

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DOI: <https://doi.org/10.5281/zenodo.17482811>

Received	Revised	Accepted	Published
17 July 2025	07 September, 2025	14 October 2025	27 October 2025

ABSTRACT The Swat region has endured significant challenges due to terrorism, severely impacting educational infrastructure and community well-being. This research paper investigates the role of resilient school architecture in enhancing security and supporting the psychological recovery of affected communities. It outlines architectural principles and strategies tailored to the unique socio-cultural and environmental context of Swat. Through analysis of case studies and field data, a "Moored Convalescence" framework is proposed, emphasizing anchored recovery and security through design. The findings present strategic guidelines for architects, planners, and policymakers to create educational environments that serve as both learning centers and safe havens, fostering long-term resilience against terrorism threats. Religious fundamentalist forces with conservative mindsets in Pakistan have persistently orchestrated schemes to manipulate youth for advancing their material and vested interests. The deeply entrenched patriarchal social structure serves to reinforce their dominance, predicated on suppressing marginalized societal groups, perpetuating gender biases, and fostering religious intolerance. Within this context, women's education is perceived as a significant threat to their hegemony. The devastating sabotage of primary and secondary educational institutions in Swat through terrorist activities during 2008-2011 reverberated globally, epitomized by tragic incidents such as the Army Public School attack in Peshawar. Such a volatile and intimidating environment inflicts profound psychological trauma on young minds, impeding progressive societal development and national growth. Youth embody the future potential of any nation, and it is imperative to prioritize their wellbeing and empowerment in national policy frameworks. This aspiration is concretely manifested in the physical form and resilience of educational infrastructure. This research aims to explore strategies for enhancing the resilience of school buildings against terrorism-related threats through cost-effective, meticulously designed, and promptly implemented protective measures. The Taliban-led insurgency not only targeted educational setups but also crippled other key civic institutions in Swat, undermining the valley's socio-economic fabric and its reputation as the "Switzerland of Pakistan" due to its natural splendor. Post-conflict recovery efforts by national and international organizations have made significant strides in restoring functional education in Swat; however, residual fear of future attacks persists among communities. It is hypothesized that such terror activities could re-emerge, necessitating proactive interventions to mitigate potential catastrophic impacts on educational spaces. Addressing this critical challenge in relation to the built environment constitutes the core focus of this research. Given that youth remain the most vulnerable demographic targeted by extremist groups such as the Taliban, it is

crucial to strategically counteract fear and insecurity among school-going children. Architects bear significant responsibility in this endeavour, encompassing roles described by Charlesworth: as analysts diagnosing conflict-affected urban conditions and proposing architectural remedies; as mediators fostering inclusive urban planning and community engagement; and as educators embedding social responsibility into architectural pedagogy. A Pakistani scholar further highlights the urgent collective priority shared by stakeholders—including government bodies, military, law enforcement, school administrators, parents, and design professionals—to safeguard children by ensuring the highest levels of protective measures. This study comprehensively addresses the multifaceted dimensions of school resilience, offering a critical conceptual framework and practical guidelines aimed at fortifying educational institutions against terrorist threats.

Keywords: "Moored Convalescence", Post-conflict recovery efforts, Terrorism & Educational infrastructure

INTRODUCTION

Terrorism in Swat has wrought devastating effects on the social fabric, particularly targeting schools as strategic sites for disruption. The destruction and threat to educational institutions not only hinder children's right to learning but also destabilize community confidence and psychological health. Ensuring that school architecture is fortified and designed with resilience in mind has become a focal point in combating the impacts of terrorism.

This research focuses on the confluence of architecture and security, with a goal to anchor school designs in Swat that support both physical safety and the convalescence, or recovery, of students and communities traumatized by conflict. While security measures such as surveillance and controlled access are vital, integrating these into the educational environment in a culturally sensitive and contextually relevant manner is critical to sustainable recovery.

The study aims to:

- (1) assess the vulnerabilities and needs of schools in terrorism-affected Swat,
- (2) examine architectural responses to similar challenges globally,
- (3) develop a framework termed "Moored Convalescence" that anchors recovery through design strategies, and
- (4) provide actionable recommendations for resilient school architecture that can be implemented in the region.

Through a multidisciplinary approach merging architectural theory, security studies, and community psychology, this paper seeks to

contribute to a design paradigm that goes beyond mere protection, fostering a resilient environment for education amidst ongoing threats.

2. "Literature Review

Terrorism and educational infrastructure have a deeply intertwined relationship, as schools often become deliberate targets to inflict psychological trauma and disrupt social continuity. Literature on terrorism's impact highlights that attacks on educational institutions undermine not only physical security but also the emotional stability of communities (Smith, 2023). The disruption of schooling impacts children's cognitive development and societal trust, necessitating adaptive architectural strategies.

Resilient architecture, broadly defined, involves the capacity of buildings to withstand, adapt to, and recover from adverse conditions, including conflict-related disruptions (Brown & Lee, 2024). In conflict zones, resilient design goes beyond structural robustness; it integrates social, psychological, and cultural dimensions to foster community well-being (Ahmed et al., 2023).

Schools, as vital social institutions, require architectural interventions that balance protective features with welcoming environments conducive to healing and learning.

Several case studies provide insights into resilient school architecture in terrorism-affected or conflict-prone areas. For instance, schools in Northern Nigeria incorporate perimeter defenses, reinforced classrooms, and spatial layouts that limit blast impact while maintaining daylight and

ventilation critical for habitability (Johnson, 2022).

In Afghanistan, modular and rapid-deployment school structures blend security with cultural appropriateness, enhancing community acceptance (Khan, 2022). These examples underscore the importance of contextualizing resilience strategies to local socio-environmental realities. Theoretical frameworks relevant to this research include environmental psychology, which emphasizes the impact of physical space on emotional recovery, and Crime Prevention Through Environmental Design (CPTED), which advocates for natural surveillance and territorial reinforcement as security principles (Cozens & Love, 2023).

Integrating these theories with architectural practice informs a holistic approach, ensuring school designs in Swat address both tangible threats and the intangible needs for psychological safety and community cohesion.

Despite the growing body of work on resilient architecture, there remains a gap regarding tailored frameworks for school architecture in the specific context of Swat, where terrorism has complex socio-political roots intertwined with cultural norms. This research aims to fill that gap by proposing a "Moored Convalescence" approach, anchoring architectural resilience not only in physical measures but also in fostering recovery and rootedness in place.

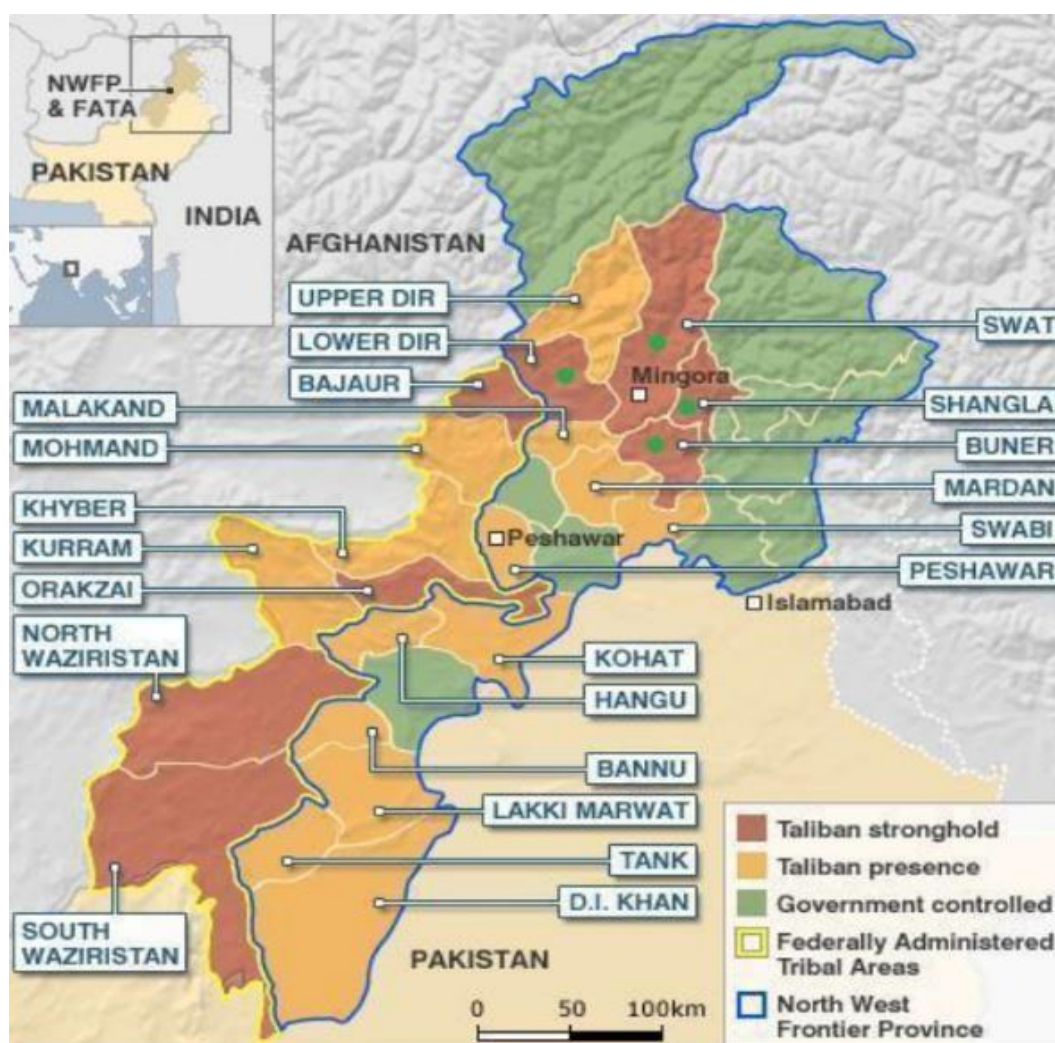


Figure 1. Map of Khyber Pakhtunkhwa, Pakistan
Courtesy: Google images



Figure 2. Map of District Swat, Pakistan

Courtesy: Google images

3. "Case Study Analysis"

To derive practical insights for enhancing the resilience of school architecture in Swat, this section examines a selection of case studies from both local and international contexts where educational infrastructure faces terrorism or conflict-related challenges.

Case Study 1: Schools in Swat, Pakistan

Several schools in Swat targeted during insurgency periods reveal architectural vulnerabilities and resilience responses. Many traditional school buildings utilized locally available materials such as mud bricks and timber, which lack blast resistance and structural robustness. In response, reconstruction efforts have incorporated reinforced concrete and boundary walls, improving physical security. However, some

rebuilt schools suffer from uninspired designs that prioritize defense but neglect psychological and cultural dimensions necessary for holistic recovery. Furthermore, community involvement in design decisions remains limited, reducing acceptance and long-term sustainability.

Case Study 2: Northern Nigeria – Boko Haram Conflict Zone In Northern Nigeria, schools have faced repeated attacks by militant groups. Architectural adaptations include elevated and reinforced perimeters, use of concrete barriers, and watchtowers to enhance surveillance. Classroom designs emphasize structural stability with impact-resistant windows and doors. Importantly, these schools incorporate multipurpose spaces that serve both educational and community functions, fostering social

cohesion vital for resilience. Engagement of community stakeholders in design and management has increased the success and protective function of these facilities.

Case Study 3: Afghanistan – Conflict and Recovery

In Afghanistan, the Taliban insurgency has severely affected schools. To address this, modular and rapidly deployable school units made from lightweight, durable materials have been designed to allow quick reconstruction in affected areas. These schools combine security features such as restricted access and blast mitigation with cultural sensitivity, ensuring spaces are welcoming and conducive to learning, especially for girls. The integration of community centers into school facilities strengthens social fabric and collective security.

Robust perimeter defenses and blast-resistant materials are essential but must be complemented by thoughtful spatial design to support safety and functionality. Community participation in design enhances cultural appropriateness and sustainability, fostering a sense of ownership and protection. Multipurpose and healing spaces contribute significantly to psychological recovery, which is critical for educational continuity. Flexible, context-tailored architectural solutions are more successful than one-size-fits-all approaches, as seen in modular designs and local material integration.

These case studies underscore the necessity of a balanced architectural response that merges security, cultural resonance, and psychosocial support, informing the development of the "Moored Convalescence" framework for schools in Swat.

3.1 Profile of Recommended Schools

Name of School	District	Tehsil	UC	Eroll	San: Staff	Ext-C-Room	Available Land
GGPS Fazil Baig Banda	Swat	Matta	Lalkoo	172	2	2	1 K

Institute for Excellence in Education & Research

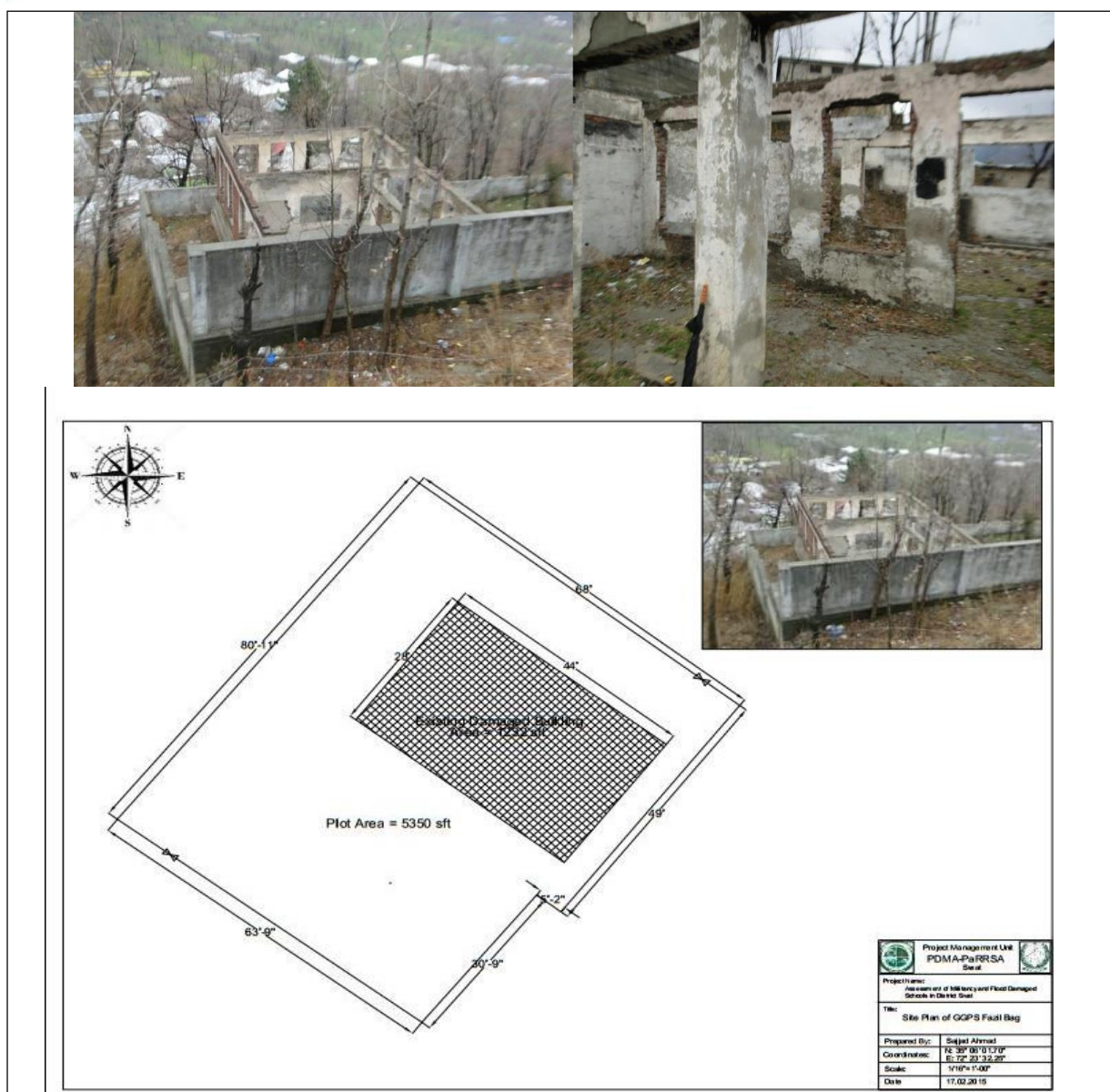
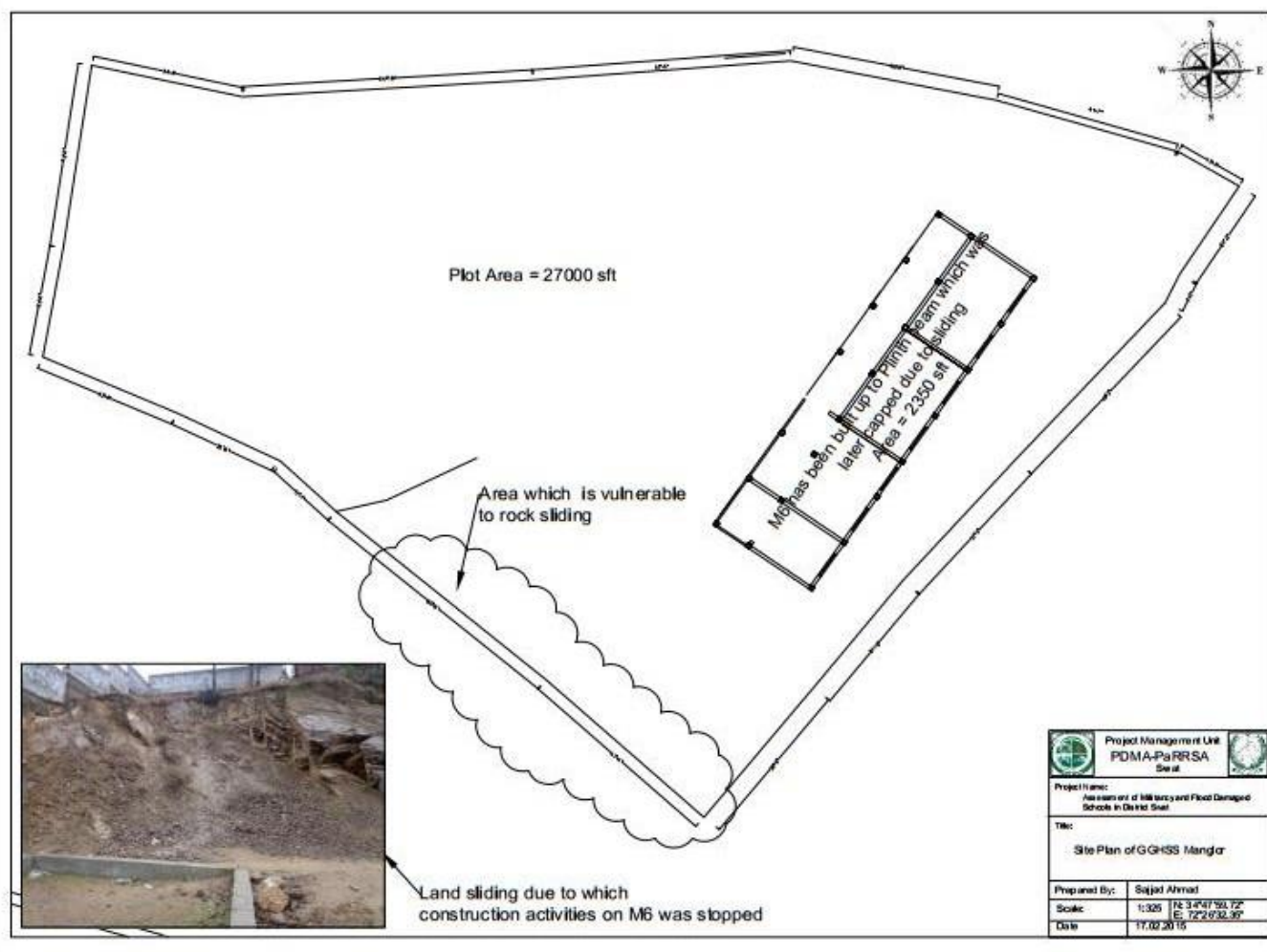


Figure 3. Profile of recommended School -1
Source: Project Management Unit PDMA-PaRRSA Swat

Name of School	District	Tehsil	UC	Eroll	San: Staff	Ext-C-Room	Available Land
GGHSS Mangalawar	Swat	Babozai	Manglawar	300	8	Nil	4.9 K



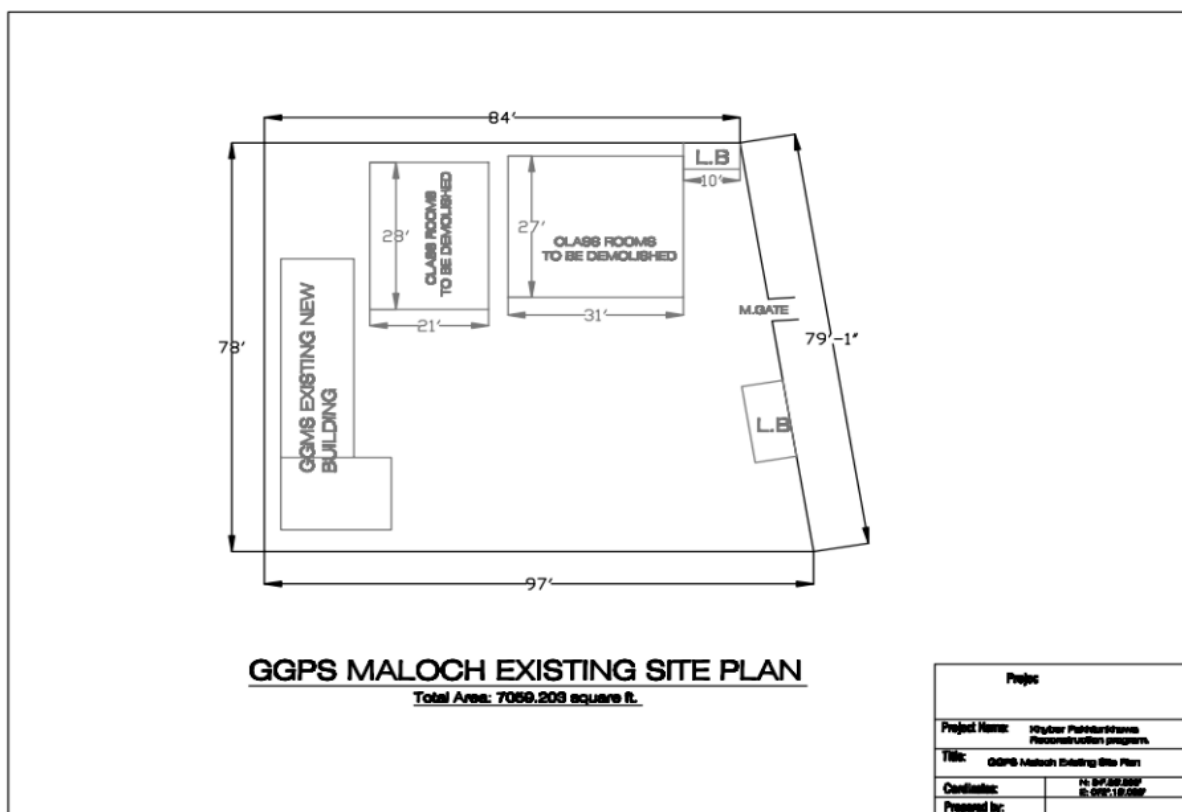


Figure 3 Profile of recommended School -3
Source: Project Management Unit PDMA-PaRRSA Swat

Institute for Excellence in Education & Research

Name of School	District	Tehsil	UC	Eroll	San: Staff	Ext-C-Room	Available Land
GHS Islampur	Swat	Babuzai	Islampur	455	19	16	3.0 K



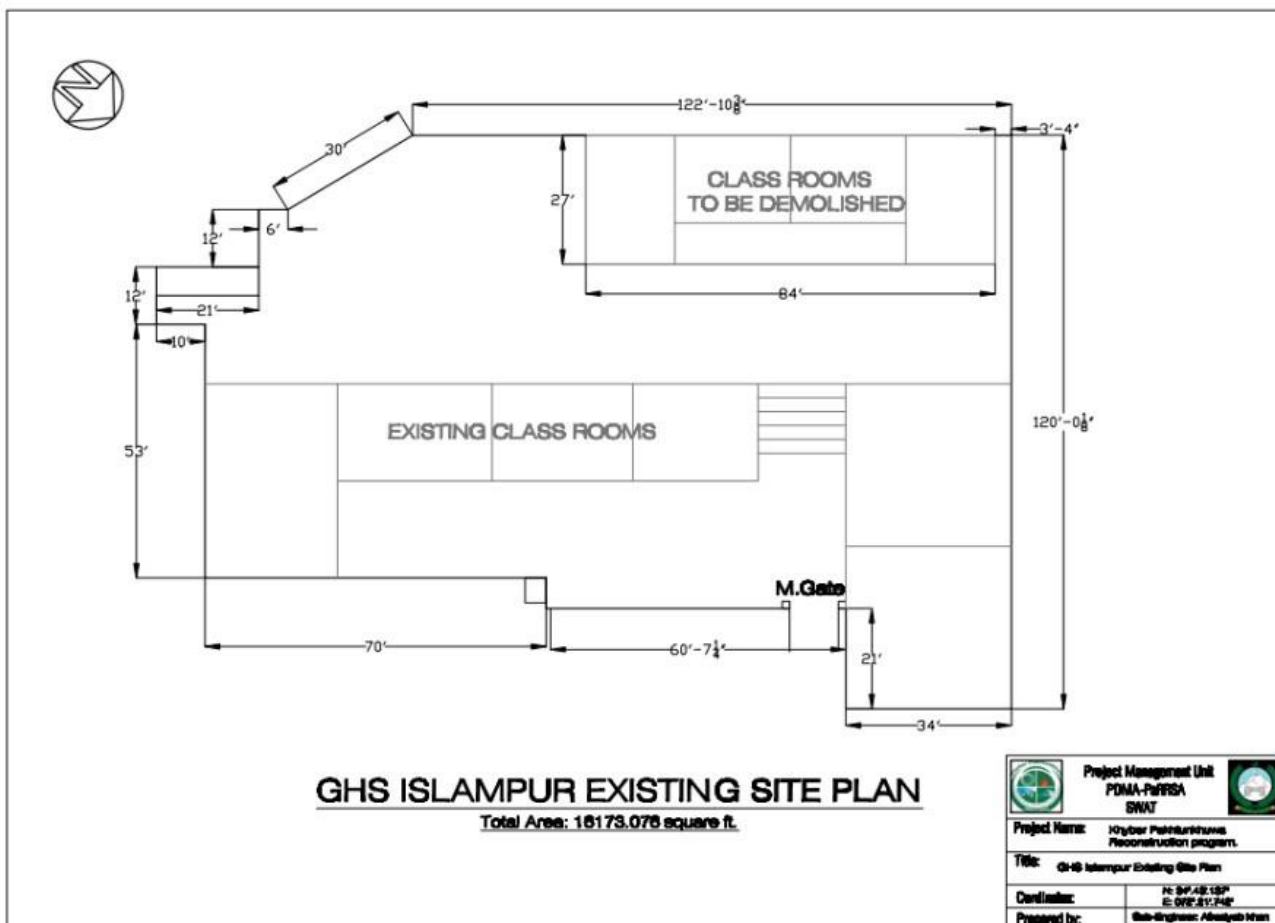


Figure 5. Profile of recommended School -4
Source: Project Management Unit PDMA-PaRRSA Swat

Name of School	District	Tehsil	UC	Eroll	San: Staff	Ext-C-Room	Available Land
GHS Swegalai	Swat	Kabal	Kuz Abakhail	480	21	07	3.46 K



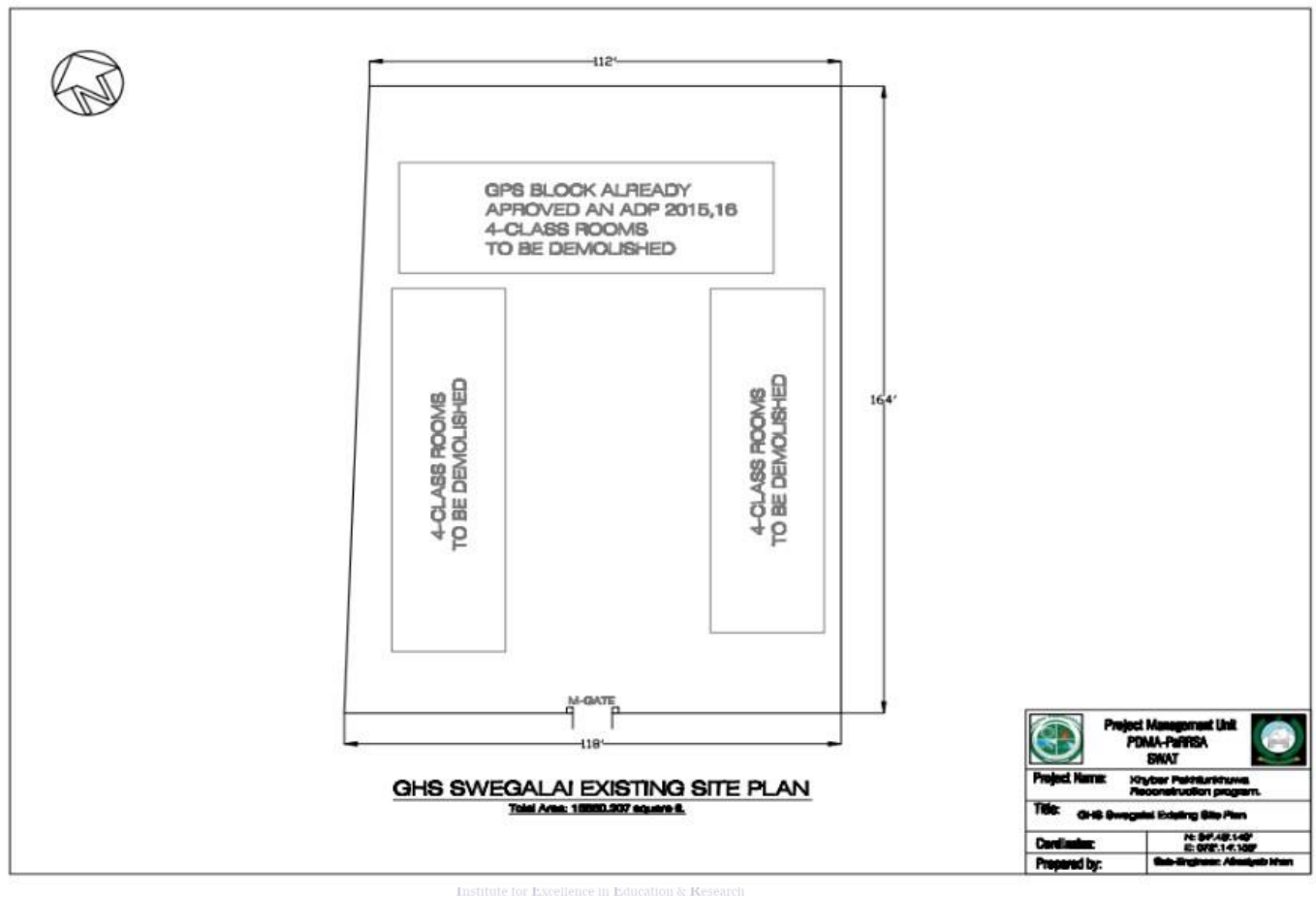


Figure 6. Profile of recommended School -5
Source: Project Management Unit PDMA-PaRRSA Swat

Destroyed condition of Koza Durshkhela Swat in 2007-2009



Figure 4 . Condition of Wall-1

Figure 5. Condition of Wall-2



Figure 6. Condition of Wall-3



Figure 7. Condition of Wall-4



Figure 8. Condition of Wall-4



Figure 9. Condition of Wall-4

Rehabilitated condition Middle and high school Durskhela, Swat



Figure 10. Condition of Exterior Wall-1



Figure 11. Condition of Internal Wall in Site



Figure 12. Condition of Exterior Wall-2
Figure 13. Condition of Wall-3

Figure 14. Condition of Wall-4

Figure 15. Condition of Wall-5

Rehabilitated condition Primary school of Durshkhela, Swat



Figure 15. Condition of Exterior Wall



Figure 17. Condition of Windows and



Figure 18.. Condition of Outer Structure
Internal Walls



3.2 Rehabilitated Government Schools District Swat

S/ No	School Name	Enrollment	U/C	School s Bags & Pencil Box	Student Furniture		Estimated Cost
					Stes	Cost	
1	GGHS Drushkhela	200	Drus hkhel a	200	100	240,000	1,258,100
2	GGMS Drushkhela	550	Drus hkhel a	550	275	660,000	783,700
3	GGPS Drushkhela	359	Drus hkhel a	359	180	430,800	340,000
4	GGPS Baidara	220	Baida ra	220	110	264,000	1,250,000

	SubTotal	1329		1329	665	159480 0	3631800
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Table 1. Rehabilitated Government Schools District Swat

Cost estimation charts for Rehabilitation of Government Schools in District Swat

<i>School Name</i>	<i>Estimated Cost</i>
GGPS Drushkhela	Rs. 340,000/-
GGMS Drushkhela	Rs. 783,700/-
GGHS Drushkhela	Rs. 1,094,000/-

Table 2. Cost estimation report

Source: Sarhad Rural Support Program

Summery Cost of Material and Labour

S / N o	Items	Quantity	Unit	Market Rate (Rs.)	Materials Cost (Rs.)
A	Materials & Transportation Cost				
1	Wood for Truss (Pine Wood)	125.30	Bags	450	56383
2	Flushing Cover	134.00	Rft	45	6030
3	CGI sheets (24 gauge)	45.07	Sheets	1350	60840
4	Distemping old surface (one coat)	1268.00	Sft	3.5	4438
5	Gypsum Board	1106.00	Sft	45	49770
6	Gola PGI sheet (3' width)	52.00	Rft	35	1820
7	2" Thick Concrete Flooring (1:2:4)	1025.00	Sft	15	15375
8	1/2" Thick Plaster in Rooms (1:6)	1268.00	Sft	11	13948
9	Misc(Nails,Iron cap,rubber washer)	1.00	Lumsu m	10000	10000
10	Water Supply Provision	1	No	15000	15000
11	Internal & External Electrification	2	rooms	5000	10000
12	Rehabilitation of Toilets	4	No	10000	40000
	Total Costs of Materials & Transportation (A)			283604	

B	Labour Cost for Truss				
1	Skilled Carpenter	63	Man Day	500	31324
2	Unskilled Labour	84	Man Day	300	25059
	Sub Total Cost of Labour (B)			56383	
	Total Estimated Cost			339,987	
	Total Cost Say			340,000	

**Table 1. Recommended Rehabilitation Profile of
GGPS Drushkhela School, District Swat**



S/No	Items	Quantity	Unit	Market Rate (Rs.)	Materials Cost (Rs.)
A	Materials & Transportation Cost				
1	Wood for Truss (Pine Wood)	389.30	Cft	450	175185
2	Flushing Cover	412.00	Rft	45	18540
3	CGI sheets (24 gauge)	151.34	Sheets	1350	204309
4	Distemping old surface (one coat)	14128.00	Sft	3.5	49448
5	Gypsum Board	4072.00	Sft	45	183240
6	Gola (3' width) PGI sheet	142.00	Rft	35	4970
7	2" Thick Concrete Flooring (1:2:4)	4072.00	Sft	15	61080
8	RCC (1:2:4) Concrete beams	16.50	Cft	160	2640
9	1/2" Thick plaster (1:4)	9944.00	Sft	11	109384
10	Misc(Nails,Iron cap,rubber washer)	1.00	Lumsu m	15000	15000
11	Water Supply (Two over head tanks+fittings)	1	No	25000	25000
12	Internal & External Electrification (8 points/room)	6	rooms	5000	30000
13	Rehabilitation of Toilets	4	No	10000	40000
	Total Costs of Materials & Transportation (A)			918796	
B	Labour Cost for Truss				
1	Skilled Carpenter	195	Man Day	500	97325
2	Unskilled Labour	260	Man Day	300	77860
	Sub Total Cost of Labour (B)			175185	
	Total Estimated Cost			1,093,982	
	Total Cost Say			1,094,000	

Table 2. Recommended Rehabilitation Profile of GGHS Drushkhela School, District Swat

nauguration Durkhela School ocmplex, Swat



Present Views of School Complex



Figure 19 . View form front entrances 2 entry gates





Figure 20. Visual from middle school staff room towards primary school courtyard



Figure 21. Main primary school gate from the side walk towards the school.



Figure 22. New constructed block for the extension of high school.



Figure 23. Boundary wall height extension for safety from intruders.



Figure 24. View form gate 2 of high school side wall.



Figure 25 .High and middle school courtyard.

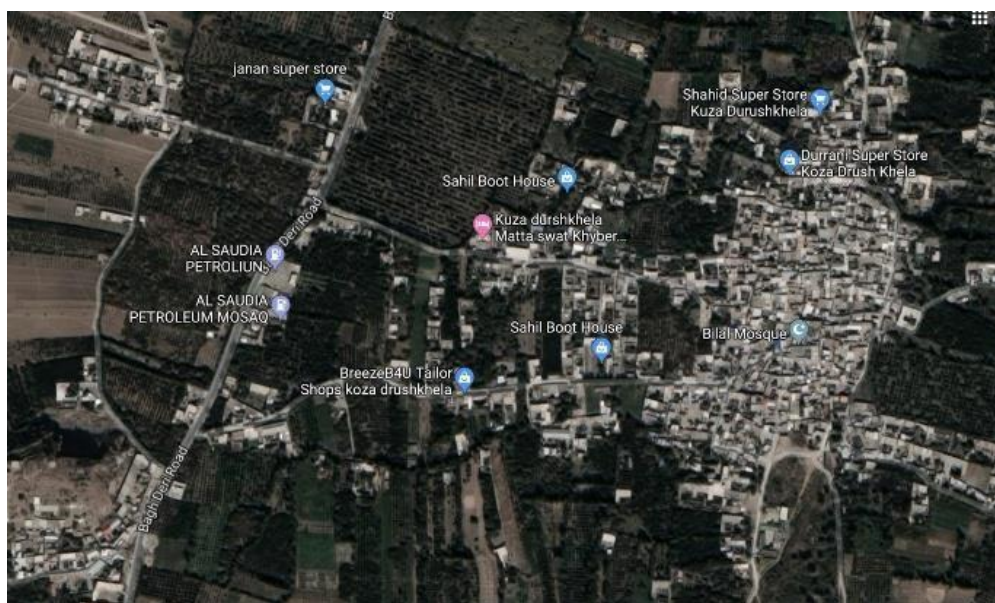


Figure 26. Macro Meso and micro level development

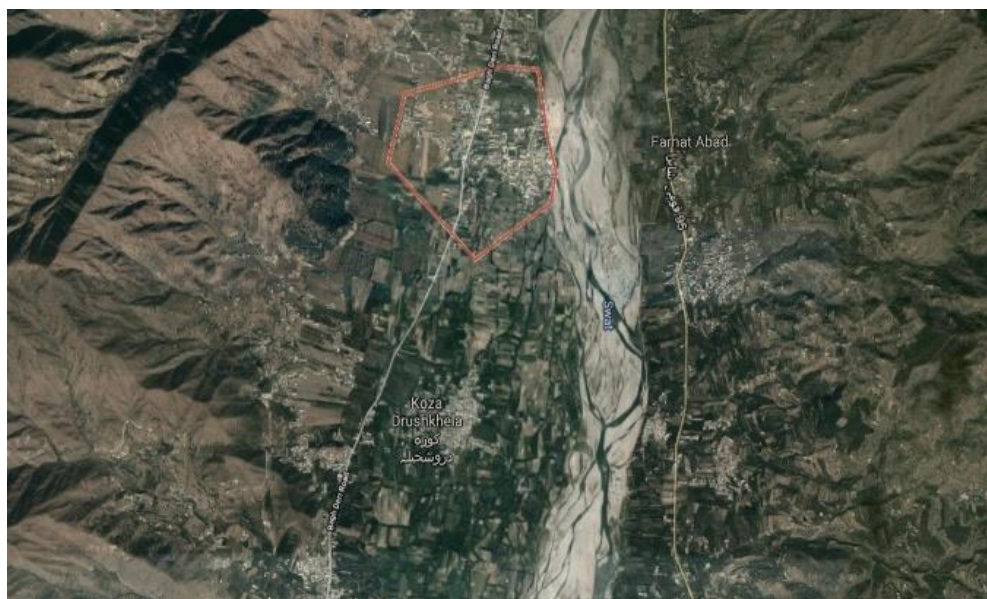


Figure 77. Koza Durshkhela, Matta Swat District.



Source: Google Earth image

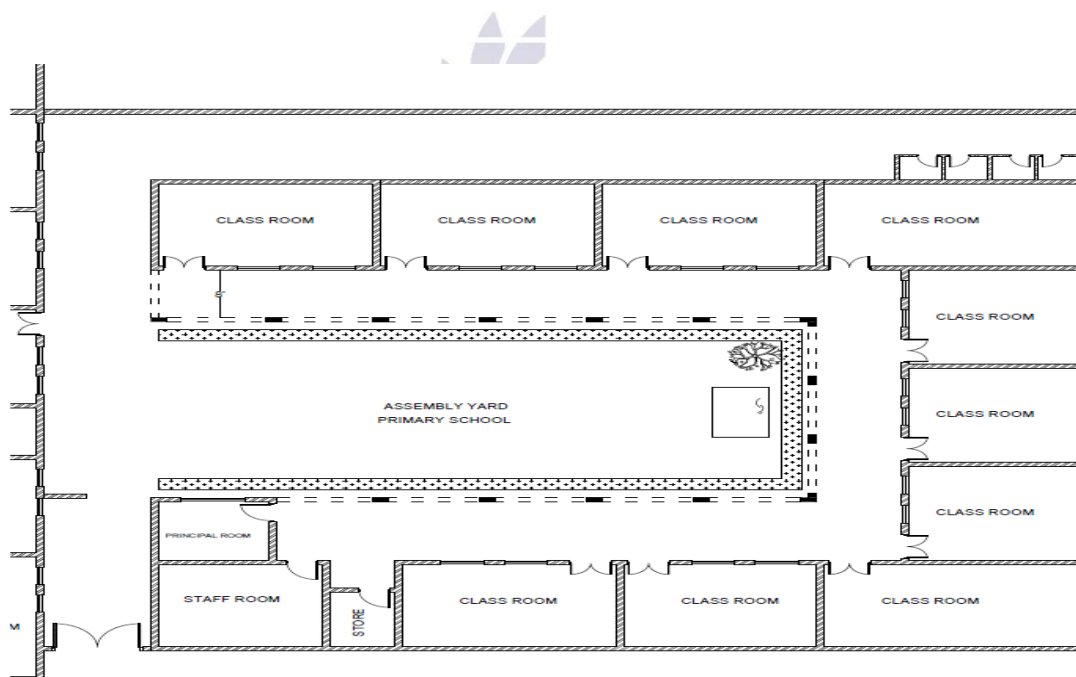
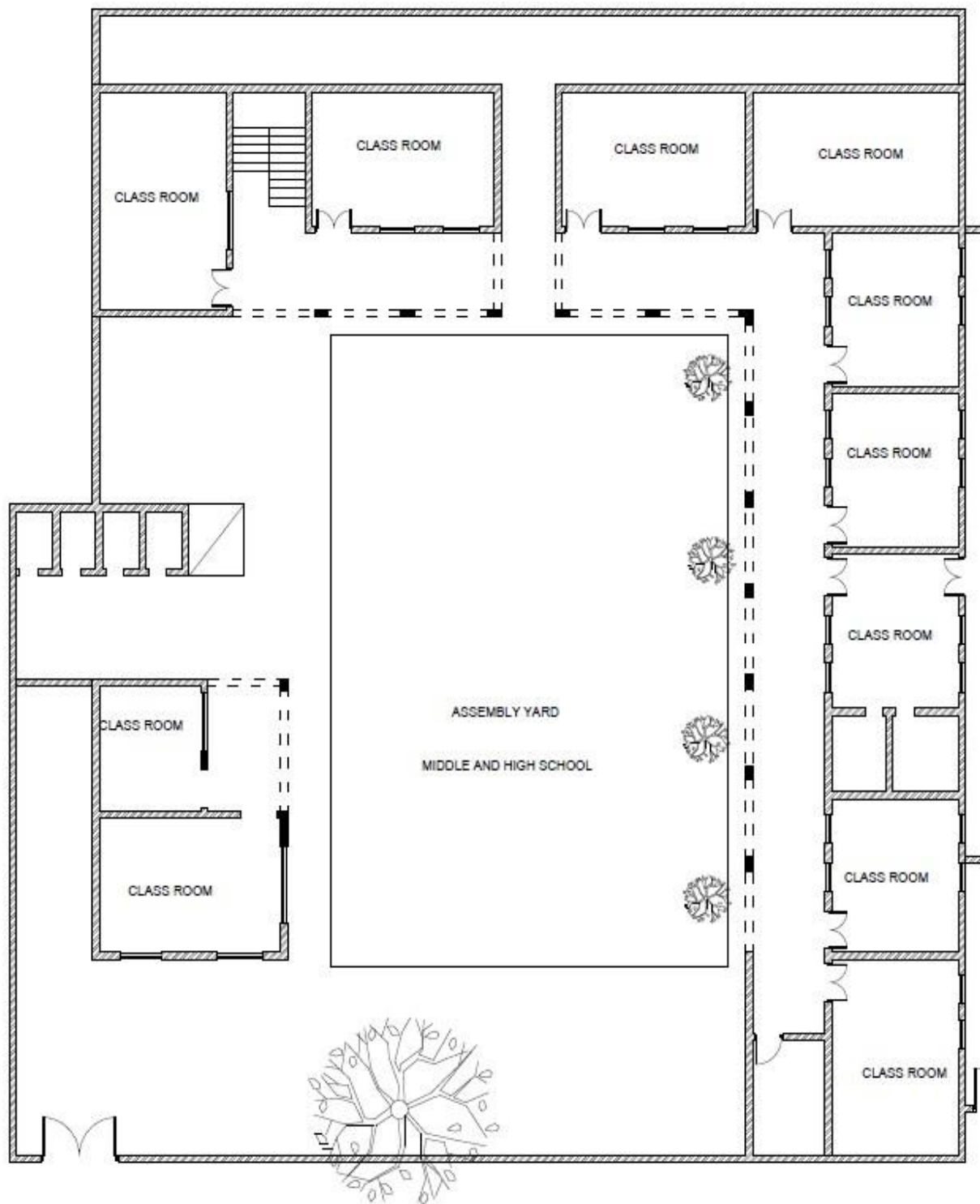


Figure 28. Government Girls Primary School Plan, Koza Durshkhela, Swat

Source: Drawn through Autocad

Figure 29. Government Girls Primary and Middle School Plan, Koza Durshkhela, Swat



Source: Drawn through Autocad

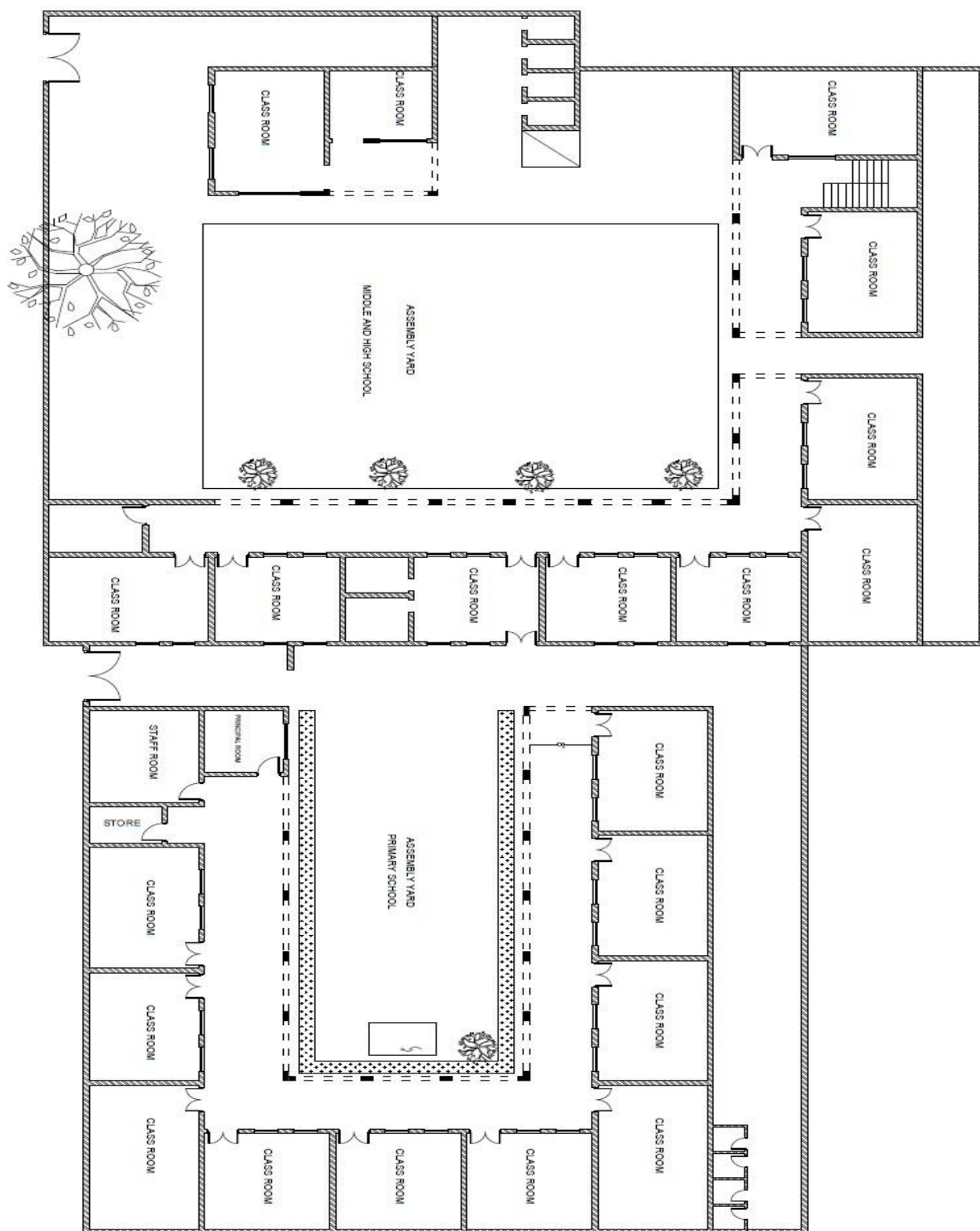


Figure 30. Koza Durshkhela School complex plan
Source: Drawn through Autocad



Figure 31 3-D Drawing render of Koza Durshkhela School complex
Curtesy: Sketchup (V-Ray render).

"Research Methodology"

This research adopts a qualitative, mixed-methods approach to explore the architectural resilience of schools in Swat in the face of terrorism. The design combines field investigations, case study analysis, and expert interviews to gain comprehensive insights into both the physical vulnerabilities and social contexts of educational buildings in the region.

Field surveys were conducted in selected schools across Swat district to document existing architectural conditions, security features, and

damages incurred due to terrorism-related incidents. Observations focused on building materials, spatial layout, access points, and any protective infrastructure such as walls, barriers, and surveillance systems.

Semi-structured interviews were held with key stakeholders, including school administrators, local architects, security personnel, and community members. These interviews aimed to

gather perceptions on security challenges, architectural responses, psychological impacts on students, and community needs for recovery spaces.

To enrich the empirical data, architectural case studies from other conflict-affected regions globally were analyzed. These studies provided comparative perspectives on resilient design strategies appropriate for terrorism-prone areas with socio-cultural similarities to Swat.

The study area, Swat, offers a unique research context owing to its history of insurgency, military intervention, and ongoing peacebuilding efforts. The complex socio-political environment necessitates architectural solutions that are context-sensitive and culturally responsive.

Limitation

Limitations of this research include potential accessibility constraints to some conflict-affected sites, time-bound fieldwork restricting longitudinal observations, and the limited availability of detailed architectural plans for some schools. By triangulating data from multiple

sources, this methodology supports the development of a robust "Moored Convalescence" framework aimed at enhancing both physical security and psychosocial recovery through school architecture.

"Context and Challenges in Swat"

The Swat region of Pakistan has experienced a turbulent history marked by periods of insurgency and counter-terrorism operations, significantly impacting social and infrastructural development. Terrorist activities in Swat have deliberately targeted educational institutions as symbols of state authority and modernity, aiming to disrupt both learning processes and community stability. This strategy has resulted in widespread destruction of school buildings, displacement of students and teachers, and pervasive fear among residents.

Schools in Swat face unique vulnerabilities due to factors such as remote geographical location, limited security infrastructure, and socio-cultural dynamics. Many school buildings are constructed with traditional materials and lack modern defensive features, making them susceptible to attacks, including bombings and armed raids. The absence of secure access points, clear evacuation routes, and resilient structural elements exacerbates the risk to occupants.

Psychological trauma caused by terrorism extends beyond physical harm, affecting children's mental health and their attitudes toward education. Fear of attacks leads to absenteeism, school dropouts, and a disrupted learning environment. Communities also experience a loss of social capital, as schools traditionally serve as centers for social interaction and collective identity.

Moreover, reconstruction and rehabilitation efforts face challenges related to economic constraints, political instability, and balancing security priorities with cultural appropriateness. The social fabric strained by conflict requires architectural responses that not only defend against physical threats but also support emotional recovery and community cohesion.

In this complex milieu, the need for resilient school architecture that addresses physical security while promoting psychological convalescence is paramount. Understanding the local context and

challenges faced by schools in Swat is critical to devising effective design strategies that can withstand threats and foster hope and stability.

Sampling Techniques

A field visit was conducted to 7-8 schools located in Tehsil Matta, particularly in the Gut Shawar area, known as the prime region where Talibanization originated. During this visit, an assessment of the physical conditions of the damaged schools was undertaken. Observations revealed that several schools remain either fully demolished or under reconstruction due to various causes, including fire damage and bombings. Attempts were made to collect qualitative data through interviews with individuals from diverse age groups and social statuses connected to these schools. However, the sample size remained limited due to the prevailing apprehension among the local population, who remain cautious of a possible Taliban resurgence and thus are reluctant to openly discuss past events.

Secondary Sources

Secondary data, defined as information gathered from preexisting sources rather than through direct collection in the current study, formed a substantial foundation of this research. As articulated by McCaston, secondary data analysis involves the examination of data originally collected by other researchers, institutions, or organizations, often for objectives distinct from the present research. This study utilized a variety of secondary sources, including academic literature, journal articles, and digital repositories. Databases such as JSTOR, Google Scholar, and the University of Maryland electronic library were instrumental in sourcing historical, theoretical, and contextual information related to terrorism, its evolution, and its impacts on Pakistan.

Survey Approach

The research employed a mixed-methods approach to address both qualitative and quantitative dimensions. Qualitative data were obtained through interviews with district officials to capture their perspectives on the subject matter. In addition, focus group discussions were

organized with representatives from local organizations actively engaged in the region, including the PARRSA, Surhad Rural Support Program (SRSP), Pakistan Disaster Management Authority (PDMA), and various community- and village-based development organizations (CBOs and VDOs).

Conclusions

This study critically explores education, particularly female education, within Taliban-controlled zones of District Swat. It primarily sought to address three pivotal questions: First, it examined the Taliban's ideological stance on female education, recognizing their declaration of it as un-Islamic and their consequent violent opposition via widespread destruction of educational infrastructure. The Taliban's preference for the madrassa system, promoting religious rather than modern secular education, was also analyzed. Second, the research assessed whether religious education alone could serve as an adequate substitute for contemporary educational needs. Third, it explored the potential for the Taliban to alter their position and compromise on female education should they regain power, a question crucial for forecasting future educational policies and societal development in the region.

"Proposed Framework for Moored Convalescence

The concept of "Moored Convalescence" in school architecture proposes an innovative framework that anchors recovery and resilience in the physical, psychological, and cultural dimensions of educational environments in terrorism-affected regions such as Swat. This approach integrates secure design features with supportive spaces that facilitate healing and community rootedness.

Definition and Rationale

"Moored Convalescence" metaphorically draws on the idea of mooring—a secure attachment point that stabilizes vessels against external forces. Similarly, schools can be designed as anchored safe havens that provide stability amid the turbulence of conflict and terrorism. The framework emphasizes not just the defense against attacks but

also the convalescence—the gradual recovery and healing—of students, educators, and communities through architectural interventions.

Architectural Guidelines

Anchored Security: Establish firm physical defenses, including reinforced perimeters, blast-resistant construction materials, and controlled access points.

Convalescent Spaces: Design healing environments such as therapy gardens, quiet zones, and communal gathering areas that promote psychological well-being and social interaction.

Cultural Integration: Incorporate local architectural language, materials, and spatial customs to foster a sense of identity and ownership essential for resilience.

Flexible Use: Create multipurpose spaces adaptable for educational activities, community meetings, and emergency use to maintain functionality under stress.

Environmental Sensitivity: Leverage natural light, ventilation, and landscaping to create comfortable and restorative atmospheres conducive to learning and recovery.

Schools as Community Anchors

Beyond being educational facilities, schools designed under this framework act as community anchors—centers for social cohesion, emergency response, and cultural resilience. This dual role enhances community investment in school security and maintenance, supporting sustainability

Design Recommendations Specific to Swat

Considering Swat's geography, climate, and socio-political context, the framework recommends the use of locally sourced stone and timber combined with modern reinforcements; courtyards shaded by indigenous trees; elevated platforms to reduce blast effects; and clear, symbolically significant entryways that represent safety and welcome.

CPTED Principles for School Design

Natural Surveillance

Encourage visibility through strategic placement of physical features like windows and open sightlines.

This allows monitoring of student activities and deters inappropriate behavior.



Figure 32 Uneven grading of site offers easy hiding places for criminals. Photo credit: Sean Ahrens.

Source: April 1981 edition of Security Management

Magazine, <https://www.sciencedirect.com/topics/social-sciences/school-buildings>



Figure 33. Broken Windows theory

Photo credit: Sean Ahrens

Access Management

Use clearly marked entrances/exits and carefully planned landscaping to control movement. For example, design landscaping to restrict access to

unsupervised or vulnerable areas within the school.

Territoriality

Foster a welcoming and owned environment using school colors, motivational signs, and student artwork displays. This cultivates pride and a sense of belonging among students and staff.

Physical Maintenance

Consistently maintain facilities by repairing damages and removing graffiti. Well-kept restrooms, lighting, and stairs contribute to safety, comfort, and signal care for the environment.

Maintain Order

Reduce negative behavior by ensuring adult supervision is present at key times and locations, especially during student transitions, to reinforce rules and safety.

Broken Windows Theory

Demonstrate active care and surveillance of the environment. Quick attention to small signs of neglect (graffiti, broken fixtures) conveys that the

school is monitored and respected, discouraging vandalism and disorder.

Target Hardening

Target hardening refers to the application of mechanical security measures, such as alarms, locks, surveillance systems, and organized crime prevention strategies including security patrols and law enforcement presence, aimed at making a site more secure and difficult to access. While these interventions increase physical protection, they can simultaneously create an environment perceived as unsafe or intimidating by occupants. Typically, target hardening measures are implemented as a reactive response following a security incident. In contrast, the integration of Crime Prevention Through Environmental Design (CPTED) principles during the initial stages of environmental planning can achieve effective security outcomes with a less intrusive and more welcoming approach.

Signage / Wayfinding

Signage plays a critical role in guiding visitors and preventing unauthorized access to restricted areas. Directional, parking, and cautionary signs should be strategically placed both offsite and onsite to facilitate ease of navigation for new visitors while minimizing disruption. However, signs should avoid revealing locations of sensitive areas unless absolutely necessary to maintain site security.

Parking

The use of obstructive barriers around parking areas is an effective tactic to limit potential threats approaching the building. Designing parking areas for threat mitigation involves incorporating perimeter buffer zones, physical barriers, and structural reinforcements to enhance security.



Figure 34 Engineered Planters used as Barrier /Planter with concealed crash-rated bollards



Figure 35 Layout of cable fencing, used in conjunction with planting

Source: Dod Handbook: Selection and application of Vehicle Barriers, Mil-Hdbk-1013/14, 1999



Figure 36. Sample bollard application
Blast Effects vs. Building Form and Structure Design

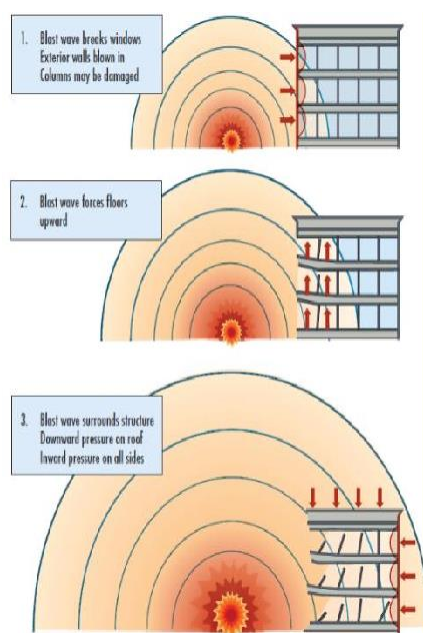


Figure37. Blast pressure effects on a structure

Building Design Guidance & Building Configuration

The predominant damage mechanism resulting from an explosion is the air-blast shock wave, which imposes pressure on building surfaces significantly exceeding the design loads for which the structure was originally intended. This elevated pressure can cause localized structural failures, including damage to exterior walls, windows, floor systems, columns, and girders.

The physical security of a school building against explosive blast threats is significantly influenced by its configuration and structural design. The layout of the building plays a key role in enabling effective monitoring and access control by school authorities. Building shapes such as U-, H-, or L-configurations with enclosed courtyards are easier to oversee and manage compared to fully open grounds. According to the International Strategy for Disaster Reduction's guidance on safer school

construction, structural design elements should be evenly distributed across the building's symmetrical layout, like U- or L-shaped plans. However, these designs contain inside corners that can increase vulnerability by amplifying blast shock waves.

Additionally, lateral shock waves can be intensified due to uneven mass distribution at upper levels, making it preferable to use lighter roofing materials. Heavy elements like water tanks should be positioned independently from the main structure to minimize stress. Ensuring secure connections among all structural components—walls, roofs, and floors—is crucial since these are primary stress points that require robust linking.

The horizontal elements that tie the walls, floors, roofs, and upper stories together are called diaphragms; they support face-loaded walls by transferring loads down to shear walls or directly to the foundation in the case of floors. To mitigate the risks posed by lateral loads, structural units should be designed to channel these forces safely down to the floors. Critical vulnerabilities arise when vertical framing systems do not extend continuously to the foundation, potentially compromising the building's overall stability during blast events.

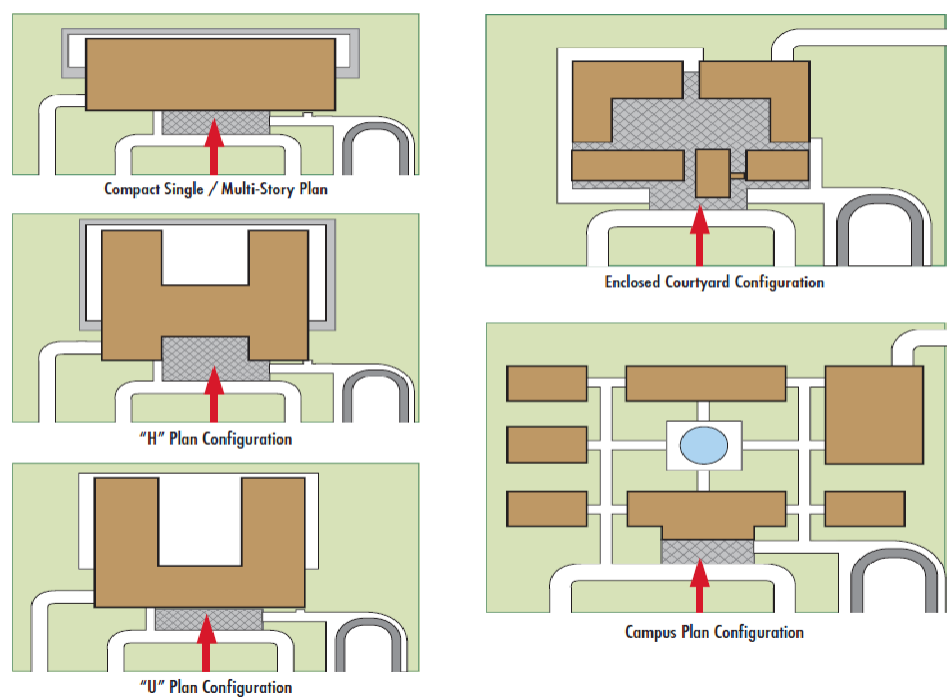


Figure 38. School building configurations
Source: Florida Safe Schools Design Guidelines, 2003

Shape and form of a building:

The shape of a building can play a very crucial role to scale the damage to the structure against explosions. For example, H-, U-, or L-shaped building helps to trap shock waves, which can further exacerbated the effect of the blast therefore school buildings with re-entrant corners with concave shapes are more vulnerable to blast

damage as compared to other convex surfaces used for the exterior of a building.

Windows and Apertures:

Building apertures and glazed walls directed towards areas that are publicly accessible increases the vulnerability of the occupants of the building to the explosives attacks.

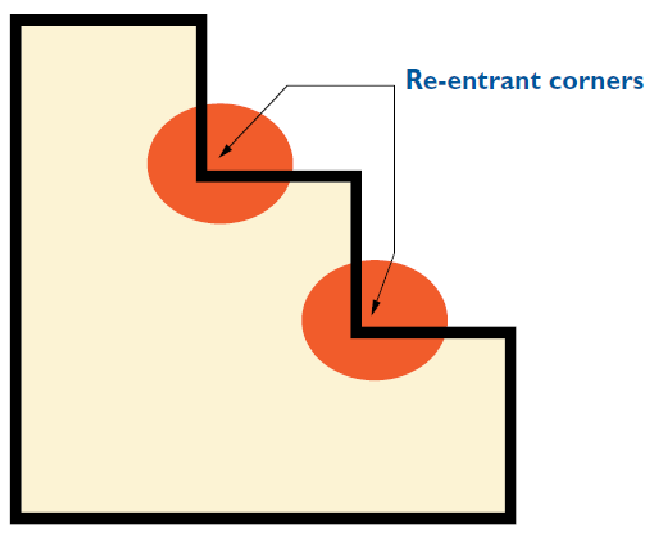
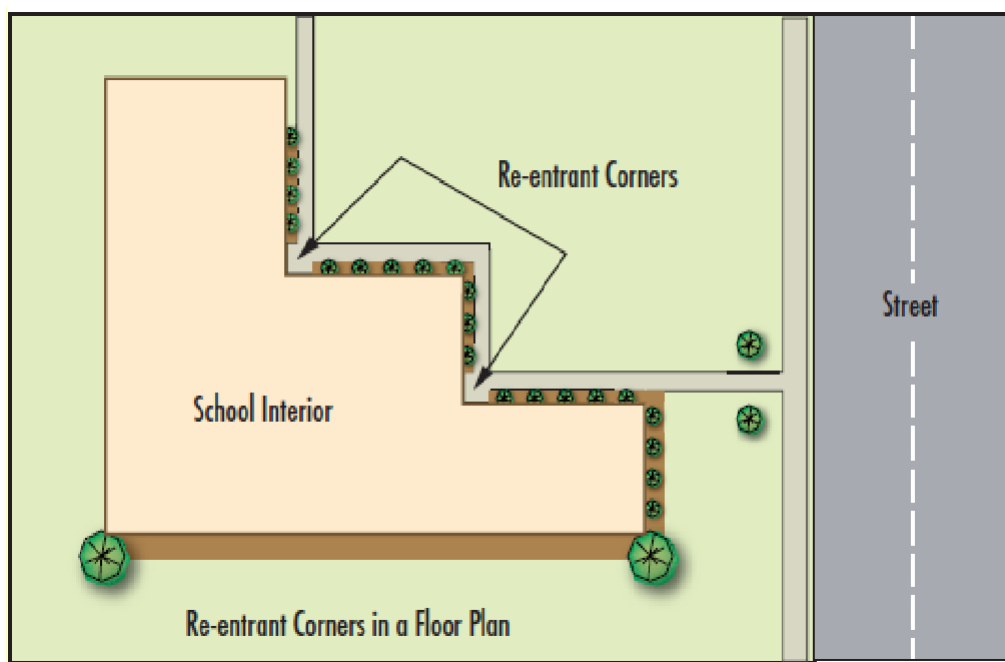


Figure 39. Re-entrant corners in a floor plan
Source: U.S. Air Force, Installation Force Protection Guide

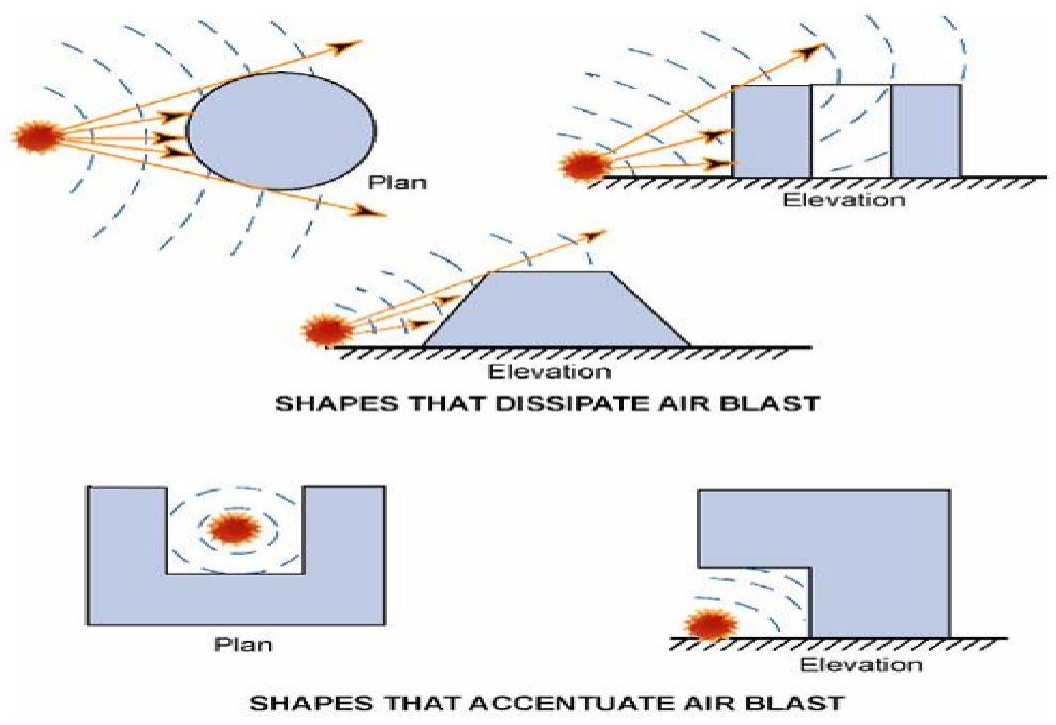


Figure 40. Shape of the school building and blast effects

Source: Google images.

https://www.google.com/search?q=convex+exterior+of+a+building+for+blasts&xsrf=ACYBGNQsDivZ9FTVftIQgMt0Zs9SQRMIfg:1569156343369&source=lnms&tbm=isch&sa=X&ved=0ahUKewjJ4sXzuuTkAhVUnVwKHVfVC74Q_AUIEigB&biw=1745&bih=807&dpr=1.1#imgsrc=RI1D0DeYY1lSdM:

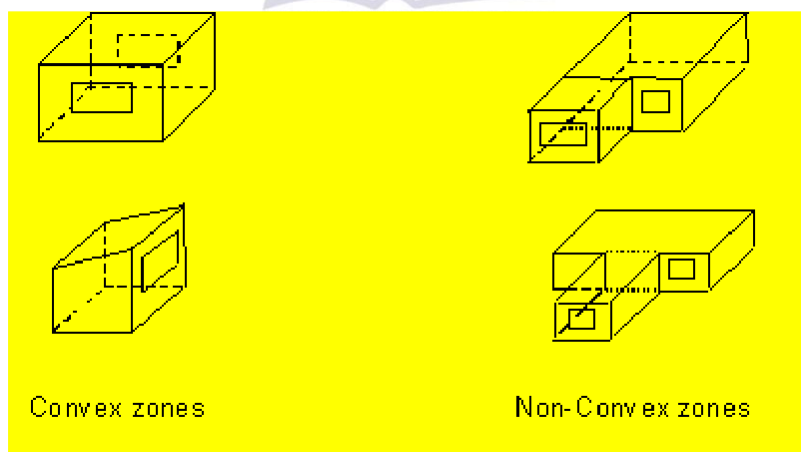


Figure 41. Convex and non convex zones

Source: Google images

According to the guidance note on safer school construction by International strategy for disaster reduction, “Structural design elements should be evenly spread over the plan of the building layouts

symmetrical in shape, such as U- and L-shaped buildings. They have inside corners which

make it more vulnerable by amplifying shock waves of a blast.”¹

Similarly, during shock waves lateral load can be amplified because of uneven distribution of mass on higher levels. For this reason lighter roofs are preferred with heavy water tanks to be located independently of the structure.

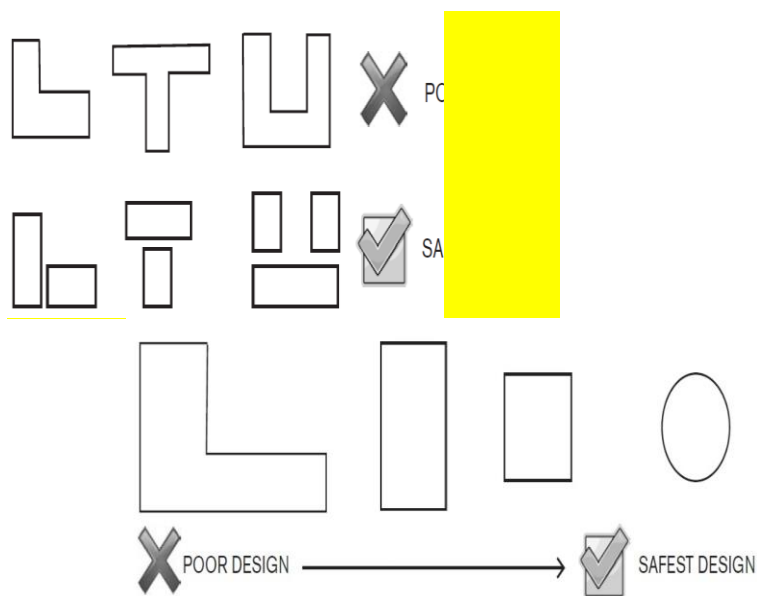


Figure 43. Safe designs in compacted and enclose forms

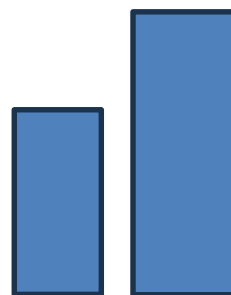


Figure 42. Design building to be vertically regular with respect to lateral stiffness and weight distribution.

Secure connectivity of all structural elements is important as walls, roofs and floors are the

crucial stress points so must given due consideration in terms of strong connectivity.

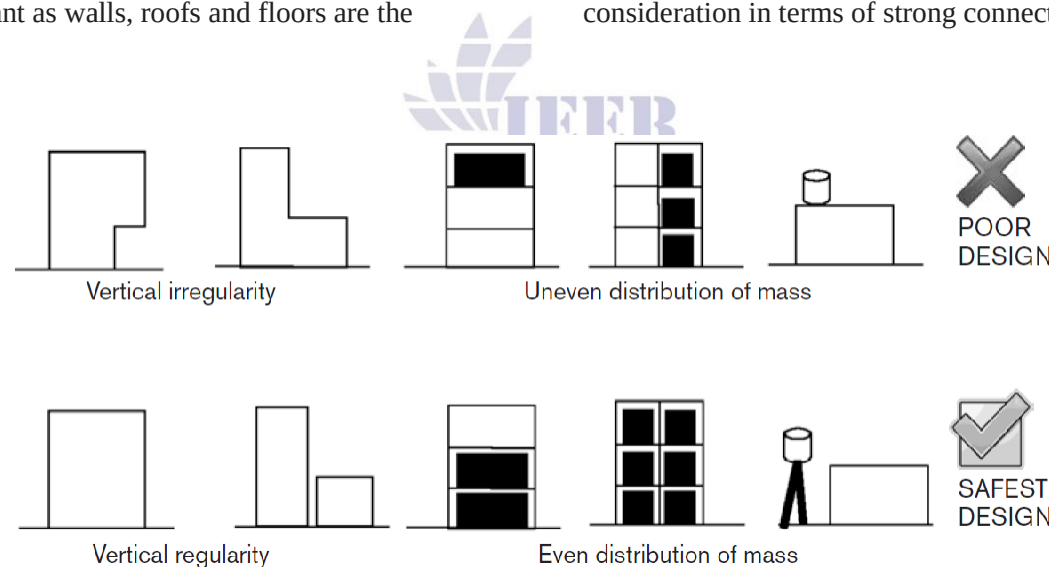


Figure 44. Design and build to resist lateral loads from all directions.

transfer the load down to the shear walls, or in

Horizontal structural elements tying walls, floor, roof, and Upper storey together is called diaphragm. They support face-loaded walls that

the case of a floor, then to the foundation directly.



to the floor. Critical weak spots can be created when vertical framing does not continue to the foundation.



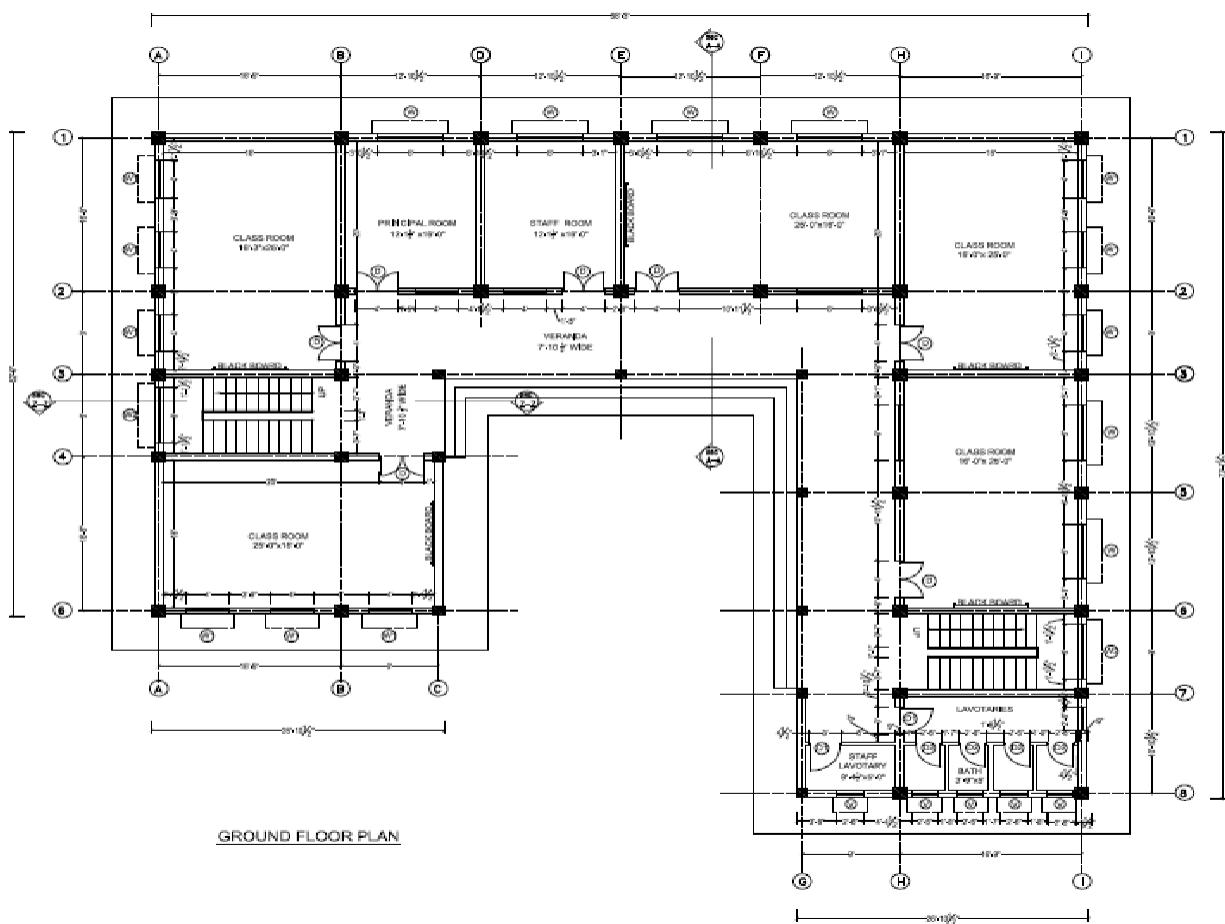
GROUND FLOOR PLAN

NO.	DESCRIPTION	AREA (SQ. FT.)	AREA (SQ. M.)
01	STAFF ROOM (10'0" x 10'0")	100	9.3
02	BATH (5'0" x 7'0")	35	3.3
03	1 LABORATORY (10'0" x 10'0")	100	9.3
04	CLASS ROOM (20'0" x 20'0")	400	37.2
05	CLASS ROOM (20'0" x 20'0")	400	37.2
06	CLASS ROOM (20'0" x 20'0")	400	37.2
07	CLASS ROOM (20'0" x 20'0")	400	37.2
08	LAB (20'0" x 20'0")	400	37.2
09	Corridor	100	9.3
10	Entrance	100	9.3
11	Storage	100	9.3
12	Restroom	100	9.3
13	Office	100	9.3
14	Kitchen	100	9.3
15	Breakroom	100	9.3
16	Reception	100	9.3
17	Waiting Area	100	9.3
18	Storage	100	9.3
19	Restroom	100	9.3
20	Office	100	9.3
21	Kitchen	100	9.3
22	Breakroom	100	9.3
23	Reception	100	9.3
24	Waiting Area	100	9.3
25	Storage	100	9.3
26	Restroom	100	9.3
27	Office	100	9.3
28	Kitchen	100	9.3
29	Breakroom	100	9.3
30	Reception	100	9.3
31	Waiting Area	100	9.3
32	Storage	100	9.3
33	Restroom	100	9.3
34	Office	100	9.3
35	Kitchen	100	9.3
36	Breakroom	100	9.3
37	Reception	100	9.3
38	Waiting Area	100	9.3
39	Storage	100	9.3
40	Restroom	100	9.3
41	Office	100	9.3
42	Kitchen	100	9.3
43	Breakroom	100	9.3
44	Reception	100	9.3
45	Waiting Area	100	9.3
46	Storage	100	9.3
47	Restroom	100	9.3
48	Office	100	9.3
49	Kitchen	100	9.3
50	Breakroom	100	9.3
51	Reception	100	9.3
52	Waiting Area	100	9.3
53	Storage	100	9.3
54	Restroom	100	9.3
55	Office	100	9.3
56	Kitchen	100	9.3
57	Breakroom	100	9.3
58	Reception	100	9.3
59	Waiting Area	100	9.3
60	Storage	100	9.3
61	Restroom	100	9.3
62	Office	100	9.3
63	Kitchen	100	9.3
64	Breakroom	100	9.3
65	Reception	100	9.3
66	Waiting Area	100	9.3
67	Storage	100	9.3
68	Restroom	100	9.3
69	Office	100	9.3
70	Kitchen	100	9.3
71	Breakroom	100	9.3
72	Reception	100	9.3
73	Waiting Area	100	9.3
74	Storage	100	9.3
75	Restroom	100	9.3
76	Office	100	9.3
77	Kitchen	100	9.3
78	Breakroom	100	9.3
79	Reception	100	9.3
80	Waiting Area	100	9.3
81	Storage	100	9.3
82	Restroom	100	9.3
83	Office	100	9.3
84	Kitchen	100	9.3
85	Breakroom	100	9.3
86	Reception	100	9.3
87	Waiting Area	100	9.3
88	Storage	100	9.3
89	Restroom	100	9.3
90	Office	100	9.3
91	Kitchen	100	9.3
92	Breakroom	100	9.3
93	Reception	100	9.3
94	Waiting Area	100	9.3
95	Storage	100	9.3
96	Restroom	100	9.3
97	Office	100	9.3
98	Kitchen	100	9.3
99	Breakroom	100	9.3
100	Reception	100	9.3

SCHEDULE OF OPENING

NO.	DESCRIPTION
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Source: US AID, PARRSA, PDMA



Institute for Excellence in Education & Research

Figure 48. Ground floor plan for a U-shape school building block

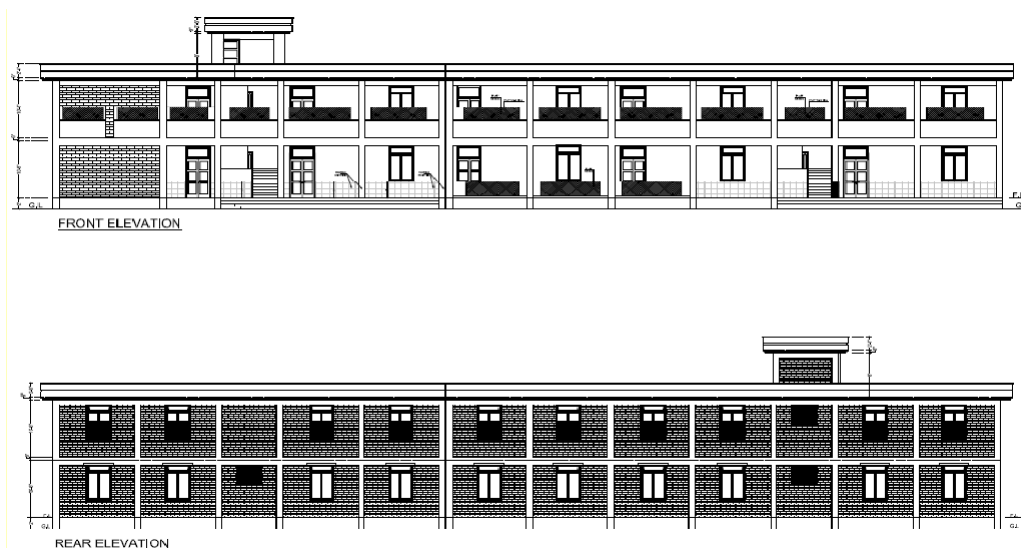
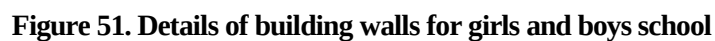


Figure 49. Front and rear elevation of a school building



S.NO	List of material used in buildings in Districts Swat
1	RCC, RBC
2	IRON, CEMENT
3	GARDER, T-IRON
4	WOOD
5	BURNT BRICK -BLOCKS
6	MUD BRICKS, MUD
7	WOOD AND OTHER MATERIALS.

Figure 52. List of material used

Source. PSLM survey

Building Design External Features (Building Envelop façade and windows)

Window Placement

Windows to be oriented perpendicular to the street and front facade to reduce exposure to blast damage.

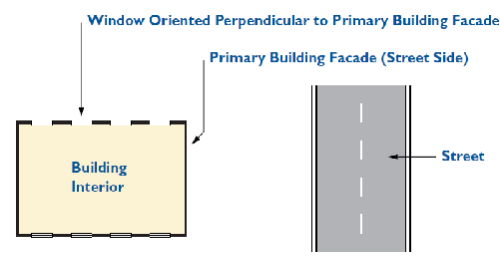


Figure 53. Window placement

Sacrificial Roof

Sacrificial sloping roof protecting the ceiling is important during emergency blast scenarios.

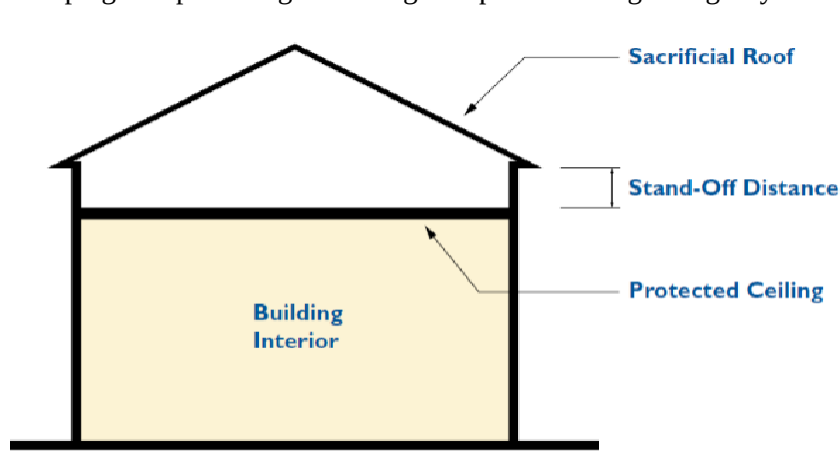


Figure 54. Sacrificial roof

Window Design

According to US Air force Installation force protection guide “Narrow recessed windows with

sloped sills are less vulnerable than conventional Ones.



Figure 55. Narrow and recessed Windows

Building Design Internal Features

Interior Barrier, Foyer Design

Use of interior barriers helps to provide security within the interior of a building.

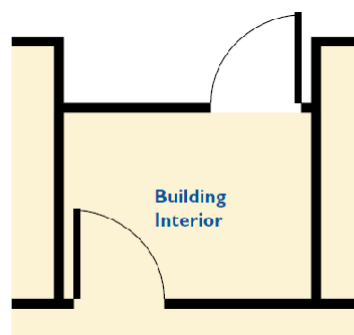


Figure 56. Foyer design for internal barrier for screening

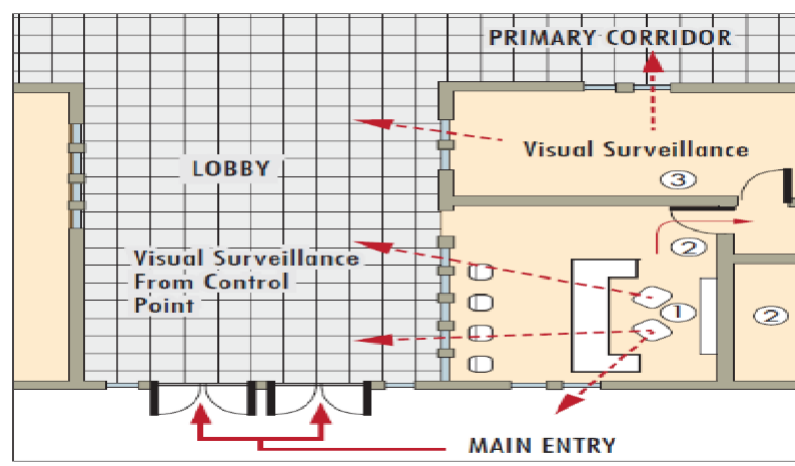


Figure 57. Considerations for entry areas

Source: Florida Safe Schools Design Guidelines, 2003

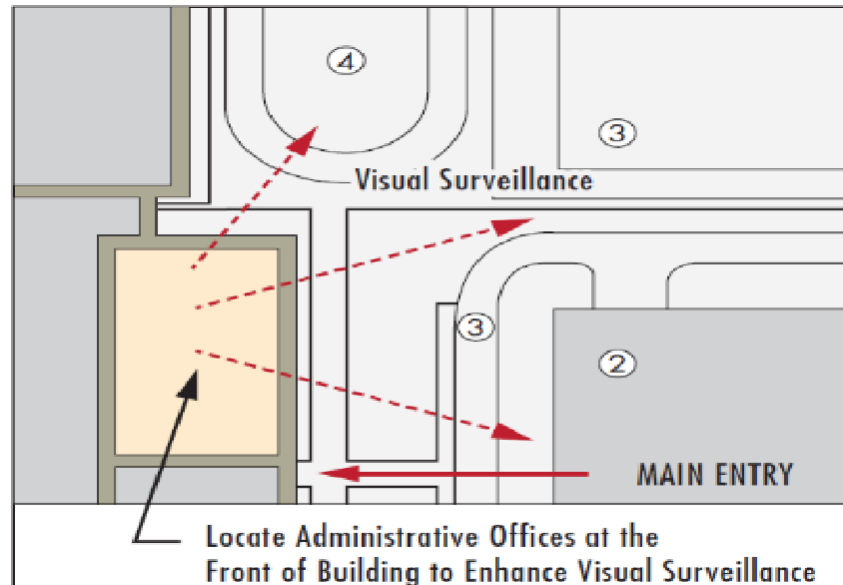


Figure 58. Position of administrative offices

SOURCE: FLORIDA SAFE SCHOOLS DESIGN GUIDELINES, 2003

Recommendations for Layers of Defense

Protective Measures:

1.First Layer of Defense

Vegetation

Dense vegetation near the building that could conceal criminal activity should be removed. An open space should be maintained inside the perimeter fence to enhance visibility. External

Barrier

Temporary passive barriers must be installed to prevent direct vehicular access to high-risk zones.

Blocking Sight Lines

Sight lines should be obstructed through strategic building orientation, landscaping, landforms, and screening techniques.

Standoff Distance

Procedural measures must be implemented temporarily to create standoff distances, restricting parking near critical areas.

Courtyard Design

High-risk land uses should be located toward the interior of the building site to minimize exposure.

Entry Control Point

Perimeters should be enclosed, providing a single controlled entry point for both pedestrians and

vehicles. The number of doors for regular access and egress should be minimized.

Security Measures: Second Layer of Defense

Operational Physical Devices

Installation of lighting systems, CCTV surveillance, and electronic alarm systems is essential to enhance security monitoring.

Access Points

Access points should be oriented at an angle relative to adjacent streets to improve visibility and control.

Operating physical devices

This subsection covers the installation of illumination systems, closed-circuit television (CCTV) surveillance, and electronic security alarm systems

Access points

Access points shall be sited so as to face oncoming streets to maximize visibility and deter illicit access

Security Measures for the Third Layer of Defense

Ensure that emergency exit and exterior doors open outward to facilitate safe and efficient egress exclusively in emergency situations. Elevate the ground floor construction to a minimum height of four feet above grade level to enhance structural resistance against hostile actions.

Eliminate single-point vulnerabilities by avoiding centralized infrastructural nodes; distribute critical building assets across multiple building blocks to reduce risk concentration.

Configure barrier layouts on sidewalks to maintain a continuous clear path of either eight feet or at least 50 percent of the sidewalk width to ensure unobstructed pedestrian movement.

Orient buildings primarily in a horizontal configuration rather than vertically to minimize external exposure and reduce the building's visible profile.

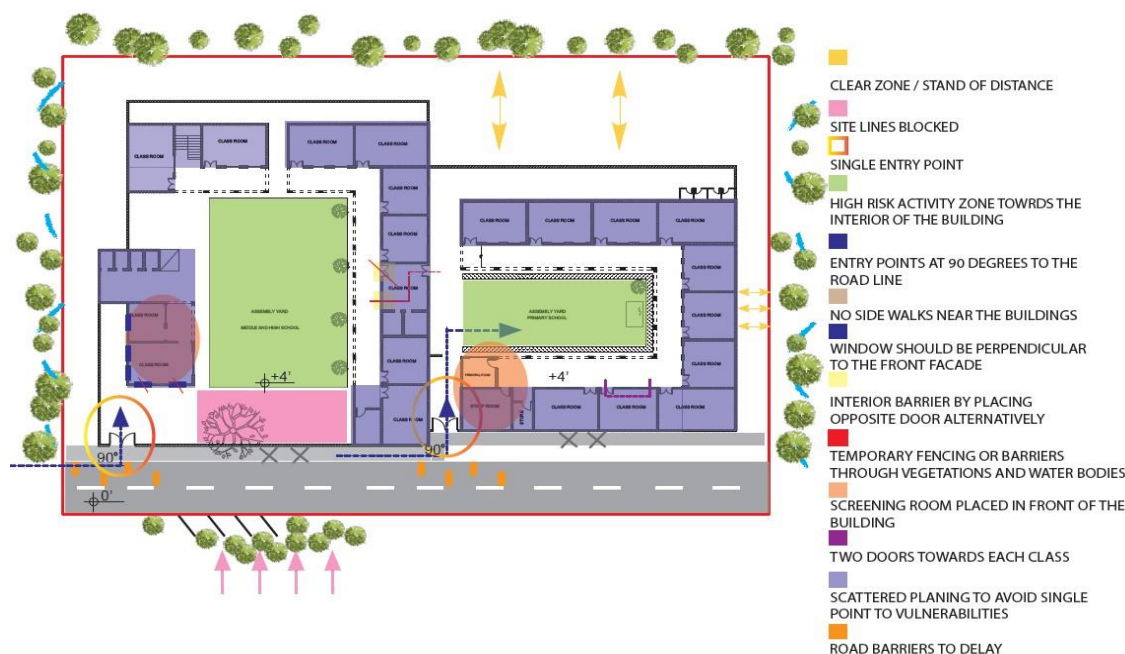
Reduce the number of windows adjacent to doors or increase the distance between them, recognizing that doors are potential points of forced entry.

Horizontal windows should be positioned at a minimum height of six feet above the finished floor to regulate entry and minimize blast penetration, as the volume of openings on the façade is directly proportional to blast effect.

Arrange asset placement within areas visible to the majority of occupants and visitors to deter concealment, ensuring spatial design mitigates potential hiding places both internally and externally.

Design circulation routes to establish controlled access points, thereby preventing unobstructed sightlines of individuals approaching sensitive areas.

The figure shows elements of Minimum Protection for Site Design.
PERSONAL ANALYSIS AND RECOMMENDATIONS



Security Measures:

Third Layer of Defense

- **Emergency Exit Doors**
Emergency exits and exterior doors must open outward to facilitate safe egress exclusively during emergencies.
- **Construction Levels**

The ground floor elevation should be raised at least four feet above grade level to increase resistance against attacks.

- **Single-point Vulnerabilities**
Avoid creating infrastructural nodes with single-point vulnerabilities; major assets

should be distributed across multiple building blocks.

- **Clear Path Distance for Barrier Layout**
Barriers on sidewalks must be arranged so that either a continuous clear path of eight feet or at least 50% of the sidewalk width remains unobstructed.
- **Building Form**
Buildings should be arranged in a horizontal layout rather than vertically to minimize the building's profile and external exposure.
- **Window Materials and Placement**
The number of adjacent windows should be reduced or spaced sufficiently away from doors to reduce breach risks. The extent of blast impact is directly related to the façade openings' size. Horizontal windows should be installed at least six feet above the finished floor to regulate access.
- **Space Planning for Asset Visibility**
Assets must be located in areas with maximum visibility to occupants and visitors, ensuring the design eliminates potential hiding spaces both inside and outside the building.
- **Circulation**
Controlled access points should be established by designing circulation routes that prevent unobstructed views of individuals approaching these points, thereby enhancing security

Discussion

This research emphasizes the critical need to view school architecture in conflict-prone areas like Swat not only as a physical shelter but as a dynamic environment for recovery and resilience. The analysis of case studies from Swat, Northern Nigeria, and Afghanistan highlights common architectural challenges and successful adaptive strategies that inform the proposed Moored Convalescence framework.

The primary insight is that resilience in school design transcends mere fortification. While robust, blast-resistant construction and perimeter defenses are essential, they must be integrated with spaces that foster psychological healing and social cohesion. The Nigerian and Afghan examples show how multipurpose community spaces and culturally sensitive designs strengthen not only physical safety but also community trust and participation, which are vital for long-term security and sustainability.

In Swat, where socio-political complexities and cultural identities run deep, the incorporation of local materials and architectural language alongside modern reinforcements promotes acceptance and ownership among communities. Schools conceived as community anchors enhance collective responsibility for protection and maintenance, bridging the gap between security needs and cultural belonging.

Furthermore, environmental sensitivity—through maximizing natural light, ventilation, and green spaces—contributes to healthier learning environments that support convalescence from trauma.

This holistic approach aligns with educational continuity goals and the psychological well-being of students and educators, a dimension often overlooked in post-conflict reconstruction.

The Moored Convalescence framework thus addresses the multifaceted nature of resilience by anchoring design in the intertwined physical, psychological, and cultural realms. Such an approach challenges conventional security-centric models, advocating for flexible, context-specific architectural solutions that respond to the lived realities of terrorism-affected populations.

Future implementation of this framework in Swat requires participatory design processes involving students, teachers, families, and local leaders to ensure contextual relevance and community empowerment. Monitoring and evaluation mechanisms will be vital to assess the framework's effectiveness in fostering both protection and healing, guiding adaptive improvements over time.

This discussion underscores the potential of architecture to contribute meaningfully to post-conflict recovery and sustainable peacebuilding,

positioning schools as proactive agents of resilience rather than passive victims to violence.

Conclusions and Recommendations

This study confirms that enhancing resilience in school architecture within terrorism-affected regions like Swat requires an integrated approach that balances security, psychological well-being, and cultural identity.

The Moored Convalescence framework provides a comprehensive model that anchors schools as secure, healing, and community-centered environments, moving beyond traditional defense-oriented designs.

Key conclusions include the necessity of combining robust physical protections with flexible, multipurpose spaces that support convalescence and social cohesion. Local material use and cultural integration are pivotal for fostering community ownership and sustainable maintenance.

The environmental design elements identified contribute significantly to creating restorative learning atmospheres essential for trauma recovery and educational continuity.

Recommendations for policy makers, architects, and educational planners in Swat and similar contexts are:

- Implement participatory design processes engaging community stakeholders to ensure cultural responsiveness and collective ownership.
- Prioritize incorporation of blast-resistant construction materials alongside architectural features that promote healing, such as therapy gardens and quiet zones.
- Design multipurpose spaces adaptable to both educational and community functions to enhance usage and social resilience.
- Utilize locally sourced materials and traditional architectural forms reinforced with modern techniques to balance cultural authenticity and safety.

- Integrate environmental strategies including natural lighting, ventilation, and landscaping to improve occupant well-being and reduce operational costs.
- Establish monitoring frameworks to evaluate resilience outcomes and inform future architectural and policy interventions.
- Adopting this holistic architectural approach will better equip schools in Swat to withstand and recover from terrorism impacts, contributing to long-term community stability and educational success.

Further research should explore implementation challenges and refine the framework through pilot projects and feedback from end-users.

Detailed Recommendations for Policymakers, Architects, and Educational Planners in Swat and Similar Contexts

Engage Stakeholders through Participatory Design

Implement design processes that actively include community members, educators, parents, local leaders, and students. This participatory approach ensures that architectural solutions are culturally sensitive, contextually appropriate, and foster a collective sense of ownership, which enhances long-term sustainability and acceptance of security measures.

Incorporate Blast-Resistant Materials and Healing Architectural Features

Prioritize the use of construction materials and structural systems with proven blast-resistance capabilities to safeguard occupants against terrorist attacks. Simultaneously, integrate architectural elements that support psychological recovery, such as therapy gardens, landscaped quiet zones, and naturalistic environments, to promote emotional wellbeing and reduce trauma among students and staff.

Design Adaptive Multipurpose Spaces

Develop flexible spaces that can accommodate both educational activities and community functions. This multipurpose strategy maximizes facility utilization, supports social cohesion, and strengthens resilience by fostering regular community engagement within the school environment.

Utilize Locally Sourced Materials and Traditional Forms with Modern Reinforcements

Balance cultural authenticity and heritage preservation by employing indigenous materials and vernacular architectural styles. Strengthen these traditional forms with modern engineering techniques to enhance structural integrity and security without compromising local identity.

Integrate Environmental Sustainability Strategies

Incorporate passive environmental controls such as optimized natural lighting, cross-ventilation, shading devices, and landscaping to improve indoor environmental quality. These strategies not only promote occupant comfort and health but also reduce energy consumption and operational costs, contributing to sustainable long-term management of school facilities.

Establish Continuous Monitoring and Evaluation Frameworks

Develop systematic procedures to assess the resilience performance of educational buildings post-implementation. Monitoring and data collection should inform iterative improvements in architectural design and policy development, ensuring adaptive responses to emerging threats and evolving community needs.

Promote a Holistic Architectural Approach

Advocate for integrated design methodologies that address security, cultural, psychological, and environmental dimensions simultaneously. Such holistic strategies will enhance the functionality and protective capacity of schools, enabling them to serve as secure, healing, and community-centered institutions.

Encourage Further Research and Pilot Projects

Support empirical investigations focused on practical implementation challenges, including cost-benefit analyses, material availability,

construction logistics, and user acceptance. Pilot projects with rigorous feedback mechanisms from students, educators, and local stakeholders are essential to refine theoretical frameworks into effective, scalable solutions.

These recommendations collectively aim to improve the resilience of educational infrastructure in Swat and comparable conflict-prone regions, fostering safer learning environments that contribute to sustained social stability and educational advancement.

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