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Resilience Guidelines for Critical Infrastructure

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Consultancy Team/ Urban Planning and Disaster Risk Reduction Center (UPDRRC) at An-Najah National University:

- Eng. Abdelhakim Al Jawhari (Specialist in Construction Engineering)
- Eng. Karim Aljawhari (Specialist in Seismic Risk Mitigation)
- Prof. Dr. Jalal Al-Dabeek (Team Leader, Specialist in Risk Assessment & Management)
- Dr. Jamal Al-Dabeek (Specialist in Disaster Risk Analysis & Modeling)
- Dr. Issam Jardaneh (Specialist in Soil Mechanics)

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LIST OF ACRONYMS:

ACI	American Concrete Institute
AFD	Agence Francaise pour Development
ASCE	American Society of Civil Engineers
DRM	Disaster Risk Management
EMP	Environmental Management Plan
ESMP	Environment and Social Management Plan
EU	European Union
EU-OSHA	European Agency for Safety and Health at Work
FEMA	Federal Emergency Management Agency
GIZ	German Technical Cooperation
IBC	International Building Code
IDA	International Development Association
IStructE	Institution of Structural Engineers (IStructE)
JSC	Joint Service Councils
KfW	Kreditanstalt für Wiederaufbau (German Bank for Development)
LGUs	Local Government Units
LTCs	Local technical consultants
MDLF	Municipal development and lending fund
MDP	Municipal Development Program
MoE	Ministry of Education
MoLG	Ministry of Local Government
MoUs	Memorandum of Understandings

NDRMC	National Disaster Risk Management Center
OPEN	Organizations Preparing for Emergency Needs
OSHA	Occupational Safety and Health Administration
PNA	Palestinian National Authority
RC	Reinforced concrete
SDC	Swiss Agency for Development and Cooperation
SDIP	Strategic Development and Investment plan
TMS	The Masonry Society
ToR	Terms of Reference
UNDRR	United Nations Office for Disaster Risk Reduction
UBC-97	Uniform Building Code (International Code Council 1997
UNRWA	United Nations Relief and Works Agency for Palestine Refugees.
VNG	International Cooperation Agency of the Association of Netherlands Municipalities
WB	West Bank

1. INTRODUCTION AND BACKGROUND

In response to a request from the Palestinian Authority (PA), the World Bank extended additional funding support to local government units (LGUs) in the West Bank and Gaza as they manage the adverse impacts of the COVID-19 global pandemic. The efforts and resources of the PA alone are inadequate to address the large financing gap created by the social and economic challenges that arose from the pandemic. As a result, the ongoing Third Municipal Development Project (MDPIII) was restructured to channel some USD15 million to affected municipalities. The Palestine Liberation Organization, for the benefit of the PA, has received an initial financing of EUR 130 million from the World Bank-International Development Association (IDA), PA, KFW, Denmark, SDC, VNG, GIZ and AFD towards the cost of the 3rd phase of the Municipal Development Program (MDPIII).

The MDPIII retains its original project development objective of enhancing the institutional capacity of municipalities for more accountable and sustainable service delivery. However, the project was enhanced to address the impacts of the public health emergency, and at the same time, contribute to the long-term resiliency of municipalities. The project allows to finance the costs of municipal activities that respond to the COVID-19 pandemic, sustain the provision of critical activities, and provide relief to vulnerable communities during the crisis. Further, a Contingency Emergency Response Component was added to finance response to forthcoming crises or emergencies throughout the life of the project.

The additional funds will finance:

- Priority investments contained in local Strategic Development and Investment Plans (SDIPs);
- Capacity development interventions;
- Projects with potential for private sector engagement.

Being at the forefront of the battle against COVID-19, LGUs could definitely benefit from resources to provide basic services critical for controlling the pandemic and facilitating the recovery of their communities. Therefore, governments, whether at the central or local levels, shall be resilient to emerging complex emergencies, brought by either natural or man-made hazards. While the impacts of such hazards could differ, there is a clear convergence in the aim of ensuring that communities have the capacities to absorb and recover from disaster consequences. Similarly, governments must equally have the means to mitigate and address the human and economic toll from disasters.

Under this restructured project, a capacity building component will be implemented to create knowledge and practice for building resilience at the local level. The project will likewise support efforts to institutionalize these efforts through the leadership of the National Disaster Risk Management Center (NDRMC). The target outcome is to lay the foundation for integrating resilience in LGUs via the production of technical knowledge, information, and guidelines and the conduct of the corresponding institutional capacity development.

To achieve this target, the assignment is composed of the following activities detailed in the terms of reference (ToR):

A. Conduct of a Multi-Hazard Risk Assessment and Mapping;

B. Development of Guidelines on Local Resilience Planning;

C. Formulation of Resilience Plans for Pilot Local Governments;

D. Formulation of Resilience Guidelines for critical infrastructure;

E. Capacity building of the National Disaster Risk Management Center (NDRMC).

The Assignment will be carried out in consideration of the following:

- Participatory engagement;
- Efficient and effective implementation;
- Practical, but sound approaches.

Apart from producing the above technical outputs, the Assignment will:

- Identify the gaps and capacities that exist among national institutions to sustain this undertaking;
- Provide guidance on how such capacities can be built by identifying key actions that can be integrated into the national DRM strategy;
- Recommend priority infrastructure (buildings) for retrofitting or rehabilitation which the municipalities can pursue in future projects targeting infrastructure e.g., MDPIII and other initiatives within scope of the assignment.

The current report focuses on Activity D in the ToR, which places emphasis on formulating resilience guidelines for critical infrastructure/facilities (e.g., hospitals, schools, civil defense, town halls). Such facilities are expected to perform strongly and remain operational in the event of disasters due to their vital role in supporting the resilience of Palestinian community and bringing in back normalcy. This indicates that new public facilities must be designed and built in accordance with state-of-the-art codes/standards. Quality control shall be maintained during both the design and construction phases. Regular assessments and maintenance must be also carried out during the operation phase to address any issues. The most challenging issue, however, pertains to existing public facilities, as a significant portion of those do not comply with modern building codes/standards and/or they may suffer from structural deficiencies due to their poor design and construction quality. This makes them highly susceptible to hazards (e.g., earthquakes, flooding, landslides), thus, the enhancement of their performance through structural rehabilitation (retrofitting) might be required. These public facilities covered the targeted twenty cities/municipalities agreed upon with NDRMC and MDLF.

Based on the previous discussion, the current report looks specifically at enhancing the resilience of Palestinian community by providing engineering guidelines for assessing and improving the structural performance of both existing and new critical public facilities during and upon disaster events. This is achieved mainly through assessing the current situation by reviewing the existing

policies or guidelines pertaining to the promotion of structural resilience, particularly for critical infrastructure. This is followed by proposing actions that can assist in improving the resilience of both new and existing critical infrastructure/facilities. Among such actions is providing detailed and comprehensive guidelines that can be implemented by different stakeholders to assess the performance of existing public facilities against user-specific objectives and design appropriate rehabilitation (retrofitting) strategies for non-compliant facilities. This report finally identifies the roles of actors and the corresponding capacities required to formally adopt and implement such standards across government agencies and the local engineering practitioners. Hence, these partners have been consulted throughout the different phases of preparing this assignment.

Prior to discussing the details and findings of this work, it is important first to identify the concept of resilience and highlight its particular importance for the Palestinian community. According to the United Nations Office for Disaster Risk Reduction (UNDRR), resilience can be formally defined as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions through risk management". Hence, enhancing the performance of susceptible critical public facilities to prepare for potential hazards clearly represents a vital part in the resilience of the Palestinian community, especially that a significant portion of such facilities are characterized by serious structural deficiencies. Those include the practice of design regulations that do not comply with modern building code standards, poor quality control during construction phase, or lack of proper maintenance. It is important to explain that the resilience of individual buildings can be characterized according to Bruneau et al. (2003) using four different pillars:

- Robustness: the strength and capability of different structural elements to withstand the demands resulting from hazards without significant degradation or loss of stability.
- Redundancy: it means that the local failure of a few structural elements will not cause any collapse or instability in the overall structure. In other words, the failure of a few elements will create a redundant structural system that at least maintains stability.
- Resourcefulness: efficiency in the identification of issues, prioritizing solutions, and resource mobilization in the context of damage or disruption of some building components.
- Rapidity: the capacity of meeting priorities, achieving goals, and recovering from the consequences of a strong event, effectively and efficiently.

Structural retrofitting (re-habilitation) mainly targets the first two pillars of resilience (robustness and redundancy), whereas the last two rely significantly on the preparedness, awareness, and understanding of policy makers and stakeholders for the potential hazards and their effects on the Palestinian community. It should be noted that those stakeholders are, but not limited to:

- Construction and property industry professionals such as material companies, designers, engineers, architects, builders, and building owners;

- Investors and financial institutions such as banks, inhabitants, and users of buildings including tenants and workers;
- Governments at the local, regional, and national levels;
- Communities, especially homeowners, small business operators.

The above stakeholders have varying understanding or interests in promoting resilience in the West Bank and Gaza. However, it is important to build a consensus on their specific roles and capacities, as well as establish a decision-support system across different institutions. To achieve this goal, this report proposes a plan leading to the formal adoption of guidelines/standards among government agencies and local engineering practitioners via a consultative and participative process. A plan must be also set to formally adopt the guidelines/standards proposed in this report amongst government agencies and the local engineering practitioners, which constitutes part of the objectives of the current task. The UPDRRC will assist in this aspect by providing support and communication with different stakeholders on equal basis as they all constitute part of the Palestinian community, regardless of the level of interest and role.

The UPDRRC has selected experienced staff with a combination of management and technical skills. The team includes a number of distinguished well-qualified experts and engineers, who have been working, or worked, over long years, in relevant projects in the Palestinian territories as well as in regional and international infrastructure projects covering all subjects about resilient infrastructure and thus has an important input. The team has also a very rich professional experience in different relevant fields and topics that will be beneficial for the accomplishment of the current task:

1. Engineering and international development, design, implementing and management of municipal and community infrastructure programs/projects in WB & G areas. They included critical infrastructure and buildings like schools, fire brigades, hospitals, and town halls.
2. Performing post disaster assessments, vulnerability studies, repair and strengthening and recovery initiatives and reconstruction. The UPDRRC also participated in the strengthening and restoration of various historical buildings in Palestine.
3. Providing support for hundreds of local government units including big municipalities, building their capacity through training, participatory process, identify needs and priorities, plan for projects, and empower them to improve their role towards sustainability.
4. Experience in social vulnerability studies that provide special attention to the needs of vulnerable populations such as elderly, women, children, low-income people, and disabled.
5. Remarkable expertise in environmental monitoring and green initiatives such as adopting solar photovoltaic systems and storm water collection.
6. Studying the local geology condition (seismic site effect) and the locations of buildings and whether they are vulnerable to landslides.

1.1. Report Contents and Organization

Based on the aforementioned discussion, the current report is divided into the following parts:

- **Chapter 2**: presents the implementation methodology in which the current situation with respect to existing buildings and guidelines/standards/codes is assessed by means of professional experience, field work, and survey among selected municipalities and various stakeholders/authorities;

- **Chapter 3**: provides a detailed review of the current situation with respect to resilience. It highlights the factors affecting the resilience of critical infrastructure and generic buildings, particularly with respect to predominant construction practices, quality assurance/control, site supervision, site selection, assessment of existing buildings, in addition to the roles and responsibilities of relevant public authorities and stakeholders. The results of the questionnaires circulated among the selected municipalities and public organizations are also presented through simplified statistical bar and pie charts;

- **Chapter 4**: summarizes relevant guidelines and rules, as well as recommendations to help improve the resilience of the new buildings and critical facilities, which apply to the different phases of building life cycle (e.g., planning, initial assessment, design stage, construction stage, repair and maintenance). Key recommendations are also presented regarding the update of the current codes and standards to be in line with state-of-the-art ones, which help accounting for multiple hazards and improve resilience;

- **Chapter 5**: offers a brief description of the guidelines developed in another report[1] for the systematic evaluation of existing building structures in accordance with user-specific performance objectives that rely on the importance of the building under consideration. The techniques and strategies that can be used for the rehabilitation (strengthening or retrofitting) of non-compliant existing buildings are also briefly discussed.

- **Chapter 6**: provides a multi-dimensional responsibility matrix that determines the exact role and tasks to be accomplished by each one of the stakeholders and relevant authorities. It also organizes the communication between them to maintain appropriate coordination at different levels. Such information will guide the efforts towards more resilient structures.

[1] Guidelines for Retrofitting of Existing Buildings, Prepared by UPDRRC as part of Integrating Resilience in Local Governance in West Bank and Gaza – Municipal Development Program (Phase III - Cycle II).

2. IMPLEMENTATION METHODOLOGY

The current assignment aims mainly to provide standards/guidelines for improving the resilience of critical public facilities/infrastructure in Palestine. It also looks at identifying the roles of actors and the corresponding capacities required to formally adopt and implement such standards across government agencies and the local engineering practitioners. To achieve those objectives, a systematic methodology has been implemented, in addition to conducting the following preparatory actions.

2.1. Methodology Description

2.1.1. Assessing the current situation connected to critical facilities/infrastructure

This step involves first the review of existing policies or guidelines pertaining to the promotion of structural resilience, particularly for critical infrastructure, such as hospitals, civil defense, town halls, and schools, knowing that the latter facilities can be used as shelters during hazards. The governmental institutions that own, construct, and utilize these buildings are the following:

- Ministry of Health for hospitals;
- Ministry of Education and municipalities for schools;
- Ministry of Local Governance (MoLG) and municipalities for town halls;
- Civil Defense for fire stations and civil defense facilities.

It is worth highlighting that a representative sample of the above critical facilities/buildings in the West Bank and Gaza were also identified, in coordination with NDRMC and concerned institutions, and were included on the multi-hazard risk maps, as part of Phase A of the project.

The assessment of the current situation incorporated the following critical steps:

- Coordination with the major licensing institutions that are in charge of issuing permits, and monitoring infrastructure's safety and construction requirements. Those are specifically the municipalities, MoLG, Civil Defense, and the Engineers Association.
- Review the current state-of-practice and construction trends to identify any potential weaknesses and deficiencies affecting the resilience of Palestinian buildings.
- Check whether the engineering codes/standards adopted in the design of critical buildings are appropriate and in compliance with state-of-the-art provisions.
- Identify the roles and responsibilities of local institutions in Palestinian National Authority (e.g., Engineers Association, Civil Defense, municipalities and others) for regulating the construction at the central and local levels. For example, discussions are conducted with the relevant licensing authorities, mainly municipalities, who are the responsible body for issuing building permits/licenses in accordance with master plans. Additionally, discussions with the

Engineer's Association as the main body regulating the sector and giving license to all engineers were also conducted.

- Circulate interview questionnaires among the largest 20 municipalities (selected upon the coordination with MDLF) to benefit from their input on the existing standards/policies related to resilience and the current roles/responsibilities of governmental institutions and different stakeholders.

- Conduct meetings/discussions with Engineers Association, the selected 20 municipalities, and the Civil Defense departments and MoLG to gather all the required information using templates relevant to resilience policies and guidelines.

2.1.2. Propose actions towards resilient critical facilities/infrastructure

The second part of the implemented methodology pertains to proposing actions that can assist in improving the resilience of critical infrastructure, based on the investigation results for the current situation. The proposed actions incorporate the following points:

- Propose the adoption of appropriate state-of-the-art codes/guidelines/standards for the design of new buildings. Those standards/guidelines are applicable for several types of structures and account for multiple hazards (e.g., earthquakes, landslides, flooding);

- Provide detailed guidelines for the systematic evaluation of the performance of existing buildings with respect to user-specific performance objectives that depend on the building importance. This helps in the decision-making process, particularly to understand whether a building requires rehabilitation and to assist in resource prioritization when implementing major rehabilitation plans at a building portfolio level. The proposed guidelines are based on state-of-the-art standards and codes and are applicable to Palestinian building structures;

- Prepare a full report that discusses the potential rehabilitation (strengthening, retrofitting) strategies to improve the performance of existing buildings that are non-compliant with the desired performance objectives mentioned in the previous point. The rehabilitation strategies will be classified based on the type of structural deficiency (e.g., strength, local detailing, stiffness, and layout) and form of intervention (e.g., add new elements, enhance the existing ones, selective removal of elements, and reduce demands);

- Various techniques for the rehabilitation strategies are discussed, with special focus on their cost, disruption, and applicability/constructability. Numerous design formulas and structural detailing drawings for those techniques will be also provided;

- Propose ideas to improve and develop the planning process towards encouraging the integration of the structural resilience as a priority within the recovery plans, in addition to fostering the effective coordination between different stakeholders;

- Encourage the relevant institutions to allocate budgets in the long term to be used for retrofitting and upgrading the critical buildings towards sustainability. This could be supported by public private partnerships initiatives and will help in maintaining the capacities of the communities at different levels;

- Encourage the relevant institutions through meetings and specialized training to adopt a long-term strategy towards building the capacities of the communities at different levels;

- Present the new findings and guidelines to different stakeholders and decision-makers within the community, including the Higher Education Institutions.

2.1.3. Advise the World Bank and the partner PA authorities on how structural resilience, including retrofitting and upgrading, can be implemented under the MDPIII.

This will include the following activities:

- Coordinate with MDLF to inform about the sectors and the types of projects that can be within the scope of MDPIII program. Possible desk review of the program proposal.

- Prepare a checklist or a template with the relevant conditions and submit to MDLF to be requested from beneficiaries (i.e., World Bank and partner PA authorities).

- Through MDLF, to request from the beneficiaries to submit the request for funding keeping in mind possible including new critical buildings and upgrading or retrofitting existing ones.

2.1.4. Reviewing proposals from participating pilots and other proposed projects for MDPIII and identifying opportunities for structural resilience, among other possible approaches.

The UPDRRC will do the following:

- Collect from MDLF the proposals requesting funding for certain projects from the beneficiaries after being screened by MDLF;

- Perform a second level of screening to select those that can be considered within the categories or sectors identified before as critical infrastructure;

- Submit a list of subprojects from LGUs that can be prioritized for structural resilience under the MDPIII based on the above analysis.

2.2. Preparations of Implementation

To launch the implementation of this activity, and other activities within the project, the following preparations and actions were accomplished by UPDRRC; supported by MDLF and NDRMC:

1. The NDRMC sent letters to all concerned stakeholders covering ministries of health, education, local, government, civil defense, the twenty municipalities, and others. This was to

inform about the project and requesting from them to nominate focal points from each institution;

2. The MDLF also sent letters to concerned municipalities in support of the work and to facilitate the UPDRRC team and assign representatives to participate in the activities of the project;
3. The UPDRRC started efficient coordination with the focal point nominated from the MoLG in order to contact the different municipalities;
4. The UPDRRC in support of MDLF collected all information about the municipalities' teams received from the different municipalities and sent letters to all about the project activities;
5. The UPDRRC prepared a questionnaire in both Arabic and English languages; (see attached)
6. The UPDRRC forwarded the questionnaire to all 20 municipalities in West Bank and Gaza, selected in coordination with MDLF;
7. The UPDRRC also forwarded the questionnaire to other stakeholders including:
    - The universities in West Bank and Gaza that have engineering faculties;
    - The Ministry of Health;
    - The Ministry of Education;
    - The NDRMC members;
    - The Engineers Association;
    - The Ministry of Local Government;
    - The Civil Defense;
    - The Ministry of Al Waqf
    - The Palestinian Contractors' Union.
8. The UPDRRC got the answers using both interviews and distribution and collection of answers;
9. The analysis and evaluation were done after that, using the feedback presented in the answered questionnaire to be integrated in the guidelines;

2.3. Data Collection and Fieldwork

The critical buildings/facilities have been visually inspected by the UPDRRC field team through conducting site visits and rapid checks. Such visits covered almost all the governorates in the West Bank, in addition to Gaza Strip. More details can be found in Appendix A1.

2.4. Joint Meetings and Discussions

The UPDRRC conducted joint meetings and discussions with the nominated focal points representatives from each department/stakeholder institution. Such meetings incorporated extensive discussions on the concept of resilience and its importance to the Palestinian Community. More details can be found in Appendix A2.

3. RESILIENCE ASSESSMENT OF PALESTINIAN BUILDINGS AND PUBLIC FACILITIES:

3.1. Existing Policies and Guidelines

Based on the meetings conducted with different stakeholders and responses to the questionnaire, in addition to the site inspections, it was realized that the currently adopted standards/guidelines are not appropriate to promote the resilience of critical buildings and facilities. This can be mainly attributed to the following reasons:

- Lack of awareness on the concept of resilience and its critical role in supporting disaster response and preparedness, especially in a country subjected to multiple natural hazards;
- Absence of codes, guidelines, or even simplified recommendations that allow engineers and decision-makers to address resilience in constructing and operating critical buildings;
- The use of obsolete building codes that do not necessarily account for multiple hazards;
- Disregarding non-structural elements during the design of buildings, even though they are essential to maintain building operability during times of disaster and their falling hazard could pose a substantial threat to life of occupants;
- Lack of appropriate guidelines for the retrofitting of existing buildings to upgrade their structural performance and enhance their resilience.

The previous issues resulted in a significant portion of buildings, including critical ones, that do not maintain sufficient levels of hazard resilience. Many of those buildings as well are characterized with several structural deficiencies, as explained later, that could adversely affect their performance against natural hazards, which can potentially lead to devastating consequences in the future.

3.2. Existing Construction Typologies in Palestine:

The type of structural systems used in building construction has a major effect on their performance during a hazard event such as earthquakes or flooding. Different structural systems are used in the Palestinian building industry, which vary depending on construction materials, type of lateral force-resisting system, and configuration. Those systems behave differently against various hazards; therefore, it is quite vital to understand their performance attributes, potential deficiencies, and vulnerability indicators. The main features of common building typologies used in Palestine are summarized in Table 1 and explained in detail afterwards.

Table 1. Main features of existing construction typologies in Palestine

Property/Building	Reinforced concrete (RC) frames	Shear-wall buildings	Unreinforced masonry buildings
Construction material	Cast in-situ RC	Cast in-situ RC	Natural stone
Lateral-load resisting system	Beam-column frame system	Shear walls	Masonry bearing walls
Flooring system	Ribbed or solid slabs (one way or two-way loading)	Ribbed or solid slabs (one way or two-way loading)	Composite slab systems of RC panel supported by steel joists
Typical number of floors	Less than 15	5 to 20	1 to 3

Reinforced-concrete (RC) frame buildings

This building typology is the most common in the West Bank. It mainly consists of in-situ cast reinforced concrete (RC) slabs supported by beams and columns. The system develops its lateral strength through the rigid connections between its individual members. This type is mostly used for buildings characterized by residential occupancy with height not exceeding 15 floors (see Figure 1). Ordinary concrete materials are usually used in those buildings. The cylindrical compressive strength of such a material ranges between 24 and 32 Megapascal (MPa). The reinforcement material is composed of deformed bars with a yield strength of 420 MPa.

In RC frames, floor height ranges between 3.0 to 3.5 m, usually governed by the number of stone cladding layers and the width of the bays ranges from 4 to 6 meters in both horizontal directions of the RC frame. Internal partitions in those buildings are made of hollow concrete blocks with 100 to 200 mm thickness. It should be noted that the exterior panels in-between beams and columns are infilled with masonry walls that could be in one of the following forms:

1. Three-layered walls composed of a layer of hollow concrete blocks with a 100 mm thickness, weak plain concrete layer of about 150 mm thick, and an external layer of stone cladding with a thickness of 30 to 50 mm. Figure 2 shows a cross section of this type of exterior walls. The range of weight of those external walls varies between 6 to 7 Kilonewton per square meter (KN/m^2).

2. Hollow concrete blocks with thickness of 150 to 200 mm. The range of weight for those walls varies between 2 to 2.5 KN/m^2 (reference DB1). Such infills are illustrated in Figure 3.

It is important to realize that the presence of those exterior walls has a significant effect on the performance of RC frames. In fact, masonry infill walls provide a considerable increase in lateral strength, stiffness, and energy dissipation capability. However, it might cause localized stress concentration at column edges due to frame-infill interaction, which can lead to brittle failure.

Figure 1. Reinforced concrete frame buildings

Figure 2. Masonry Walls, Concrete, Hollow block with Stone cladding

Figure 3. Concrete block exterior walls covered with plastering

With respect to flooring systems, RC slabs with two different configurations are typically used in the Palestinian construction practice/industry:

1. Ribbed slabs with hidden beams: slabs of this type are cast as either one-way or two-way ribbed slabs using hollow concrete blocks for this purpose. Each hollow block has 400 mm

length, 200 mm width and thickness in the range of 140 mm to 320 mm. Figure 4 shows details of both systems. Typical depths of such slabs vary from 200 to 500 mm. The rib width is generally in the range of 100 to 200 mm. The weight of one-way slabs is in the range of 4 to 7 kN/m^2, while that of two-way slabs ranges between 5 and 8 kN/m^2. This is in addition to a superimposed dead load in the range of 3 to 4 kN/m^2. The beams are usually hidden as they have the same thickness as the slab.

2. Solid slab with dropped beams: slabs here are made solid with a typical thickness from 150 to 300 mm, supported on dropped beams. The weight of the slab ranges between 3 and 6 kN/m^2. This is in addition to a superimposed dead load in the range of 3 to 4 kN/m^2. Depth of the beams may range from 400 to 800 mm. Such a high beam depth allows for large spans for slab panels, ranging from 6 to 8 m in both directions. This type of floor system is typically implemented for heavily loaded slabs such as those used as parking lots and commercial buildings. It has been adopted recently for school buildings as well.

Figure 4. One-way ribbed slab with dropped beams (left) and two-way ribbed slab (right)

Shear-wall buildings

Shear-wall buildings have gained an increased popularity upon enforcing the seismic design by law in 2015 based on the request of the Engineers Association. Typically, such buildings range from 5 to 20 floors in height. RC shear walls are between 200 and 300 mm in terms of thickness. The seismic resistance in shear-wall buildings is usually provided by the dual action of the shear walls and frame elements (i.e., beams and columns). However, shear walls have significantly larger lateral strength and stiffness compared to frame elements, thus, the vast majority of the lateral resistance of such buildings is provided by the shear walls. Many engineers even prefer to assume that the lateral-load resistance is provided by the shear walls only, while they assume the frame elements resist solely the gravity actions. Shear walls are typically covered with stone cladding, similar to RC frame buildings as schematically illustrated in Figure 5. The range of weight for external walls including cladding stone varies between 8 to 10 kN/m2. The total weight consists of slab weight ranging from 4 to 7 kN/m^2 and superimposed dead load of 3 to 4 kN/m^2 (depending on the occupancy category).

Figure 5. Stone cladding of a shear-wall building

Unreinforced masonry buildings with bearing wall system

Masonry buildings used to be common in the West Bank up to the 1970s. They consist of double-leaf masonry walls made of natural stone units. Those walls directly support solid RC concrete slabs. The stone units used to construct such walls are typically 250 mm in height, 300-600 mm in width, and 150-200 mm in thickness. They are generally placed on a row-by-row basis with lime mortar to fill the joints between stone units. Plain concrete of generally low compressive strength fills the inside cavity of the double-leaf walls. The cavity thickness is between 100 and 150 mm and the overall thickness of the wall could be between 400 and 500 mm. Unreinforced masonry buildings are generally low rise, i.e., they are between 1 and 3 floors only.

Another less common type of masonry construction also existed in the West Bank, in which the walls are composed of a single leaf, with a layer of plain weak concrete cast behind the wall via an appropriate formwork. The wall thickness in such a case could be up to 350 mm. As a rule of thumb, the cross-sectional area of walls represents around 10 to 30% of the floor area due to their large thickness. Figure 6 and Figure 7 report some examples of masonry school buildings in the West Bank. Stone masonry walls have a very high shear strength and lateral stiffness. Their main issue, however, is the lack of ductility and improper connection between walls and floors (diaphragms). Also, there is no experimental data on the behavior and shear resistance of such walls, therefore, engineers conservatively assume the shear strength of cement block walls. Such a strength ranges between 40 kN/m^2 to 100 kN/m^2.

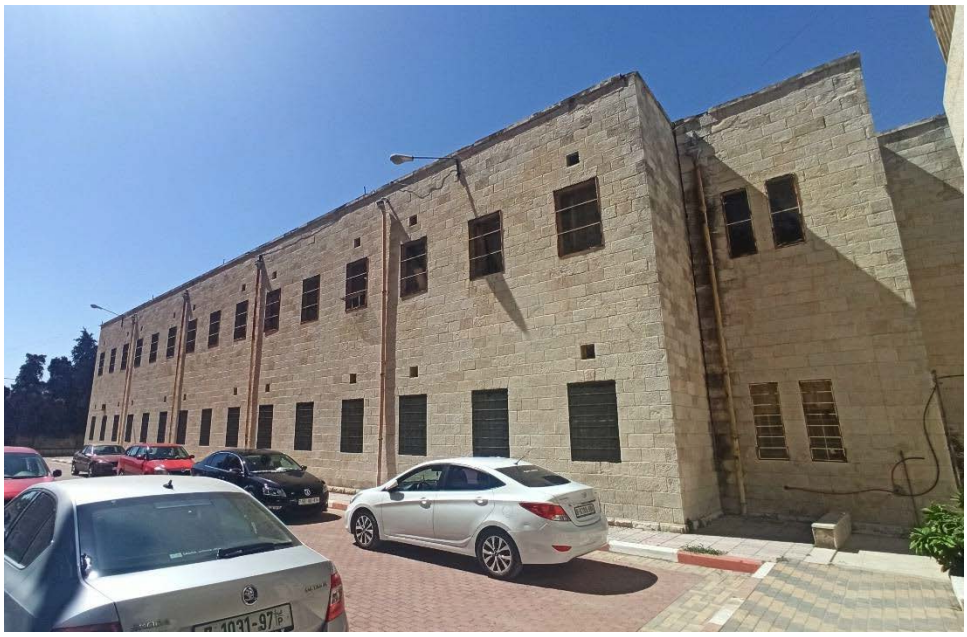

Figure 6. Masonry walls of a school building in Nablus city

Figure 7. Masonry walls of a school building in Nablus city

Regarding slabs in unreinforced masonry buildings, two forms of slab construction exist. The first one is two-way solid slabs with typical thickness around 200-250 mm as per Figure 8 (dropped beams might be used to support such slabs). The second type is a composite floor consisting of an RC slab (or deck) supported by steel joists of an I-shaped cross section. The latter slabs are usually thinner

than the former ones (100-120 mm in terms of thickness) as indicated in Figure 9. While the first type slab might span between 4 to 5 m, the spans of the second type are larger, and could reach between 5 and 7 m in both directions. The weight of the slab and the superimposed dead load comprise about 5 to 10 kN/m^2. The unit weight of the masonry wall is about 25 kN/m^3.

Figure 8. One-way Solid Slab with Dropped beams

Figure 9. Masonry with composite section for slabs (Solid resting on steel I beams)

3.3. Survey on Existing Policies for Supporting Resilience in Palestine

For the purpose of involving the municipalities and different stakeholders in understanding the current situation, a specifically-developed questionnaire has been circulated over the largest 20 municipalities in the West Bank and Gaza (as agreed with MDLF, NDRMC and World Bank), which incorporate the vast majority of buildings. The questionnaire has been also sent to key stakeholders, including:

- Ministry of Education;

- Ministry of Local Governance;
- Civil Defense – Nablus;
- Civil Defense – Gaza;
- The Engineers Association;
- Environmental Quality Authority;
- Palestinian Agricultural Disaster Risk Reduction and Insurance Fund (PADRRIF);
- Palestine Technical University – Kadoorie (PTUK);
- Ministry of Social Affairs and Development.

It should be noted that other stakeholders were also contacted regarding the questionnaires but have not yet provided any feedback. The questionnaire generally aims to (a) review existing policies/guidelines pertaining to the promotion of structural resilience particularly of critical structures; (b) identify the roles and responsibilities of public institutions in the Palestinian National Authority involved in the regulation of the construction at the national and local levels; (c) check and discuss the roles and responsibilities of the relevant licensing and planning authorities. The questionnaire is composed of 15 different questions, which are summarized in Table 2 below.

Table 2. Questionnaire circulated among different municipalities and stakeholders

Q1	What is the role of your entity/organization? Does your organization have a role in spatial planning? If yes, do you adopt land use policy?
Q2	How many buildings do you own, operate and maintain? Do you have annual resources? Are they enough?
Q3	What design guidelines/standards/policies do you normally implement? Do they apply for all building occupancy categories? (e.g., commercial, residential, public facilities, health-care facilities, education).
Q4	Are these guidelines/standards/policies based on international codes/references? If yes, are they compatible with the local construction practices?
Q5	Do you implement the same guidelines/standards/policies for the assessment of existing buildings? If not, please specify any guidelines/standards that you normally follow.
Q6	Do you believe that the currently implemented guidelines/standards/policies are suitable to provide resilient critical infrastructure (e.g., schools, hospital, civil defense, town halls) in case of disasters?
Q7	Do you conduct any review for the design documents if they are submitted to your organization/entity? If yes, what does the review process incorporate and what engineering aspects? (Quick screening, detailed peer-review, structural, architectural)?

Q8	In your opinion, what is the level of quality control during the construction process? Who is responsible to do and monitor that?
Q9	What is the level of coordination between the relevant authorities involved in the process? Do you think it requires improvement? How?
Q10	What do you think about the level of public awareness and agreement among all concerned regarding the resilience of our critical buildings and the priority for resilience enhancement?
Q11	What do you think about the status of existing buildings with respect to resilience? What measures can be implemented to improve it?
Q12	Do you believe that the currently implemented guidelines/standards/policies require modifications, updates, or improvements, and why? If yes, can you propose any other international references, standards, or codes that could be applicable?
Q13	What challenges do you face performing your mandate related to structural resilience?
Q14	Towards resilient infrastructure, do you have any comments, recommendations or actions towards improvements you would like to propose regarding the following: Current practices, Implemented codes/standards, Licensing process Roles of stakeholders Other
Q15	What do you advise regarding disaster insurance?

The majority of municipalities and stakeholders have completed the questionnaire, with an overall response rate equal to 60%. Upon analyzing and grouping the answers, some critical findings and conclusions are drawn regarding the current situation of critical buildings/infrastructure with respect to resilience. Figure 10 reflects the opinion of the selected municipalities and stakeholders on the compliance of the current guidelines/codes/standards with international standards, and whether they are compatible with the engineering construction reality (Q4). It can be observed that more than 50% of the stakeholders believe that the current standards and guidelines related to resilience are partially compatible with international codes and Palestinian construction reality, mainly because they require major updates to be in line with state-of-the-art knowledge. They also require modifications that make them more applicable to the local construction practice. On the other hand, 30% of the stakeholders and municipalities believe that the current guidelines and standards are appropriate and fully compatible, whereas 17% do not agree on this.

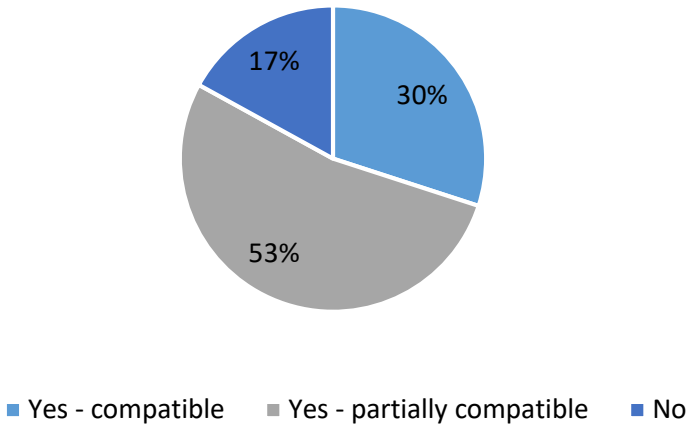

Figure 10. Response to Q4: Are implemented standards/guidelines compliant with international references? Are they consistent with Palestinian construction reality?

Another important point concerns Q5, i.e., the availability of guidelines/standards dedicated for the evaluation and rehabilitation (strengthening) of existing structures. Figure 11 demonstrates that more than 90% of the municipalities and stakeholders use the codes dedicated for the design of new buildings to conduct evaluation of existing building structures. Only 6% reported that they use additional guidelines in such a situation, but without specifying what type of guidelines. This represents a major problem as the codes used for the design of new buildings significantly differ from those dedicated for existing buildings with regard to demand estimation procedure, factors of safety, margin of acceptable risk, and expected performance. More discussion and details on such a major issue are provided in later sections.

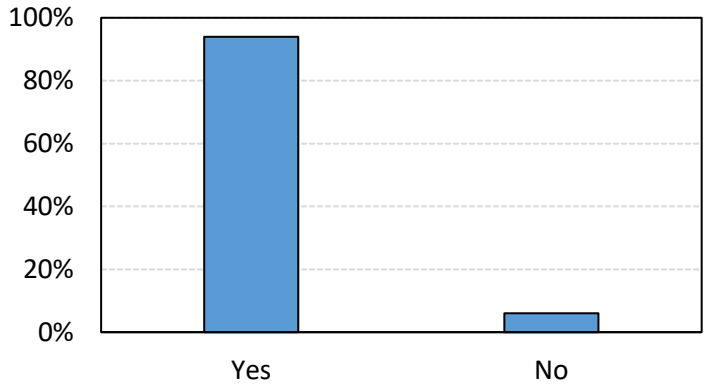

Figure 11. Response to Q5: Do you implement the same guidelines/standards/policies for the assessment of existing buildings?

The municipalities and stakeholders were also asked whether the currently implemented codes and standards are suitable for providing resilient critical buildings/infrastructure in the event of disasters (Q6). Almost half of the respondents, as per Figure 12, were partially satisfied that the current codes/standards are suitable for maintaining resilience for two reasons: 1) because those codes require updating; and 2) most of those codes are strictly applied to schools and hospitals only rather than the entire building population and facilities. Around 30% of the questioned stakeholders and

municipalities believe that the current codes/standards are not suitable for resilience, whilst only 23% claim that they are satisfactory. Such results reflect a good level of understanding by Palestinian public organizations with respect to the urgent need of up-to-date practical standards to maintain the resilience among the Palestinian community.

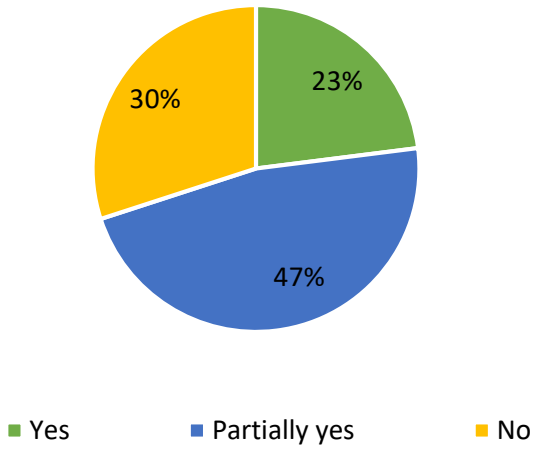

Figure 12. Response to Q6: Do you believe that the currently implemented guidelines/standards are suitable to provide resilient critical infrastructure in case of disasters?

Adding to the previous information, the selected municipalities and stakeholders were asked if they believe the current codes/standards/guidelines require major modifications and/or updates (Q12). As shown in Figure 13, more than 70% believe that modifications are required so that the current guidelines become in line with state-of-the-art knowledge/standards and more applicable to the Palestinian construction reality. On the contrary, 29% of those parties believe that the current standards/guidelines are sufficient to maintain the resilience of critical infrastructure. However, they stressed on the fact that the construction industry lacks mechanisms and procedures that effectively monitor the implementation of the current guidelines and correct any deviations. Therefore, they believe that efforts must be directed towards improving quality control and quality assurance, in addition to site supervision and monitoring.

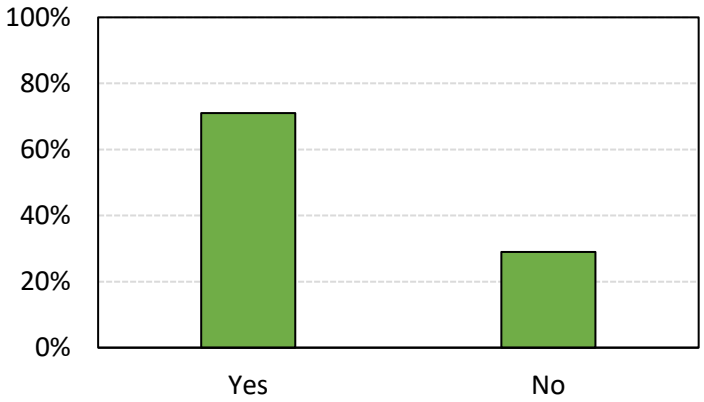

Figure 13. Response to Q12: Do you believe that the currently implemented guidelines/standards/policies require modifications, updates, or improvements?

It is interesting to highlight that almost all the municipalities and stakeholders who responded to the questionnaire pointed out the issue of lack of effective coordination between the different relevant authorities (Q9). They proposed developing a unified digital system (and a platform) that can be accessed by interested parties. Through such a platform, authorities can maintain appropriate levels of coordination, conduct a faster review process, share results with others, and remain on track regarding any updates or issues that might arise, etc.

Regarding the insurance against disasters (e.g., earthquake, flooding) as per Q15, the vast majority of municipalities and stakeholders recognized the value of insurance. However, mandatory implementation of which would be difficult as this could be costly considering that most of the existing buildings do not comply with modern codes and standards. The UPDRRC will review previous experiences and studies about the vulnerability levels and expected evaluated losses in the critical infrastructure and its reflection on the economy. A benefit cost analysis is an additional tool that can be used by stakeholders to demonstrate the financial benefits of retrofitting (an example is discussed later in Figure 35 for such analysis).

The selected municipalities and stakeholders were also questioned about the most important challenges that could hinder the efforts of developing resilient critical infrastructure (Q13). Almost all those entities highlighted several common challenges as listed below:

- Lack of proper understanding on guidelines/standards/policies;
- Insufficient financial and human resources for the relevant authorities to support the implementation and monitoring of resilience guidelines/standards/policies;
- Absence of firm and effective monitoring/supervision procedures to ensure that building owners and investors are complying with the resilient design and building license;
- Lack of public awareness about the importance of developing resilient infrastructure;
- Most of the existing critical facilities/infrastructure are relatively old, so they were not designed and built in accordance with modern codes/standards. Some of the critical facilities constitute typical residential buildings that have been rented due to the limited availability of spaces and land within urbanized areas;
- Institutional constrains regarding the ability of amendment/modifying or adding new laws;
- No specific rules/guidelines on the regular maintenance of critical facilities/infrastructure;
- Lack of awareness with respect to disaster insurance.

Overall, the previous questionnaire results can be characterized by some general trends that must be taken into consideration when working on improving the resilience of critical infrastructure. Such trends incorporate: 1) A general belief by the municipalities and stakeholders that the current guidelines must be updated to be consistent with state-of-the-art references/standards; 2) appropriate monitoring, quality control, and site supervision procedures must be developed to ensure that every building, especially critical ones, are designed following the permits, licenses, and standards; 3) the

communication and coordination between relevant authorities shall be maintained in a modern and effective manner; 4) there are no specific unified rules and guidelines that can be implemented for the assessment and rehabilitation of existing buildings.

3.4. Existing Factors that Affect the Resilience of Buildings in Palestine

A significant portion of the Palestinian buildings, including public facilities, is highly susceptible to hazard-induced damage, thus reducing their resilience during times of disaster. This is due to various issues that can be found in the common construction practices, implemented design and assessment codes/guidelines, enforced policies, etc. Those are thoroughly discussed in this section.

3.4.1. Geometric irregularities

A major part of the issues related to construction, which adversely affect the resilience of buildings in Palestine, is related to the extreme geometric irregularities that could drastically make buildings highly vulnerable. Those irregularities can be classified into plan (horizontal) irregularities, vertical irregularities, and other irregularities. More details on each of those are provided as follows:

Plan (horizontal) irregularities:

Plan irregularities mostly result from asymmetrical geometric plan shapes, such as L-shaped and irregularly shaped buildings, thus creating an eccentricity between the centers of mass and stiffness in the building. This leads to a torsional behavior that causes a high stress concentration in corner elements (i.e., columns), which results in an early conductible failure. Such a severe irregularity is unfortunately quite common in the Palestinian construction practice due to the lack of appropriate regulations that enforce more regular building plan shapes. Figure 14 shows an L-shaped 3-story school building located in Palestine.

Figure 14. L-shaped school building

It should be noted that the plan shape could be irregular, but the asymmetric distribution of vertical structural elements (e.g., shear walls, columns) could lead to a large eccentricity between the mass and stiffness centers, leading eventually to a torsional brittle behavior. An example is provided in Figure 15, where a school building located in Nablus city is regular with respect to plan shape, but

the position of the staircase shear wall on the edge of the building causes a considerable eccentricity, therefore, a torsional behavior is more likely to occur.

Figure 15. A school building with a regular plan shape and irregular distribution of vertical elements

Another example of plan irregularity is the high plan slenderness ratio. In such a case, the diaphragm behavior in the weak direction of the building can potentially change from rigid to flexible, thus leading to uneven distribution of stresses over the vertical structural elements such as columns and shear walls. An illustration is provided in Figure 16 for buildings with high slenderness ratio.

Figure 16. Buildings with high slenderness ratio in plan

Vertical irregularities:

The presence of vertical irregularities can cause uneven distribution as well as abrupt changes in mass and/or stiffness among different floors. Discontinuity of vertical structural elements is another impact of such type of irregularities. A very common example of vertical irregularities in Palestine is the setbacks, where a particular floor is reduced in size from one or multiple sides. This causes a clear discontinuity in the vertical structural elements, and large stresses are expected to occur at the columns or shear walls located at the edge of the setback area. Examples of setbacks in Palestinian buildings are illustrated in Figure 17.

Figure 17. Buildings with setback vertical irregularities

The most prevalent form of vertical irregularities in Palestine is the presence of soft (weak) story in the building, which has at least 30% lower stiffness and lateral strength compared to the adjacent stories. Due to such severe reduction in strength/stiffness, stresses and deformation demands will be concentrated in those soft (weak) stories, leading them to a dangerous early collapse, whereas the remaining stories experience little-to-no deformation and remain elastic in most of the cases. This type of irregularity in Palestinian buildings is usually formed by removing the infill walls on the ground floor, which is commonly used for commercial activities or as a car-parking space. Such a construction trend is reported in Figure 18.

Figure 18. Buildings with soft (weak stories)

Another common vertical irregularity is formation of short columns. This happens when the effective length of the column that can undergo lateral sway becomes significantly less than the actual column height. This causes a drastic increase in the lateral stiffness of the column, leading to absorbing more shear stresses, which can cause an early non ductile shear failure. This case is very common in school buildings as shown in Figure 19 as the windows are relatively very big.

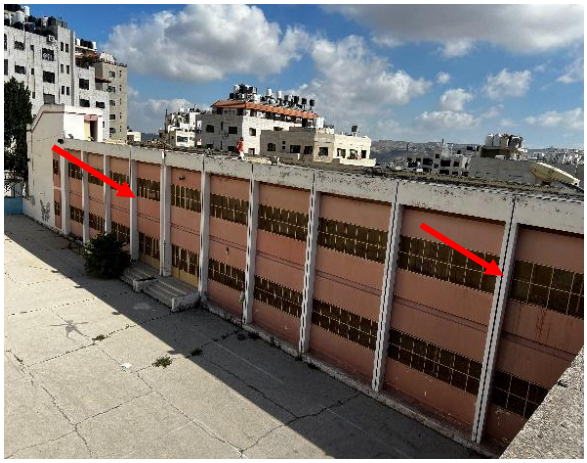

Figure 19. Formation of short columns in school buildings

The final vertical irregularity that exists in many buildings in Palestine is the use of different structural materials and/or systems across different floors. This case usually exists when new RC floors and frames are added on top of an old existing building made of unreinforced masonry for instance. This type of irregularity has drastic effects on the integrity of structural elements. It also creates significant differences in terms of mass and stiffness amongst different floors. Figure 20 provides an example of a building composed of unreinforced masonry, RC frames with concrete-steel composite slab, and RC frames with ribbed slabs.

Figure 20. A building with different structural systems/materials across different floors

Other irregularities:

There are some other types of irregularities that cannot be classified as either horizontal (plan) or vertical. The most common one is the lack of appropriate separation between individual buildings, which could increase the pounding potential in case of earthquakes for example. A graphical illustration is provided in Figure 21 for such a case.

Figure 21. Improper separation between buildings

The presence of long and heavily loaded cantilevers in buildings, which are typically utilized as balconies, could be another significant irregularity that must be taken into account. In fact, such cantilevers might be significantly affected by the vertical component of ground-shaking, leading to heavy damage. Figure 22 shows example structures with those cantilevers.

Figure 22. Buildings with long and heavily loaded cantilevers

3.4.2. Neglecting the effects of non-structural elements

The performance of non-structural elements during hazard events is usually neglected by designers and engineers, although the failure of those elements constitutes the main contributor to seismic losses. The falling hazard associated with some types of non-structural elements such as shelves and false ceilings could pose a major threat to the lives of building occupants. In critical public facilities like hospitals, the non-structural damage might lead to loss of functionality, thus leading to adverse consequences. It should be noted that the non-structural elements are those components that cannot be classified as part of the lateral-force resisting system. Those elements can be categorized based on their purpose/functionality type as shown in Table 3:

Table 3. Classification of non-structural components with examples

Non-structural component	Examples
Architectural	Chimneys, parapets, false ceiling, infills, partitions, stone cladding, curtain walls
Electrical	Chandeliers, lighting fixtures, power generators, sockets
Mechanical and plumbing	HVAC devices, heating pipes, potable-water pipes, boilers, water tanks
Contents	Furniture, storage cabinets, shelves

Figure 23 to Figure 26 illustrate photos of some non-structural elements, which are: parapets, infill walls, water tanks, and loaded shelves, respectively. Nonstructural elements are typically incorporated in the structural design process by considering their own weight; in other words, they are treated as an extra live load acting on the structural system. However, for critical buildings like hospitals, the functionality and stability of such elements must be taken into account. This must be done through using specific fixtures that tie them to the main structural elements to prevent falling hazards and avoid sudden damage/collapse. Designers can refer to Chapter 13 in the ASCE 41-16 (ASCE 2017) for more details on the seismic design of non-structural elements.

Figure 23. Parapet on the top of a school building

Figure 24. Infill walls made of cement hollow blocks

Figure 25. Water tanks installed on the roof of a residential building

Figure 26. Heavy shelves in a hospital

Another major threat stems from the exterior masonry infills walls covered by stone cladding, which exist in almost all the buildings in Palestine. The stone cladding units are susceptible to falling during a hazardous event, posing a significant risk of injury or even death. An effective practice in this case could be fixing those cladding units to the exterior masonry walls as clarified in Figure 27, where steel dowels are drilled inside stone units then connected with a reinforcement mesh that lies in the cavity between the cladding and cement blocks.

Figure 27. Fixation of stone cladding units to the masonry cement block exterior wall

In order to prevent the interaction between the infill walls/partitions and the main structural system, a good practice is to isolate those elements from the main frame. However, the falling hazard must be prevented, which can be easily done by designing steel dowel fixtures to connect the walls to the surrounding beams or diaphragms.

3.4.3. Geotechnical aspects (site selection and land-use planning)

It is mandatory by the Engineers Association to implement site investigation for the design and construction of new buildings or structures, as well as for additions and alterations to existing structures. The general main purpose of site investigation is to help in selecting the type and depth of foundation suitable for the structure and the site; evaluating the bearing capacity, estimating the probable settlement of the structure; and determining the location of the water table. In general, two steps precede site investigation as shown below.

Collection of Preliminary Information

- This step involves obtaining information regarding the type of structure, approximate column loads, spacing, local code and any other information that will help to fulfill the purpose of site investigation.
- Other information can be obtained from google maps, geological and geotechnical maps, hydrological maps, agronomy maps, and highway department maps.

Reconnaissance

- In this step the engineer makes a visual inspection of the site to obtain information about general topography, soil stratification from nearby existing cuts, such as those made construction, evidence of slope instability, water marks, types of construction especially foundation construction, problems in existing structures, such as cracks, etc.

The typical site investigation consists of planning, determining the number and depth of boreholes, drilling boreholes, sample collection, and field testing. Those steps are usually carried out by local geotechnical laboratories. The code to carry out these steps is based mainly on the Jordanian Code. Usually, the Engineers Association – Jerusalem Center checks the elements of the site investigation report and states whether the report fulfills all requirements. Through the revision of the site investigation processes carried out by local geotechnical laboratories, it is found out that:

- Municipalities and LGUs require only the acceptance of Engineers Association on the site investigation report, and they do not check the contents.
- The site investigation reports prepared by local geotechnical laboratories typically focus on the general purpose, such as type and depth foundation, bearing capacity. However, some elements in those reports are neglected, despite their major influence on the construction of foundation as they might lead to unsuitable design, safety problems, and extra costs. Such elements include expansive soil, collapsible soils, landfill, cavities, soils with possible sliding (slope instability), sites with deep excavation, site with special seismic characteristics. etc.

3.4.4. Quality assurance/quality control and site supervision

The quality assurance/control and site supervision are among the major challenges affecting the resilience of buildings in Palestine. While such procedures are compulsory regarding governmental and internationally-funded construction projects, buildings belonging to private sector are usually

constructed with little-to-no site supervision. This is attributed to the lack of resources and strict monitoring policies, in addition to the low commitment levels by some municipalities and investors. Those issues are pervasive in rural areas, but they are still considerable in urbanized regions.

The Engineers Association has tried recently to tackle such issues by getting a decision from the cabinet in 2021 to make engineering supervision and quality control obligatory through the entire construction phases of any project. Moreover, several memoranda of understanding were signed between the Engineers Association and most of the big municipalities in the West Bank with respect to the same challenges. The Engineers Association also issued a detailed book of guidelines for site supervision. These guidelines are dependent on the size and nature of projects, and they cover all aspects related to the role of engineers and required level of expertise. The guidelines are made publicly available through the Engineers Association website[2].

Nevertheless, construction projects are still not subjected to obligatory site supervision, therefore, more efficient monitoring/follow-up procedures are strongly required to ensure quality control. Also, the guidelines of site supervision are not followed in all municipalities due to the lack of proper legislation.

3.4.5. Site (workplace) safety

Site-safety monitoring is applied almost only in the projects constructed through international donations given as such a procedure is always a main requirement from international donors. For public/governmental projects, site safety is a requirement, but strict monitoring procedures are not implemented, making the safety questionable. The Ministry of Labor is responsible for that, but their resources are quite limited. The municipalities on the other hand have no influence regarding the safety inside construction sites, but rather in the area surrounding the building, including pedestrians and adjacent infrastructure. There are high records of accidents that caused various deaths and injuries throughout the recent decades. Those could be effectively reduced, or even avoided, if safety procedures are applied and monitored by qualified safety engineers.

3.4.6. Environmental requirements.

There are good initiatives towards environmental sustainability by MDLF. The main focus here is to ensure the soundness of social and environmental impact assessments and determine adequate mitigation measures that reflect sound analysis are in compliance with the MDLF Environmental and Social Framework (ESMF). For each project, the local technical consultants (LTCs) contracted by MDLF are requested to prepare and submit an Environmental and Social Management Plan (ESMP) for approval before going for tendering. An environmental specialist is required to monitor compliance with the ESMP during requirements and to submit the required reports.

3.4.7. Implemented design codes and standards

The Engineers Association is the body solely responsible for enforcing design codes/standards and quality control guidelines for buildings and infrastructure. Even though the seismic hazard is

[2] https://www.paleng.org/

considerable in Palestine, the seismic design has been enforced by the Engineers Association only a few years ago. This applies to all critical buildings (e.g., hospitals, schools) and ordinary ones with more than three stories. Although this represents a major step towards producing more resilient buildings during the event of hazards, the Engineers Association implements obsolete design codes that were developed more than 25 years ago, such as the 1997 Uniform Building Code (International Code Council 1997), also known as UBC-97, and the Jordanian code of practice, which was issued in 1997 and updated between 2006 and 2008. This code is entirely based on obsolete standards like UBC 97 and ACI 318-95 (ACI Committee 318 1995).

Despite the major initiatives by the Engineers Association towards enforcing seismic design, the use of obsolete codes can negatively affect the resilience of buildings. In fact, modern design codes provide more optimal design procedures and more accurate evaluation of structural demands (e.g., internal forces, displacements) resulting from earthquakes or any other hazards. They also embrace the concept of resilience and sustainability. Therefore, a major update in such a regard needs to be discussed with the Engineers Association. It should be noted that special design provisions for vulnerable people groups such as elderly, handicapped, and those with special needs, are not part of the mandatory requirements for ordinary structures and many public facilities. Such a vital point must be also taken into consideration by the Association in any future update of codes/standards.

3.4.8. Assessment and rehabilitation of existing buildings

As mentioned earlier, seismic design was imposed by the Engineers Association a few years ago, which indicates that the majority of existing buildings are designed to sustain gravity loads only. This means that such buildings might demonstrate a weak structural performance during any type of hazard event (mainly earthquakes), thus affecting the overall resilience of the Palestinian community. Therefore, it is strongly required to assess the performance of existing structures to understand whether a structural intervention is needed or not and prioritize retrofitting efforts towards buildings in critical situations.

It is important to note, however, that there are no specific standards/guidelines/codes in Palestine for the assessment of existing buildings. Instead, engineers rely on their personal judgment and use the traditional seismic codes, which are originally dedicated for new buildings, to assess the existing ones. This represents a major challenge, as the seismic performance of new buildings can be easily predicted and determined because the designer has full control over material properties, sectional dimensions, and structural detailing (reinforcement). On the contrary, predicting the performance of existing buildings is more cumbersome, and requires special analysis and modeling procedures. Moreover, design codes for new buildings are more conservative as they include many factors of safety. The margin of acceptable risk in new buildings is also lower than that accepted for existing ones. This reveals that addressing the performance of existing buildings using the same standards of new ones can prove to be over conservative, infeasible, and impractical.

On the other hand, if a building is found non-compliant with performance requirements, engineers working in the Palestinian construction industry usually use personal judgement and experience, in addition to overly simplistic models, to design structural rehabilitation (retrofitting, strengthening) without a real measure of seismic behavior with respect to performance objectives or acceptance criteria. This happens primarily due to the lack of specific guidelines/standards that provide

systematic procedures for the assessment of existing buildings using appropriate performance metrics. A specific document discussing the applicable rehabilitation strategies, in addition to their pros, cons, applicability to the Palestinian construction reality, is not available until this moment. Therefore, such guidelines must be proposed and introduced to the construction practice.

3.4.9. Roles/responsibilities of local government institutions

This subsection explains the roles/responsibilities of different public institutions and stakeholders in Palestine with respect to the construction industry. Those have been identified based on the results of questionnaires, and relevant personal experience of the UPDRRC as follows.

Municipalities and local councils:

The roles of municipalities in construction regulation can be summarized in the following points:

- Preparation of the urban master plan for the municipal jurisdiction. This generally includes classification of the areas and land parcels which govern the types of occupancy categories like residential, housing, commercial, industrial, agricultural, etc. The master urban plan is subject to the approval of the Ministry of Local Government (MoLG).
- Sets limitations when it comes to the maximum height and number of stories for buildings, in addition to setbacks. Such limitations depend mainly on the master urban plan.
- Issues building licenses after assuring that all the required approvals by various institutions (e.g., the Engineers Association, Civil Defense) are obtained.
- Issuing permits or no objection letters to owners in order to use buildings.

Despite the critical role of municipalities in the resilience of communities, there are several issues in terms of their roles and responsibilities. For example, the preparation of master urban plans is quite generic, without appropriate spatial planning. Such master plans mainly determine the locations of potential future expansion with land use. However, more refined and systematic planning is usually needed, which takes into account different hazards and their effect on community resilience. Moreover, although the municipality is the official body for issuing building licenses, they assume no responsibility in the construction process. *In other words, they do not take place in monitoring technical procedures, quality of work, and structural safety*. Instead, municipalities only recommend technical supervision by qualified engineers in cooperation with the Engineers Association. Some of those municipalities enforce site supervision, but those are the ones which signed MoUs with the Engineers Association. These MoUs are not mandatory and subject to possible freezing or even cancellation by the municipal councils. Another major challenge is that a considerable number of municipalities do not have a sufficient number of engineers and technical staff to appropriately monitor construction sites. This problem becomes more serious, especially with the lack of appropriate financial resources. Some of the municipalities, such as in Gaza Strip, are still following obsolete municipal laws that have not been updated since the British Mandate on Palestine in 1936. Based on this discussion, it is obvious that some responsibilities and roles of municipalities must be reviewed/modified.

The Ministry of Local Government (MoLG):

The MoLG is responsible for the spatial planning and the building permits outside the boundaries of the municipalities. The MoLG also reviews and checks issues related to licensing requirements for areas outside the responsibility of municipalities. It should be noted that the requirements and limitations imposed by the MoLG regarding construction work might be different from those issued by municipalities. But the main difference is that the MoLG has no role/responsibility with respect to site supervision and quality control of construction work. No real monitoring/follow-up procedures are used to ensure application of licensed construction drawings, mainly due to the lack of human resources. This results in owners/investors not abiding by building licenses and construction drawings. Therefore, it is quite important to strengthen the role of MoLG and implement strict monitoring procedures to mitigate such major challenges.

The Joint Service Councils (JSC):

As an important step towards improving the services submitted to the citizens in different rural communities located close to each other and to achieve some decentralization and delegation of authorities, the MoLG founded the JSCs. These councils are given the role of the municipalities covering most of the responsibilities mentioned previously including building licenses. Those JSCs encounter quite similar challenges to regular municipalities, even more difficult.

The Engineers Association:

This association is responsible for critical tasks related to construction work, such as:

- Manages all consultancy work related to construction of buildings and infrastructure.
- Pre-qualification of consultancy firms.
- Review designs submitted by consultancy institutions/firms to make sure all requirements are followed and grant no objection accordingly.
- Extra review for adding new construction over existing buildings.
- Coordinates with relevant authorities, like the Civil Defense and Ministry of Labor for site safety requirements.
- Adopts and recommends design codes/standards/guidelines.
- Coordinates with all concerned governmental institutions and municipalities to make sure that all requirements are integrated in the designs and drawings of the buildings.
- Conducts several capacity building programs covering seismic design, relevant codes, site supervision, quality control, testing, site safety, retrofitting, green buildings, design and analysis computer programs.
- Participates in the licensing and planning committees within the MoLG.

The Engineers Association has also a significant role in maintaining the quality control and site supervision of construction work, which is related directly to the resilience of buildings. In fact, they work closely with the government towards the obligation of engineering site supervision by qualified engineering firms in all construction projects. As mentioned earlier, a first step has been taken in 2021, where a decision by the council has been made to oblige engineering supervision and quality control on construction projects. However, multiple difficulties have been encountered during the application of such rules, mainly due to the lack of resources and effective monitoring procedures, in addition to the low cooperation on the owners/investors side. Therefore, appropriate engineering supervision and quality control is almost limited to internationally-funded projects and governmental construction.

Vulnerable populations such as children, handicapped, and those with special needs are amongst the highly susceptible people to hazard consequences. Therefore, they require special provisions in the design and construction of buildings, regardless of their occupancy categories. Although the Engineers Association has started giving more attention to such a vital aspect, the application of such provisions is limited to some governmental and critical buildings. Therefore, more work is needed towards integrating those requirements into typical design standards/codes.

The Ministry of Education (MoE):

The MoE mainly manages the education sector covering public, private and UN-related schools, in addition to kindergartens. More importantly, they prepare, issue and update guidelines for the design of school buildings (in line with the Engineers Association). They are also responsible for schools planning, design, supervision, operation and maintenance, which is accomplished in collaboration with private consultancy firms and/or contractors. The MoE is the governmental body that conducts detailed review of school designs to make sure they are compliant with the MOE requirements and approves construction documents upon the initial approval by the Engineers Association. Although the MoE has a vital role, they encounter several issues that can affect the resilience of school buildings, despite their role in the Palestinian community as critical infrastructure. Examples include:

- Funding is usually insufficient for continuous maintenance and retrofitting of old school buildings. Some of the school buildings are rented from private landlords, indicating that they were not initially designed and constructed in accordance with the strict specs and requirements of school buildings.

- Not all school buildings have special provisions for handicapped and people with special needs due to the lack of resources.

- The seismic design for school buildings has been enforced in 2005. A peer-review for such a design is usually done by the UPDRRC (or any third party) to make sure the requirements are fully met. Nevertheless, this means that numerous school buildings built before 2005 do not comply with seismic provisions, and therefore they need extensive and special performance assessment in order to proceed with rehabilitation. The lack of funds represents the major challenge in this process, as well as the absence of specific standards/ guidelines for the assessment and rehabilitation of existing structures. The latter issue is tackled within the scope of the current task.

Based on the previous discussion, more efforts must be exerted to identify a clearer and stronger role for the MoE in order to support their actions towards improving the resilience of school buildings.

Civil Defense:

The Civil Defense has a major role in the resilience of Palestinian community. They also have representation in all key committees related to building safety such as municipalities, the Engineers Association, and others. Its main task is to guarantee and maintain all safety requirements based on the number of stories, occupancy category, and number of inhabitants. Previously, many problems occurred as a result of applying local old instructions for safety. Therefore, the Civil Defense adopts now the Jordanian code of practice until having a Palestinian national code.

Several challenges can hinder the role of Civil Defense. They always endeavor to maintain a high level of coordination with other concerned institutions and investors, but the lack of resources makes things difficult to implement and monitor. This leads to non-commitment on the side of investors and building owners with respect to providing safety requirements. Moreover, the Civil Defense has guidelines for fire protection, but they lack guidelines covering other natural hazards. Those aspects must be improved in the future to increase the resilience of Palestinian community.

Coordination between different authorities:

Coordination between the aforementioned stakeholders and public institutions is a must. However, the coordination level that exists now is not to the required level. This can be improved through using networking, adopting state-of-the-art technology (e.g., electronic review of the requirements and documents). However, each institution should take the responsibility to apply its mandates and guarantee the needed resources and seek support from possible resources including the central government. There is also an urgent need to integrate all institutions into a single system through adopting unified requirements to avoid possible contradictions between different areas, which might affect the quality level. Similar technology can be used to integrate plans for the purpose of development and improvement. These cover the preparation of master plans, land use, with the need to update and unify the prevailing laws.

4. GUIDELINES FOR IMPROVING THE RESILIENCE: NEW BUILDINGS

This chapter provides some guidelines and specifications intending to improve the resilience of critical public facilities and communities in Palestine. Those guidelines are divided into several stages (or groups) based on the phase of construction as detailed and presented below.

4.1. Initial Assessment and Site Selection

When it comes to critical buildings and vital public facilities, an assessment must be done by a qualified team of engineers and other specialists in order to select the most appropriate project in terms of location, scope, functionality, cost effectiveness, target groups, sustainability, and other important considerations. Discussions and effective communications must also be maintained with end-users and other beneficiaries to encourage their active participation in the decision-making

process, so that their needs can be understood and addressed. It is important as well to make sure that owners, investors or operators of critical public facilities such as schools and hospitals, have the capacity, sufficient budget and human resources to fully operate and maintain the facilities. A plan must be set for that, and it must also address the effects of natural hazards (e.g., earthquakes, flooding).

With respect to site selection, it must comply with the rules of licensing authorities and the urban master plans. The following points must be taken into account, to improve the resilience of critical facilities during the times of disaster:

- As near as possible to the beneficiaries with good accessibility and easy transportation.
- The area is sufficient in order to cover the scope and other requirements, like parking and emergency situations.
- Easy connection to lifeline systems and other services.
- Perform the required testing and calculations for the soil dynamic characteristics to avoid possible amplification of seismic waves.
- Perform slope stability analysis to avoid potential landslides. If a landslide is quite likely to occur, it is recommended to change the planned location, or at least take required precautions with respect to excavations.

4.2. Planning and Design

Several aspects must be taken into account during the planning and design phase of buildings, especially critical public facilities. Those aspects incorporate the qualifications of engineers, building codes/standards, legislation, safety, etc. More details are provided below.

4.2.1. Engineers qualifications

Design must be accomplished by a qualified consultancy firm, which is accredited by the Engineers Association. For important and special projects, pre-qualification of engineers for the design and supervision must be done following specifically developed criteria.

It is always important to conduct advanced capacity-building programs covering seismic design, design for other hazards like floods, relevant codes, site supervision, quality control, testing, site safety, retrofitting, green buildings, design and analysis computer programs. This will help improve the technical skills, qualifications, and knowledge of engineers.

4.2.2. Design codes and standards: structural systems

As mentioned previously, seismic design is only mandatory for buildings with more than three stories. The engineers also rely on obsolete design codes such as the UBC-97 and ACI 318-95 that do not implement state-of-the-art design and calculation procedures. In order to improve resilience of buildings, it is recommended to adopt the following points regarding the codes and standards:

- Enforce seismic design requirements through legislation and to cover for all new buildings regardless of the number of stories or occupancy category.
- Enforce the implementation of state-of-the-art design codes/standards for new buildings.
- Incorporate the design for different hazards, e.g., wind, earthquakes, flooding.
- It is recommended to use the "2018 International Building Code", or simply IBC-2018 (International Code Council 2017) and the "Minimum Design Loads for Buildings and Other Structures", also known as ASCE 7-16 (ASCE 2017), for the estimation of design forces resulting from multiple hazards such as earthquakes, wind, and flooding. The same references can be also used to satisfy the requirements for handicapped and people with special needs, in addition to the fire safety design.
- For structural design procedures, evaluating strength (capacity), and detailing provisions of structural RC components, it is recommended to use the ACI 318-14 (ACI Committee 318 2014) – "Building Code Requirements for Structural Concrete".
- For structural design procedures, strength evaluation and detailing requirements for steel structures, it is recommended to use the "2016 Specification for Structural Steel Buildings", also known as AISC 360-16 (American Institute of Steel Construction 2016).

The previous codes are applicable to the Palestinian construction industry. However, specific data like site hazard information can be obtained from local hazard maps prepared by the UPDRRC. It is important to understand that such major updates are not expected to take place immediately, so a gradual change must be allowed. This should be accompanied with training courses for engineers, capacity-building programs, and continuous updating of university programs. The changes will also allow commencing the work on a specifically-developed Palestinian code of practice.

4.2.3. Design codes and standards: non-structural components

It is quite critical to consider special design provisions for non-structural components against seismic hazard due to the severe effect of ground shaking on them. This is particularly important for critical public facilities, where operability must be maintained during and after the event of hazards. Moreover, many research studies have demonstrated that the damage to non-structural elements constitutes the largest contributor to seismic losses, especially at low levels of ground-shaking intensity (e.g., De Risi et al. 2018; Del Gaudio et al. 2019). The importance of those elements is even larger for critical buildings such as hospitals, as they could cost more than the structural system itself, and they are also required to remain functional.

Both the ASCE 7-16 and IBC-2018 can be adopted to estimate demands acting on non-structural elements and design fixtures and dowels accordingly. It should be noted that the non-structural components here include any component that does not qualify as part of the lateral load-resisting system and does not exceed 25% of the seismic weight of the structure. Non-structural elements can be generally classified in accordance with their importance as per ASCE 7-16. Thus, such elements are deemed highly important if they meet the following conditions:

1. Non-structural elements that are required to function during and after hazard events due their importance to life safety such as fire protection systems and steel emergency stairs;

2. Non-structural components that are used to store toxic, explosive, or hazardous materials;

3. Non-structural elements placed inside critical buildings such as schools, hospitals, civil defense, police stations, and shelters.

Any other non-structural elements that do not belong to the aforementioned ones can be deemed of normal importance. Such a classification is required to determine the design requirements for those elements. For instance, the seismic design forces acting on the elements with high importance must be at least 50% higher than the forces acting on the same elements if they were with normal importance. It should be noted that some non-structural elements are fully exempted from any design requirements, mainly because they do not hinder a building's functionality, or they are not expected to affect the life safety of the occupants. A few examples are listed below:

- Furniture (except cabinets used for storage);

- Temporary equipment;

- Mechanical and electrical components installed in non-critical buildings located in regions characterized with low-to-moderate seismicity.

The seismic design of non-structural components aims at two main targets:

- Prevention of falling hazard, primarily through attaching the non-structural elements to the main structural system via anchorage systems (e.g., dowels, fixtures, nails);

- Ensuring that the non-structural element itself is capable of sustaining the seismic demands such as shear forces, deformation, and large drifts (or relative displacements).

The calculation of the required seismic design force acting on non-structural elements can be accomplished in accordance with Section 13.3 in the ASCE 7-16. This incorporates both horizontal and vertical seismic force components. The design of anchorage for fixing non-structural building components can be performed using the following references:

1. Reinforced-concrete buildings: ACI 318-14

2. Masonry buildings: TMS 402/602-16 (The Masonry Society 2016).

Steel anchorage must be governed by shear or tensile strength. Some seismic design provisions for non-structural elements are shown here for the sake of clarity. For example, Figure 28 shows the anchorage and bracing mechanism to be used for protecting parapets from falling in masonry structures. Figure 29 on the other hand illustrates seismic bracing of suspended-ceiling systems.

Masonry infills, which represent a dominant construction practice in Palestine, could be isolated from the surrounding structural frame to prevent frame-infill interaction that leads to demand concentration and brittle shear failure. This can be done by surrounding them with steel frame as schematically

displayed in Figure 30. A gap must be left between the main building frame and the steel frame surrounding the infill wall. It is important to highlight that the isolated infill wall must be protected from falling due to seismic forces. In such a case, it can be fixed using any form of anchorage with the upper and lower floors, but not with the columns in order to avoid infill-frame interaction. Storage racks are another example of important non-structural elements that need to be fixed to the ground to prevent falling as reported in Figure 31, especially if they are carrying heavy equipment. The storage rack itself can be designed as a non-building structure as per the classification of ASCE 7-16 in order to make sure that it can sustain earthquake-induced ground shaking. Finally, stone cladding is part of the architectural components that are very common in Palestinian buildings. Those can be attached to the walls to prevent falling using different mechanisms, which are explained in Chapter 3.

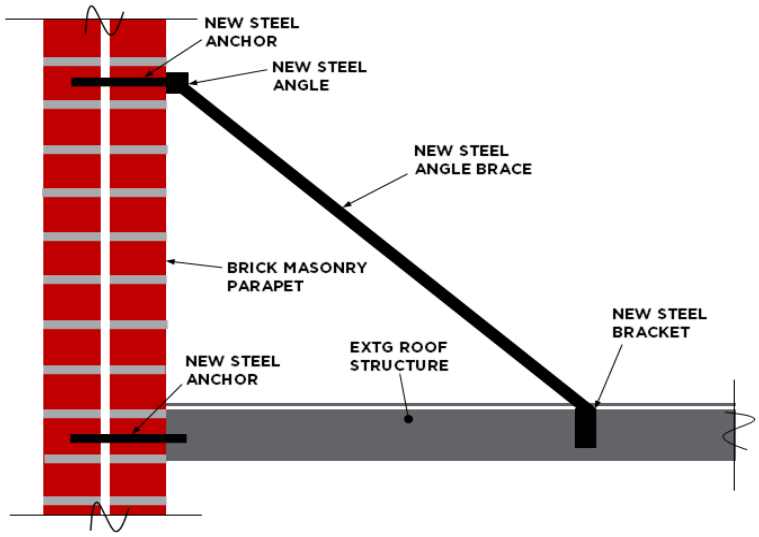

Figure 28. Bracing and fixing a parapet in a masonry structure

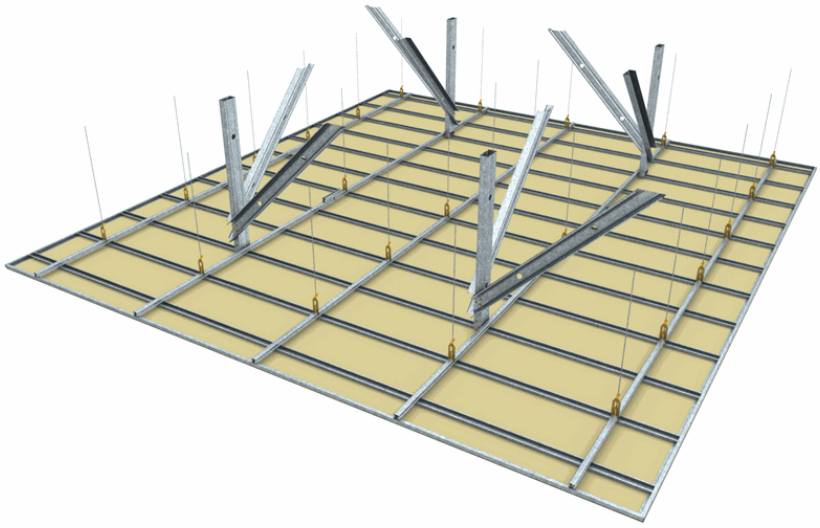

Figure 29. Seismic bracing of suspended-ceiling systems

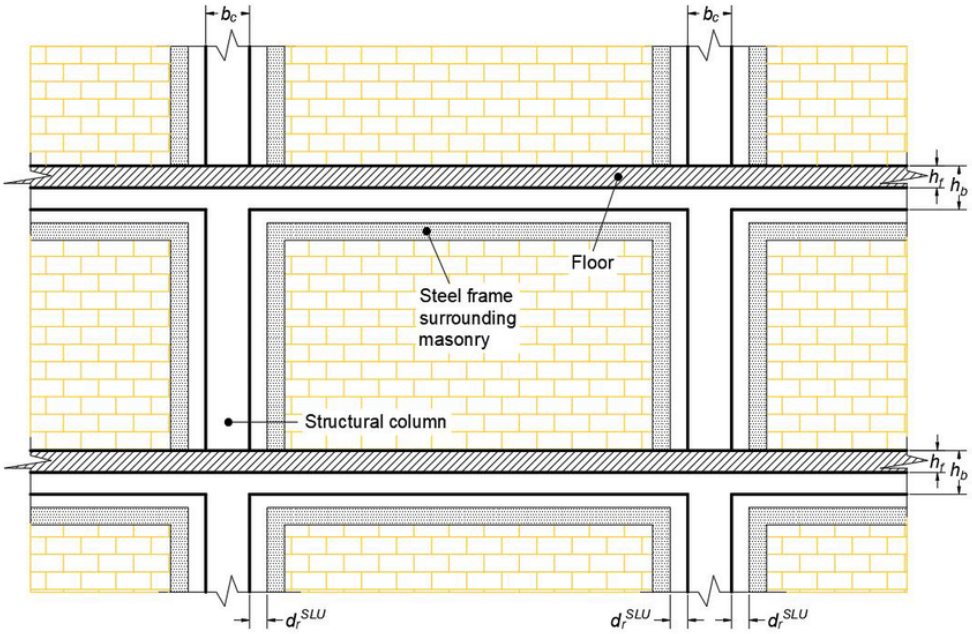

Figure 30. Isolation of infill walls using external steel frames

Figure 31. Fixing storage racks to the ground

4.2.4. Provision for people with special needs

Vulnerable populations such as handicapped, women, children and those with physical disabilities are amongst the highly susceptible people to the devastating consequences of hazards. Therefore, accessibility must be facilitated in buildings, especially critical ones. The details related to the design and construction for accessibility means can be found in Chapter 11 of the IBC-2018. Extra technical

details can be also found in ADA 2021 (Department of Justice 2010). For clarification, a brief summary of the most important rules and highlights is provided.

Also, it is advisable to implement the handbook prepared and published by the Engineers Association and can be found and downloaded at the website of the Association https://www.paleng.org/. It is important to exert all efforts towards legislating these guidelines and to be applied on all types of buildings with the required level of mandatory monitoring. A key point here is to create an accessible route for people with special needs at different levels, as explained below:

Site arrival points:

At least one accessible route shall be provided at the site. This route must have public transportation stops, accessible parking, accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance served. Figure 32 provides a schematic illustration for the accessibility related to site arrival points.

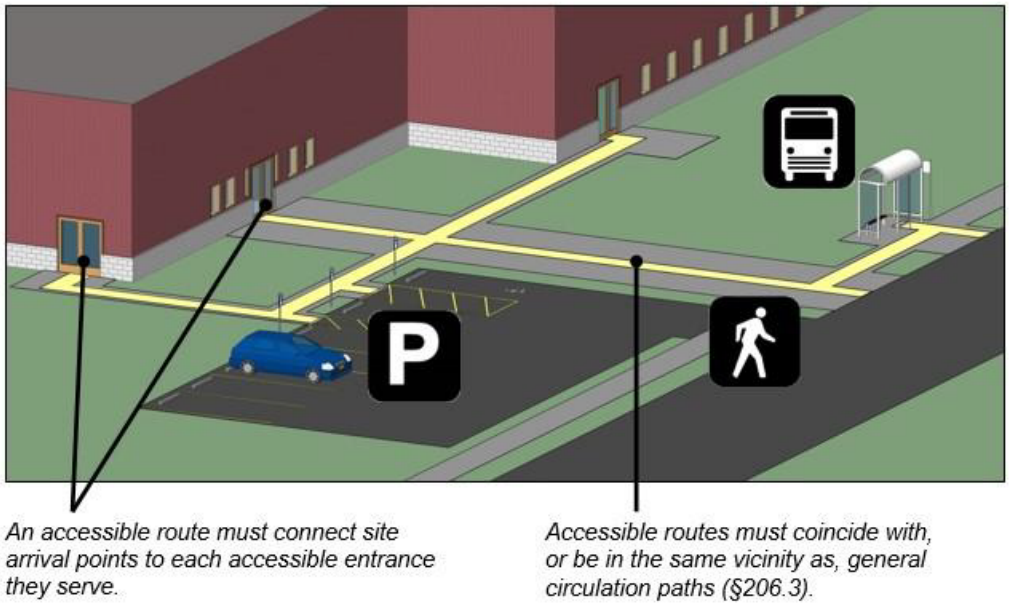

Figure 32. Accessibility related to the site arrival points

Within a site:

At least one accessible route shall connect accessible buildings, accessible facilities, accessible elements and accessible spaces that are on the same site, as clarified in Figure 33. It should be noted that such a route is not required if the only means of access in between different buildings, facilities, or elements, is a vehicular way that does not provide pedestrian access. The accessible routes within a site must also serve all accessible spaces and elements on a site, even the exterior ones such as courtyards and drinking fountains. If security barriers such as bollards and security checkpoints exist within buildings, they shall not obstruct accessible routes. If security barriers incorporate elements that cannot comply with these requirements (e.g., metal detectors, fluoroscopes or other similar devices), accessible routes shall be provided adjacent to security screening devices. The accessible route shall permit people with disabilities to pass around security barriers to maintain visual contact with their personal items to the same extent as others.

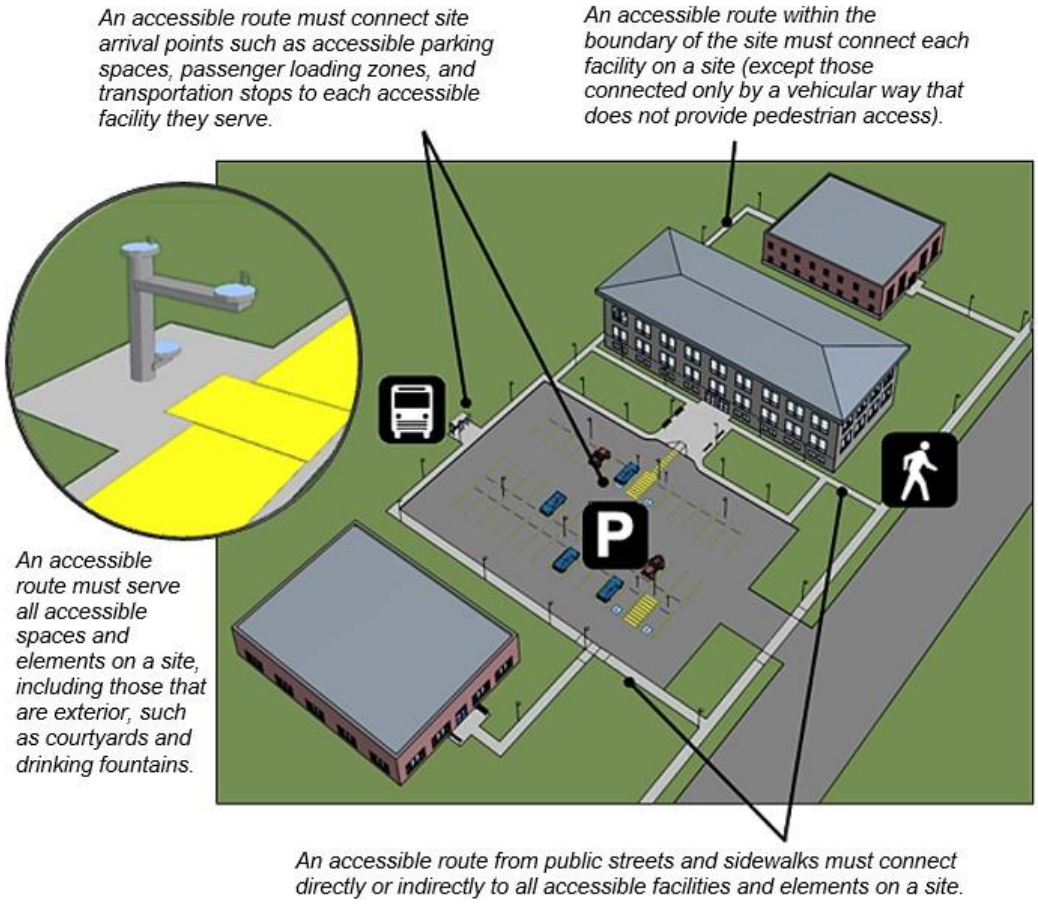

Figure 33. Accessibility needed within a site

Employee work areas:

Common-use circulation paths located within the work areas for employees must be accessible routes. This procedure is preferable compared to providing accessibility routes different from the common-use circulation paths. The former practice promotes equivalency and precludes accessible routes that are obscure, hard to find, or diverge from circulation paths more than necessary.

Accessible Routes within a Building or Facility

At least one accessible route must connect all accessible spaces and elements. If a circulation path is interior, the accessible route also must be interior. Accessible vertical interior circulation must be in the same area as stairs and escalators, not isolated in the back of the facility. Where only one accessible route is provided, the accessible route shall not pass through kitchens, storage rooms, restrooms, closets, or similar spaces. Such requirements are depicted in Figure 34.

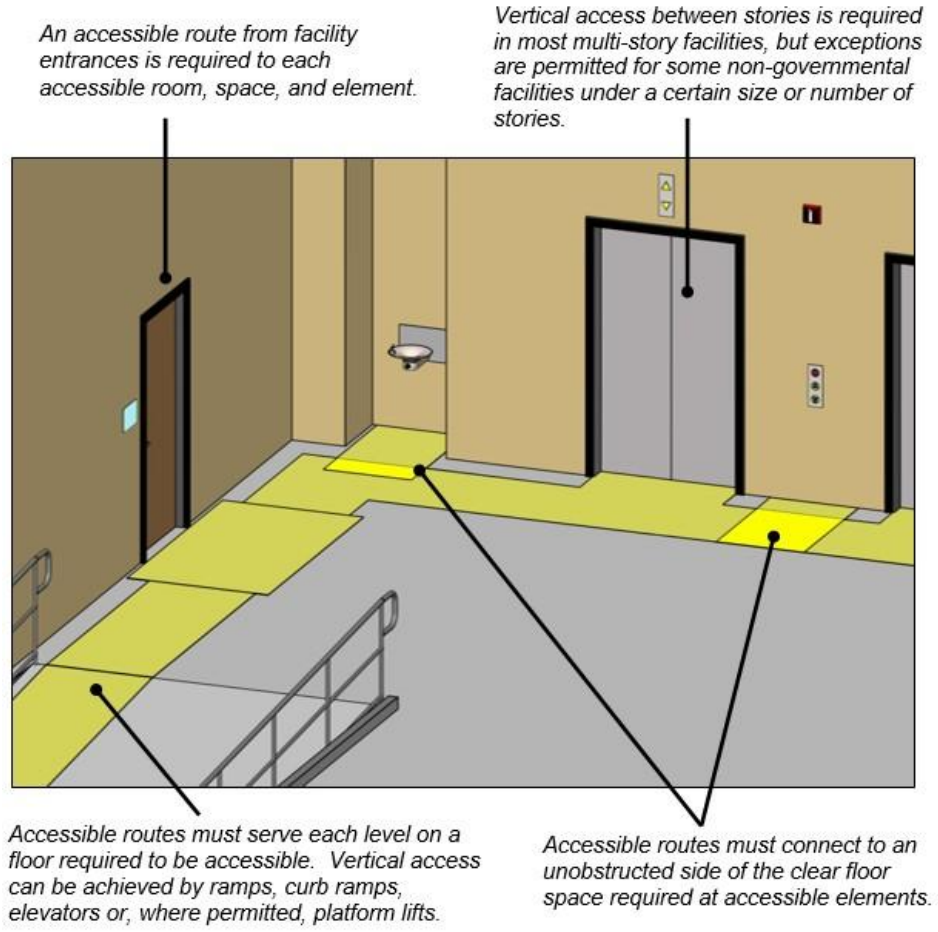

Figure 34. Accessibility needed within the buildings and facilities

Multi-story structures:

In the case of multi-story buildings, at least one accessible route must connect each accessible story, mezzanine, and any occupied roofs. Some exceptions apply, which can be found in the IBC-2018.

Besides the accessibility related to site and buildings, the entrances must be also applicable. In fact, it is required that at least 60% of all public entrances to be accessible. This means that accessibility must be provided in the following situations:

- The direct access for pedestrians from parking structures to buildings and facilities;
- Entrances for pedestrians from tunnels or elevated walkways to a building or facility;
- If restricted entrances exist, at least one of them must be accessible;
- In the case a service entrance is the entrance to a building, it must be accessible;
- At least one accessible entrance shall be provided in each sleeping unit or dwelling.

The reader is referred to the IBC-2018 for more details regarding accessibility requirements of other building components such as parking facilities, dwellings, sleeping units, medical care units, and any structures characterized with special occupancies.

The previous brief summary of part of the accessibility requirements has gained more attention in Palestine during the past few years. However, its application is still limited to some governmental buildings and hospitals. Therefore, more work is needed towards integrating those requirements into typical design standards/codes.

4.2.5. Specifications and Licensing requirements

In cooperation with all concerned parties, work must place emphasis on adopting unified requirements and specifications that can be applied for all projects. This includes mainly the adoption of the requirements issued by the Palestinian Standard Institution (PSI), in conjunction with regulations related to technical aspects, testing and inspection, quality and certification, etc. Continuous development and improvement of the adopted specifications must be also maintained based on international references that apply to local context and engineering industry.

With respect to urban planning, it is important to legislate and adopt a land use policy that informs city plans and licensing requirements. It is also recommended to unify building licensing requirements and conditions among all urban areas in the West Bank, with special regulations to be applied in the case of rural areas.

4.2.6. Environmental issues

Adopt relevant initiatives to demonstrate good practice. One of the most impactful is the introduction of an Environmental and Social Framework (ESMF) by MDLF, which made it mandatory in all its projects inside the West Bank and Gaza. In fact, MDLF considered the preparation of an Environmental and Social Management Plan (ESMP) as part of design requirements that must be accomplished by Local Technical Consultants (LTCs). LTCs are also in charge of monitoring the implementation of such plans during the construction phase.

4.3. Construction Stage

4.3.1. Quality assurance/control and site supervision

As mentioned previously, appropriate quality assurance/control and site supervision have key roles in supporting the resilience of buildings in Palestine. However, this practice only applies to projects funded by international donors and critical governmental priorities, despite the efforts of Engineers Association in making quality control/site supervision mandatory starting in 2021. Such a problem can lead to many structural deficiencies and performance issues with damage during hazard events, thus adversely affecting resilience. This is because the major portion of the construction industry comes from the private sector, which suffers a lot from the above deficiencies.

Accordingly, the following can be proposed to account for such issues:

- Incorporate the site supervision and quality control by qualified engineering consultancy firms as part of the legislation, so they become applicable to all buildings regardless of their importance, type, and occupancy category.
- Sign obligatory and binding MoUs with all municipalities and MoLG in order to unify the requirements of construction work among different areas, both in the West Bank and Gaza.
- Adopt effective monitoring procedures, such as the formation of external independent committees from the municipalities, the Engineers Association, the civil defense and other concerned institutions to conduct regular site visits to make generic checks on the construction work and degree of compliance with the technical requirements of engineering supervision and quality control.

4.3.2. Safety and environmental concerns

It is recommended to adopt international safety standards such as the Occupational Safety and Health Administration (OSHA)[3], affiliated with the United States Ministry of Labor, and the European Agency for Safety and Health at Work (EU-OSHA)[4]. Such publicly-available resources will provide valuable information regarding the prevention of illness at work, job health, and practices during construction work for health and safety, etc.

For site environmental issues, it is recommended to adopt the relevant frameworks such as the Environmental and Social Framework (ESMF) introduced by MDLF and prepare the Environmental and Social Management Plan (ESMP) and monitor that during construction.

4.4. Operation and Maintenance Stage

The license to operate (إذن الاشغال) must be granted through a specialized committee that include all concerned intuitions, under the leadership of the Municipality. Potential members of the committee include: the Engineers Association, Civil Defense, electricity provider, telecommunication companies, Contractors' union, and other institutions depending on the type of occupancy.

Special attention must be given to industrial buildings and facilities as their operation is directly linked to environmental, sustainability, and safety issues. Therefore, especially for such buildings, the license to operate must be subjected to annual review for renewal upon conducting an appropriate inspection. It is further recommended to adopt and apply the guidelines for operation and maintenance of buildings and roads, which has been developed by MDLF.

4.5. Further Recommendations: Geotechnical Issues – New Proposed Aspects

Upon revising the site investigation processes (refer to sec 3.4.3) implemented by local geotechnical laboratories, it is found out that:

[3] https://www.osha.gov/

[4] https://osha.europa.eu/

- Some requirements are neglected although they significantly influence the construction of building foundations, leading to unforeseen consequences such as unsuitable design, safety issues, extended construction duration, extra costs, etc.;

- Some soils are challenging in terms of construction and require special considerations, such as expansive soils, soils with high water level, collapsible soils, landfill, cavities within the foundation soils, soils with possible sliding (slope instability), site with deep excavation, site with special seismic characteristics. etc.

Slope Stability Analysis

A large part of the Palestinian territories is composed of hilly and mountainous regions; therefore, landslides are considered as a major problem, therefore, a site investigation report should consider slope stability analysis especially for sites that are located on slopes. Additional guidelines covering the process of excavation and installation of suitable excavation support systems are necessary to ensure safe conditions for the construction sites and neighboring structures. Moreover, sites that have previous slope instability problems (landslides) should be considered as special sites and correction measures should be suggested by the site investigation report. As a guideline, the following measures are to be considered for correction of landslides:

- Geometrical methods: flattening of slope; excavation at top of slope; fill at toe of slope.
- Hydrological methods: surface drains; drain holes; sand drains; inverted filters. The purpose of hydrological methods is the drainage of surface water and lowering of ground water level.
- Mechanical methods: compaction; freezing; grouting; rock bolts; piles; retaining walls;

Protective measures can be also taken into account through land use policy for sites that have experienced landslides before. In this case, maps are prepared by municipalities or LGUs to limit the types of structures and buildings to be constructed at specific sites that have previous landslides or are susceptible to landslides or other expected problems due to foundation soil.

Areas of High-Water Level

In some cases, mostly in winter seasons, high water levels may lead to problems in construction, especially foundation construction. Dewatering system should be designed to overcome such a problem both during and after the construction throughout the entire service life of the structure.

Expansive Soils

Silty clay soils of high plasticity (expansive soils) have high swelling potential. Such types of soil are common in many regions in Palestine. Precautions should be considered to overcome those problems. A potential solution could be to change the properties of expansive soil, control water, insert non-expansive soils (base course) on top of the silty clay soil, etc.

Cavities and Joints

Cavities with no soil or cavities filled with fine soil (joints) are common in Palestine, especially in mountainous areas, which consist of Karst (lime or marl) formation. Where these cavities or joints

are discovered, they should be cleaned and filled with rubble concrete under the direct supervision of both the geotechnical and structural engineers. If these are not discovered and the area is well known to have such a problem, the foundation type should be either continuous or mat (raft) foundation. It is possible to use of certain instruments available at the university centers to deduct these cavities.

Collapsible and landfill Soils

It is very common in Palestine to have collapsible soils, where large thickness of dumped soil is placed in a single site neither having suitable type of soil nor compacted according to standards. These sites are usually unsuitable for construction of multi-story buildings and several problems will occur in these sites. Also, they are usually very sensitive to earthquakes, so the dynamic properties of the soil layers should be included in the site investigation report, including shear waves velocities, natural frequencies, etc.

On the other hand, landfills in Palestine are not common, however, there are few landfill areas and sooner or later they will be closed and may be used as construction sites. Again, land use policy should deal with this problem. Accordingly, land-use policy maps prepared by municipalities or local governments should limit the type of structures to be constructed in such sites and prescribe the appropriate methods of construction as well.

Excavation Support Systems

Deep excavations in many sites are nowadays necessary for construction of several basements below the ground surface. This requires preparing a plan for a suitable method of excavation with bracing systems or scaffolding system, if necessary. Otherwise, safety within the site and surrounding areas will not be fulfilled. A special excavation support system should be designed, implemented, and monitored for such sites.

Retrofitting of Foundation for Existing Buildings

Existing buildings might require retrofitting if they do not comply with performance requirements, especially seismic ones. In other cases, building owners might decide to build new stories on the top of old buildings, leading to increasing stress levels on the foundations. This might require retrofitting of these foundations, which should be performed by an authorized person that has knowledge and experiences to do this task (Refer to Section 5 for more details on structural retrofitting).

Liquefaction of Soil (Gaza Region only)

In the Gaza region, the existence of high-water levels close to the seashore and the type of soil (sandy) makes the soil susceptible to liquefaction during earthquakes. This should be checked, and correction measures should be adopted to overcome such problems

Seismicity of the Site

Palestine is seismically active due to the existence of several active faults. Therefore, all structures should be designed to resist potential ground shaking. As the site has a great influence on the seismic design and the possibility that the soil layer has an amplification factor due to matching of natural

frequency of the soil and the proposed building. This point should be considered in the site investigation report. It is necessary for suitable design of structures to be done for both shear wave velocity for all foundation soil layers as well as for the natural frequency.

Land Use Policy (Planning)

Preparing maps of land use policy by Municipalities and Local Government is of great importance as they help regulate the construction processes and activities. In fact, some sites may not be suitable to construct structures on them, so they should be designated as special structures or as green areas. Some sites that have previous landslides (slope instability) and are not suitable for construction of structures either. This can be controlled as well by land use policy. In the same way landfills, collapsible soils, and sites with liquefaction susceptibility are to be included in the land-use policy.

5. GUIDELINES FOR IMPROVING THE RESILIENCE OF EXISTING BUILDINGS

Despite the presence of a large portion of existing buildings that are not particularly designed to withstand different hazards (earthquakes, flooding, wind), specific codes/standards that can be used for the assessment of their performance with respect to appropriate objectives are not available. On the top of that, there are no dedicated guidelines that provide comprehensive documentation for the design of rehabilitation (retrofitting) strategies for different structural typologies and their applicability in the Palestinian construction industry. Engineers, instead, rely on the guidelines and codes for new buildings, in addition to their judgment/experience.

Therefore, a full report has been prepared, including guidelines for the systematic assessment of seismic performance for existing building structures, in addition to the appropriate rehabilitation (retrofitting) strategies that can be implemented to improve such a performance. This report adopts state-of-the-art codes, standards, and guidelines that have been developed in the US by various specialized institutions such as the Federal Emergency Management Agency (FEMA), the American Society of Civil Engineers (ASCE), and the American Concrete Institute (ACI). Examples for those codes/standards/guidelines incorporate:

- FEMA 356 (FEMA 2000)
- ASCE 41-13 (ASCE 2013)
- FEMA P-58 (Applied Technology Council 2018)
- ACI 440 (ACI 440.2R 2008)
- FEMA 547 (FEMA 2006)

The measured seismic performance of existing buildings can be then compared to a set of acceptance criteria that corresponds to the selected performance objective. The latter varies according to the importance of the building. Critical public facilities are usually assigned with higher performance objectives as they are always required to maintain functionality during hazard events. The report prepared for the assessment and rehabilitation of existing buildings also proposes some retrofit

(rehabilitation) strategies for structures noncomplying with the assigned performance objectives. Those strategies are systematically classified based on the following:

- Type of structural deficiency (e.g., lack of global strength, low stiffness, irregular layout, inappropriate structural detailing).
- Type of structural intervention (e.g., add new elements, enhance the performance of existing elements, remove selected elements, reduce seismic demand).
- Typology of the structure (e.g., moment-resisting RC frame, unreinforced masonry, shear-wall RC building.

The applicability, advantages, and limitations of each rehabilitation strategy are discussed in detail. Some design/detailing guidelines for such strategies are also provided (e.g., Aljawhari et al. 2022).

An example of the benefits of improving the resilience of buildings in the West Bank and Gaza is depicted in Figure 35. Those benefits are expressed in terms of the reduction in seismic risk upon adopting a rehabilitation (retrofitting) plan in comparison with the risk related to existing building conditions. This in turn, is weighed against the cost of rehabilitation to produce a benefit cost ratio (BCR) that reflects the effectiveness of the rehabilitation. The adopted retrofitting technique in Figure 35 is wrapping the columns with the Fiber Reinforced Polymers (FRP). It can be observed that the economic benefits are generally higher than the cost of implementation for the retrofitting, especially in areas close to high and moderate seismic hazard along the Dead Sea fault. These results were obtained assuming 2% discount rate and 100 years for the time horizon. It should be noted that the intangible benefits e.g., saved lives or benefits arising from reduced indirect losses, are not included in the BCR calculations, although they could pose a profound positive impact on the feasibility of retrofitting especially when considering critical infrastructure buildings such as hospitals and schools.

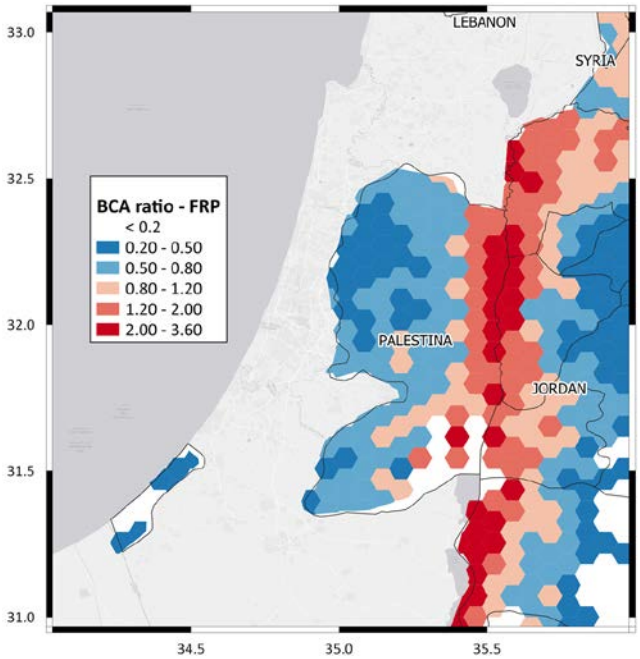

Figure 35. Distribution on CBR in West Bank using partial FRP method, after Dabbeek and Silva (2020).

6. GUIDELINES FOR IMPROVING THE RESPONSE OF PEOPLE AND COMMUNITY

Resilience is often described in lay terms as 'the ability to bounce back' after a disaster in accordance with the definition of the Institution of Structural Engineers[5] (IStructE) in the United Kingdom. As Palestine is subjected to multiple hazards, it is important for all the communities to be resilient through developing abilities to:

- Successfully mitigate against prospective hazards;
- Prepare for disaster event scenarios;
- Resist the effects of disaster events;
- Respond to these effects;
- Recover from such effects in a timely and efficient manner.

Part of the resilience is related to the response of the built environment, especially critical facilities and their ability to maintain functionality. Another important part is related to the response of people and their preparedness in the event of a hazard, and their adaptability to new conditions. Therefore, appropriate emergency preparedness and response plans will contribute to the reduction of casualties and minimize damage, in addition to improving resilience and post-disaster recovery. This requires a sufficient level of understanding among the community members themselves and among local authorities on the role and importance of emergency preparedness and effective response. Such aspects need major improvement across the Palestinian community, which can be achieved through increasing awareness, fostering capacity, and effective training. The United Nations Office for Disaster Risk Reduction[6] (UNDRR) identifies several points that can be achieved to improve the aforementioned aspects:

- Develop and regularly update emergency preparedness plans, and communicate it to all stakeholders;
- Conduct regular training and exercises for all aspects of the wider emergency response system involving all members of the community and volunteers;
- Schedule and conduct periodic exercises to ensure that team members know their roles and responsibilities;
- Invite representatives from first responder organizations to review and critique emergency drills and simulation exercises as well as critique team members following each exercise.
- Teach children about preparedness and its importance;

[5] https://www.istructe.org

[6] https://www.unisdr.org/

- Integrate risk reduction and emergency response with key groups such as engineers, contractors, university programs, to be able to effectively engage in preparedness, response and recovery;

- Assign adequate funds for post-disaster response and recovery.

Extensive materials are available online, which can be used as basis for conducting training for both individual citizens and emergency teams. Some of the recommended ones are provided below:

- Community preparedness by the Federal Emergency Management Agency (FEMA)[7], which also developed a program called "Organizations Preparing for Emergency Needs (OPEN)[8]";

- A Framework for Major Emergency Management[9] – Department of the Environment, Heritage and Local Government, Ireland. This is designed to enable principal response agencies to prepare for and make a coordinated response to major emergencies.

- North Shore Emergency Management Office[10] – City of North Vancouver, Canada. The *website incorporates a variety of manuals including:* Earthquake and Tsunami Smart Manual.

7. ROLES AND RESPONSIBILITIES OF DIFFERENT STAKEHOLDERS/PUBLIC INSTITUTIONS

As discussed previously, part of the challenges related to improving the resilience of Palestinian buildings and communities is related to the lack of clear and appropriate roles and responsibilities with respect to construction of critical public facilities, or even ordinary buildings. Under the prevailing regulations, different relevant parties such as the Engineers Association, municipalities and MoLG are not sufficiently involved in the construction process, licensing, and monitoring, which could lead to buildings with poor quality and multiple deficiencies, thus making them non-resilient during hazard events. Therefore, this chapter proposes a responsibility matrix that provides a clear definition of the responsibilities and roles of different institutions. This, in turn, will provide those institutions with a better vision of what is expected from them and make coordination and communication easier. Table 4 provides a summary of the current roles of all stakeholders during the whole project phases (i.e., initial planning, design stage, project implementation, operation, and maintenance). A set of recommendations are proposed in the same table to improve such roles and set clearer vision on anticipated responsibilities.

[7] https://community.fema.gov/PreparednessCommunity/s/?language=en_US
[8] https://community.fema.gov/PreparednessCommunity/s/open-training?language=en_US
[9] https://www.gov.ie/en/collection/ca182-a-framework-for-major-emergency-management/
[10] https://nsem.ca/

Table 4. Current responsibilities and roles of different stakeholders with respect to projects of critical infrastructure, in addition to recommendations on improving those roles and responsibilities to enhance resilience

المؤسسة	الدور والمسؤوليات الحالية				التوصيات			
	مرحلة التقييم الأولي والتخطيط المكاني	مرحلة التصميم	مرحلة التنفيذ	مرحلة التشغيل والصيانة	مرحلة التقييم الأولي والتخطيط المكاني	مرحلة التصميم	مرحلة التنفيذ	مرحلة التشغيل والصيانة
وزارة الحكم المحلي	الوزارة مسؤولة حسب قانون تنظيم المدن والقرى عن التخطيط المكاني وتتبنى سياسات استخدام الأرض طبقا لأدلة معدة لهذا الغرض	يتركز عمل وزارة الحكم المحلي بأعمال التخطيط والتنظيم والترخيص لكافة المنشآت داخل القرى وخارج حدود البلديات حيث تقوم بفحص سريع لوثائق التصميم، وتقوم بتدقيق معماري للمساقط الافقية والارتفاعات والأحكام التنظيمية (للقرى التي تقع خارج حدود البلديات).	تواجه الوزارة تحديات عديدة وهي البناء بدون ترخيص او عدم الالتزام بالتراخيص الممنوحة والمخططات المعتمدة وعدم وجود إشراف فعلي في الموقع ولا سيما في القطاع الخاص. فيما يخص المباني التابعة لوزارة الحكم المحلي فإنها تولي مهمة الإشراف لمكتب هندسي لضبط الجودة أثناء التنفيذ، كما تلعب وزارة الاسكان دور المراقب أيضا على الأبنية الحكومية.	فيما يخص المباني التابعة للوزارة فيتم صيانتها وهي مباني مستأجرة ضمن الموازنة التشغيلية للوزارة بالحدود الدنيا. أما فيما يتعلق بالمنشآت الأخرى فينحصر الدور بازالة المنشآت الأيلة للسقوط وكذلك طلب موافقات الجهات المختصة كالدفاع المدني ومن خلال تدقيق نقابة المهندسين	يجب العمل على تطوير الأدلة الخاصة بالتخطيط المكاني وسياسات استخدام الأراضي بالتعاون مع البلديات والمجالس المحلية، حيث انه يتم حاليا تصنيف الأراضي بناء على الاستعمال كأرض زراعية أو تجارية او سكنية وتحديد حجم البناء المسموح والارتدادات ولا يتم إجراء دراسات هندسية دقيقة وتحليلية تأخذ بعين الاعتبار طبوغرافية الأراضي ونوعية التربة وتحليلها وربطها بحجم المنشآت. العمل على تعديل قوانين التنظيم المعمول بها بما يتلاءم مع الدارسات.	التعاون مع نقابة المهندسين وجميع الوزارات ذات العلاقة لسن القوانين وتطوير كودات ومعايير خاصة بما يتناسب مع متطلبات الواقع في فلسطين وبالية واضحة توضح فيها معايير كل جهة مسؤولة عن المنشآت بما يضمن سهولة فهم الاحتياجات والمعايير عند التصميم.	إيجاد الية معينة لزيادة الرقابة وضبط الجودة على المشاريع التي تقع خارج حدود البلديات، وضمان تنفيذ التصاميم كما هي وعدم تجاوز القوانين والأنظمة خلال التنفيذ. إضافة الى ما ذكر أعلاه إيجاد الية لمتابعة التنفيذ للمناطق التي تقع من صلاحيات البلديات والتأكد من تنفيذ الواجبات المطلوبة.	تفعيل دور لوزارة الحكم المحلي في لجنة منح اذن الاشغال وذلك من خلال إعادة تشكيل هذه اللجنة لتضم ممثلين من جميع الهيئات ذات العلاقة لمنح الاذونات بآلية سهلة تضمن زيادة التنسيق بين كافة المؤسسات والوزارات المعنية لعدم حدوث لبس وتداخل في الادوار الرقابية.
البلديات	يقتصر دور البلديات على متابعة قوانين التنظيم وإعداد المخططات الهيكلية وسياسات استخدام الأراضي حيث يتم تصنيف الأراضي حسب الاستعمال فقط (تجاري، سكني، زراعي) وإصدار الرخص بناء على قوانين التنظيم ذات العلاقة والمعتمدة من قبل وزارة الحكم المحلي.	يقتصر دور معظم البلديات على مراجعة التصميم فيما يتعلق بقوانين التنظيم كالمساحات والارتفاعات والارتدادات وما الى ذلك وعدم وجود مخالفات، بينما يتم اعتماد التصميم للمجالات الأخرى (كالمعماري والانشائي والكهرباء والميكانيك) بشرط وجود موافقة نقابة المهندسين والدفاع المدني على التصاميم المقدمة للبلدية والمخططات. فيما تقوم بعض البلديات كبلدية رام الله وبيت لحم وخانيونس بفحص سريع للتصاميم والمخططات...	يقتصر متابعة التنفيذ لجميع البلديات على التأكد من عدم وجود مخالفات تتعلق بقوانين التنظيم، اما ضبط الجودة ومتابعة التنفيذ فلا يعتبر ضمن مسؤولياتها، بينما قامت بعض البلديات بتوقيع مذكرة تفاهم مع نقابة المهندسين يفرض بموجبها الاشراف الإلزامي من قبل مكتب هندسي مختص شرطا للحصول على الرخص من البلدية قبل التنفيذ، ولكن لا تعتبر هذه الاتفاقية ملزمة قانونيا لكافة البلديات حيث ان بعض البلديات لم تعمل بها.	لا يوجد دور محدد للبلديات فيما يخص مرحلة التشغيل والصيانة ومتابعة المباني القائمة عدا المباني المملوكة او التابعة للبلديات. ولا يوجد قوانين سارية تفرض فحص المباني القديمة القائمة والتي تم بناؤها دون وجود معايير وكودات معتمدة او تم بناؤها بناء على معايير دارجة حينها تغاير المعتمدة حالياً.	التخطيط المكاني وسياسات استخدام الاراضي بمجملها لا تتبع الية هندسية محددة خلال مرحلة الاعداد والتخطيط، حيث انه يتم اعداد المخططات الهيكلية وسياسات استخدام الأراضي وتوزيعها حسب الاستعمال فقط دون دراسة لنوعية التربة وربط ذلك بنوعية الاستعمال المقترح أو حجم المنشأة. يوصى بدراسة موضوع التخطيط المكاني وعمل دراسات هندسية ومعايير يتم من خلالها دراسة وتقييم خواص التربية الديناميكية وربطها بخواص المنشأ المقترح حسب الارتفاع والحجم والتأكد من ملاءمة التربة للبناء لتجنب المشاكل المترتبة كحصول تضخم زلزالي او انجراف للتربة في مناطق معينة على سبيل المثال.	ليس بالضرورة ان يكون هنالك دور للبلديات في ضبط التصميم واجراء عملية الفحص ولكن من المفضل ان يتم تعميم اية تعديلات تتعلق بقوانين التنظيم من حيث المساحات والحجوم والارتفاعات والارتدادات ومناطق التنظيم المختلفة على الجميع من خلال نقابة المهندسين التي تشرف على عمل المهندسين ومن ضمنها التصميم الذي يرتبط ارتباطا مباشرا بقوانين التنظيم. ان يتم التأكد من ان التصميم سوف يتم من خلال مكاتب هندسية مصنفة ومؤهلة من نقابة المهندسين بالاستناد الى حجم العمل وما يتلاءم مع خبرة كادر المكتب ونوع المشروع.	عمل اتفاقيات مع نقابة المهندسين في موضوع ضبط الجودة اثناء التنفيذ وكذلك التنسيق مع باقي المؤسسات ذات العلاقة كالدفاع المدني او الوزارة المعنية (المالك) لضرورة العمل على ضبط الجودة من خلال تشكيل لجنة مشتركة لتفعيل عملية المراقبة وهذا يتطلب كوادر إضافية متخصصة تنفذ قوانين ذات درجة عالية من الإلزامية.	الاهتمام على المستوى المحلي ورفع الوعي وزيادة بناء القدرات بالمجال (على مستوى البلديات والمؤسسات الحيوية من جهة والمواطن من جهة أخرى).

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نقابة المهندسين	يقتصر دور النقابة بالاشتراط بوجود فحص تربة حسب المتطلبات المحددة من النقابة.	يتمثل دور النقابة في اعتماد معايير التصميم والكودات العالمية المستخدمة ووضع الحد الأدنى من المتطلبات الواجب توافرها في مرحلة التصميم وتعمل النقابة على تدقيق ومراجعة المخططات والتصاميم المقدمة من المكاتب الهندسية.	هنالك قوانين معمول بها بخصوص الإشراف الهندسي على المشاريع حسب حجم ونوع المنشأة، وتم توقيع مذكرة تفاهم بين نقابة المهندسين وبعض البلديات لفرض الاشراف ولكن لا تعتبر هذه الاتفاقية ملزمة قانونيا حتى ان بعض البلديات لم تعتمدها.	ليس لها دور	يفضل ان تكون ضمن اللجان المتخصصة كمرجعية او عضو في مجلس إدارة هذه اللجان كمجلس التخطيط الأعلى، صندوق تطوير واقراض الهيئات المحلية، اللجنة المحلية لتأهيل المقاولين وغيرها.	• يجب العمل على تطوير المعايير والكودات المستخدمة والتعاون مع المؤسسات ذات العلاقة مثل (وزارة الإسكان، وزارة الحكم المحلي، الدفاع المدني، الهيئات المحلية) لعمل كودات ومعايير فلسطينية خاصة بما يتواءم مع الكودات العالمية والواقع الفلسطيني واحتياجاته. • العمل على إعداد معايير التصميم لمواجهة جميع الكوارث المحتملة كالفيضانات أو الرياح أو الزلازل وغيرها وذلك لجميع المنشآت بغض النظر عن حجم ونوع المنشأة. • يجب اعتماد شروط سلامة وأمان خاصة اثناء تنفيذ المشاريع مع اشتراطات واضحة وملزمة لأصحاب المشاريع بما يضمن تنفيذها على ارض الواقع. • كما يوصى بوضع معايير ملزمة لاعتماد التصاميم بما يتلاءم مع احتياجات الفئات الضعيفة كذوي الاحتياجات الخاصة والكبار في السن... • العمل على اعداد معايير لتحليل المباني القديمة او القائمة والتي لا تتماشى مع الكودات المستخدمة حاليا والمعايير الحديثة.	العمل على تأمين طاقم قادر على متابعة وجود إشراف هندسي فعلي على كافة المشاريع وليس الاشراف نفسه حيث ان الطواقم الحالية غير كافية لمتابعة جميع المشاريع، وهو ما يتطلب موارد إضافية وتدريب للمهندسين.	المشاركة في اللجان ان لزم بناء على طلب المالك او صناع القرار.
الدفاع المدني - الضفة	قام الدفاع المدني بعمل كود خاص به شبيه بالكود الأردني يحدد طبيعة اشغال المبنى والإجراءات الواجب تنفيذها في المبنى، بخصوص الأبنية القائمة يتم دراسة واقعها وان كان النظام الجديد قابل للتنفيذ بها يتم تنفيذه ولكن في حال عدم قابلية المبنى لذلك يتم اخذ قرارات من خلال لجنة مكونة من الدفاع المدني والبلدية ونقابة المهندسين لوضع إجراءات موازية للإجراءات المطلوبة ولكن تكون قابلة للتنفيذ حسب وضع البناء إجراءات الدفاع المدني تكون محددة فقط بالوقاية من الحرائق ولا تراعي عادة الكوارث الأخرى كالزلازل وما شابه.	يواجه الدفاع المدني بعض التحديات حيث يحاول الملاك احيانا التهرب من الإجراءات المفروضة وذلك يرجع الى التوفير وعدم الوعي الكافي وعدم وجود قوانين وتشريعات ملزمة قانونياً تجبر المالك على إيقاف البناء. أما بالنسبة لمعدات إطفاء الحرائق لا يمكن السيطرة على ضبط جودة العمل نظرا لإمكانية إدخال أي مواد خاصة بالإطفاء دون فحصها وفي ظل ان سلطة المواصفات لا تمتلك الأجهزة الكافية للفحص في بعض الأحيان يتم استخدام معدات سيئة لأعمال الإطفاء.	مركبات جهاز الدفاع المدني غير مربوطة ب GIS مما يُصعب متابعة المهام من خارج المقرات ويُؤخر زمن الاستجابة.		يجب العمل على تطوير كودات خاصة ومعايير سلامة تحسبا لجميع الكوارث وليس فقط الحرائق، ويتم ذلك من خلال تعاون الدفاع المدني مع نقابة المهندسين وباشراك الجهات ذات العلاقة ثم تدريب المهندسين للعمل على هذا الكود من خلال ورشات ودورات تدريبية والعمل على الزام المكاتب الهندسية بالتصميم مع الاخذ بعين الاعتبار جميع اجراءات السلامة لجميع المباني وإيلاء اهمية خاصة للمباني الهامة كالمستشفيات والمدارس مع مراعاة الفئات الضعيفة بالتصميم كذوي الاحتياجات الخاصة والكبار في السن..	مراقبة مدى ضبط الجودة وتنفيذ متطلبات السلامة بالتعاون مع نقابة المهندسين والجهات ذات العلاقة. يجب العمل على اعداد اليات لفحص مواد اطفاء الحريق المستخدمة وضبط ميزانيات محددة لتوفير المعدات اللازمة.	العمل على تحديث وتطوير اجهزة الدفاع المدني بما يتواكب مع الاجهزة الحديثة التي تسهل وتسرع من عمل الدفاع المدني عند الكوارث. توفير اليات معينة وادوت خاصة تراعي الظروف الخاصة للبلدات القديمة لا سيما اثناء الاخلاء إثر حدوث حرائق او حوادث أخرى. تدريب كادر متخصص وعمل دورات تدريبية ولقاءات توعوية مع المواطنين مع اعطائهم امثلة نموذجة على مناطق مشابهة وذلك للخروج من الازمة بأقل حجم ممكن من الاضرار.

المؤسسة	الدور والمسؤوليات الحالية				التوصيات			
	مرحلة التقييم الأولي والتخطيط المكاني	مرحلة التصميم	مرحلة التنفيذ	مرحلة التشغيل والصيانة	مرحلة التقييم الأولي والتخطيط المكاني	مرحلة التصميم	مرحلة التنفيذ	مرحلة التشغيل والصيانة
الدفاع المدني - غزة	لجهاز الدفاع المدني دور في التخطيط المكاني، حيث يشارك في اجتماعات اللجنة المركزية الخاصة بالتخطيط المكاني والمشاركة في اتخاذ القرار.	• المعايير التي يتم تطبيقها تعتمد في الغالب على مراجع دولية مثل الكود الدولي للإطفاء التابع للأمم المتحدة، القانون الدولي الإنساني، واتفاقيات جنيف. المعايير والأكواد غير متلائمة مع الواقع الهندسي المحلي. من الصعب تطبيق معايير أو سياسات معينة (مثل الامريكي او السعودي) في قطاع غزة بسبب طبيعتها المعقدة والاستثنائية • المنشآت التي تتطلب ترخيص من جهاز الدفاع المدني للسماح ببنائها متعددة مثل المباني التي يزيد ارتفاعها عن خمسة طوابق أو التي تزيد مساحتها عن 500 متر مربع، محطات الغاز والوقود، مخازن المواد الخطرة، المولات التجارية، المخابز، المطاعم، المستشفيات، الخ. • بعد موافقة وزارة الحكم المحلي على المنشأة، يتم تحويل الملف إلى إدارة الأمن والسلامة في جهاز الدفاع المدني والتي تضم 35 مهندس من كافة التخصصات، حيث تقوم برفع توصياتها الخاصة بإجراءات الأمن والسلامة إلى مدير الجهاز وبعد اعتماد التوصيات ترسل إلى الحكم المحلي لاستيفاء متطلبات الأمن والسلامة مع المالك. • يوجد تعاون وثيق بين جهاز الدفاع المدني ووزارة الحكم المحلي. • يقوم جهاز الدفاع المدني بتدقيق ومراجعة وثائق التصميم مخططات كافة التخصصات بشكل تفصيلي.	يقوم جهاز الدفاع المدني بإجراء زيارات ميدانية للتأكد من التزام أصحاب المنشآت بإجراءات الأمن والسلامة قبل منح الترخيص المؤقت للمنشأة. يقوم جهاز الدفاع المدني بالتأكد من الالتزام بإجراءات الأمن والسلامة في المنشآت سنوياً، وذلك قبل منح الترخيص السنوي.	مركبات جهاز الدفاع المدني في غزة غير مربوطة ب GIS مما يُصعب متابعة المهام من خارج المقرات ويُؤخر زمن الاستجابة.		يجب العمل على تطوير كودات خاصة ومعايير سلامة تحسبا لجميع الكوارث وليس فقط الحرائق وبما يتناسب مع طبيعة قطاع غزة، ويتم ذلك من خلال تعاون الدفاع المدني مع نقابة المهندسين وإشراك الجهات ذات العلاقة ثم تدريب المهندسين للعمل على هذا الكود من خلال ورشات ودورات تدريبية والعمل على إلزام المكاتب الهندسية بالتصميم مع الأخذ بعين الاعتبار جميع إجراءات السلامة لجميع المباني وايلاء أهمية خاصة للمباني الهامة كالمستشفيات والمدارس مع مراعاة الفئات الضعيفة بالتصميم كذوي الاحتياجات الخاصة والكبار في السن..	مراقبة مدى ضبط الجودة وتنفيذ متطلبات السلامة بالتعاون مع نقابة المهندسين والجهات ذات العلاقة.	العمل على تحديث وتطوير اجهزة الدفاع المدني بما يتواكب مع الاجهزة الحديثة التي تسهل وتسرع من عمل الدفاع المدني عند الكوارث. توفير اليات معينة وادوت خاصة تراعي الظروف الخاصة للبلدات القديمة لا سيما اثناء الاخلاء إثر حدوث حرائق او حوادث أخرى. تدريب كادر متخصص وعمل دورات تدريبية ولقاءات توعوية مع المواطنين مع اعطائهم امثلة نموذجة على مناطق مشابهة وذلك للخروج من الازمة باقل حجم ممكن من الاضرار.

ملخص بالعربية

يهدف هذا التقرير إلى تقديم إرشادات ومقترحات لتعزيز صمود المجتمع الفلسطيني أمام الكوارث الطبيعية مثل الزلازل، الفيضانات، و الانزلاقات الأرضية، من خلال تطوير و تحسين الأداء الهندسي الإنشائي و الإداري لمباني البنية التحتية الهامة في فلسطين مثل المستشفيات، المدارس، الدفاع المدني، و البلديات، الجديدة منها و القائمة. تضمنت هذه الجزئية من العمل دراسة الوضع الحالي، و شمل هذا الجوانب التالية:

- مراجعة الأنظمة الموجودة حالياً فيما يخص الصمود امام الكوارث.
- مراجعة أنماط البناء الدارجة والتي قد تؤثر على قدرة مجتمعنا على الصمود.
- مراجعة المتطلبات الجيوتقنية والإدارية والرقابية المرتبطة بمشاريع البناء.
- مراجعة الدور والمسؤوليات الحالية المرتبطة بمؤسسات مثل البلديات و نقابة المهندسين.
- مراجعة الكودات التصميمية الخاصة بالمباني المقاومة للكوارث.

تضمن العمل أيضا عقد لقاءات مع مختلف المؤسسات ذات العلاقة و إجراء الاستبيانات التي يتم من خلالها تسليط الضوء على أهم المشاكل و التحديات التي تواجه عمل هذه المؤسسات. و تم أيضاً القيام بعدد كبير من الزيارات الميدانية لمختلف المباني الهامة، و خاصةً المدارس، للوقوف على المشاكل المتعلقة بالممارسات الهندسية الدارجة، سواء في مرحلة التصميم، أو التنفيذ، أو المتابعة و الصيانة، و التي من شأنها إضعاف القدرة الإنشائية لمباني البنية التحتية الهامة، مما يهدد قدرة المجتمع على الصمود أمام الكوارث الطبيعية. و بناءاً على نتائج تقييم الوضع الحالي، تم صياغة عدد من المقترحات الضرورية و تصنيفها بناءاً على وضع البناء (جديد أم قائم) بالإضافة إلى مرحلة البناء (تخطيط، تصميم، تنفيذ، أو صيانة). تتضمن هذه المقترحات توصيات عملية متعلقة بالجوانب التالية:

- الكود الهندسي المستخدم في عملية التصميم الإنشائي للمباني، و تم التركيز على إمكانية الأخذ بعين الاعتبار كوارث متعددة في نفس الوقت مثل الزلازل و الفيضانات في عملية التصميم.
- تم التركيز على الجوانب التصميمية المتعلقة بحماية العناصر الغير إنشائية من خطر السقوط نتيجة للهزات الأرضية، خاصة و أنها قد تشكل خطراً على حياة الناس و قد تؤثر على قدرة المبنى (و خاصة المستشفيات) على العمل بشكل اعتيادي بعد حدوث الكوارث الطبيعية.
- تم تقديم بعض الإرشادات العملية فيما يخص الجوانب البيئية للبناء.
- ، تم تقديم بعض الإرشادات العملية فيما يخص المرافق المتعلقة بذوي الاحتياجات الخاصة لتحقيق سهولة الوصول و التنقل و الحركة، خاصة في حالة حدوث الكوارث.
- تمت الإشارة أيضاً لبعض المتطلبات الخاصة بضبط الجودة في أثناء التنفيذ بالإضافة للفحوصات و الحسابات الخاصة بالجانب الجيوتقني لتربة الموقع من أجل الحد من الانزلاقات و انهيارات التربة.
- تم أيضاً وضع مقترح لتحديد الأدوار و المسؤوليات المطلوبة من كل جهة ذات علاقة (بلديات، نقابة مهندسين، حكم محلي، الخ) بما يكفل جودة العمل و آليات التنسيق الفعالة.

يرجى العلم أن هذا التقرير يقدم إرشادات مختصرة حول تعزيز صمود مباني البنية التحتية الهامة. هناك مراجع تفصيلية و تحتوي على كثير من المعلومات الهامة التي يمكن للمهندسين الاعتماد عليها، و قد تمت الإشارة لهذه المراجع بشكل واضح لتسهيل الرجوع إليها.

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APPENDIX

A1. Field Inspection of Selected Buildings

In coordination with all concerned, Selection of the buildings for visual inspection covering schools, hospitals, town halls, civil defense facilities,

Based on the above, the inspected buildings incorporated:

- All hospitals in the West Bank and Gaza Strip, including both private and public ones, and those associated with the United Nations Relief and Works Agency for Palestine Refugees (UNRWA)
- All civil defense buildings in West Bank and Gaza
- 55 buildings, all town halls in the selected 20 municipalities;
- About 170 schools in the West Bank and Gaza, covering private, public, and those associated with the UNRWA (dedicated mainly for refugees).

It should be noted that the field visits for schools focused mainly on old buildings designed and constructed before 2003, as the vast majority of them were not designed to resist earthquake-induced ground shaking. Some of those are even very old buildings that suffer from major structural deficiencies. Selected schools were diversified across geography, ownership (public/private), gender (male/female), age group (primary secondary), and development (urban/rural). Figures A1, A2 and A3 show the field inspection and data gathering accomplished for a public high school building in Yasid town, which belongs to Nablus Governorate.

Figure A1: Inspection of roof conditions for a public high school in Yasid – Nablus governorate

Figure A2: Inspection of structural deficiencies for a public high school in Yasid – Nablus governorate

Figure A3: Structural elements condition for a public high school in Yasid – Nablus governorate

The information gathered during the field visits has been documented through the accomplishment of forms developed by the UPDRRC team. The forms include critical information related to the geometric features of buildings (i.e., number of stories, existence of basement floors, presence of

external walls, size of openings in ground floor, geometric irregularities, type of construction material and lateral load-resisting system), which are directly related to the structural performance of the building during different hazard events. The form also looks at the presence of factors that could increase the building vulnerability such as orientation, its location with respect to surrounding buildings, presence of fire protection systems, and site slope. This information can serve as a baseline for conducting multi-hazard risk assessment for the critical facilities/buildings as they help in the prediction and modeling of the seismic response of such structures. It should be highlighted that for practicality, the forms mentioned earlier were digitized via the Google Forms[11] platform.

A2. Joint Meetings and Discussions

The UPDRRC conducted joint meetings and discussions with the nominated focal points representatives from each department/stakeholder institutions through different approaches:

- Zoom meetings with all stakeholders.
- Face to face meetings with part of the stakeholders from municipalities, civil defense, universities, engineers association, etc.
- Contacts using e-mails, phone calls, others.

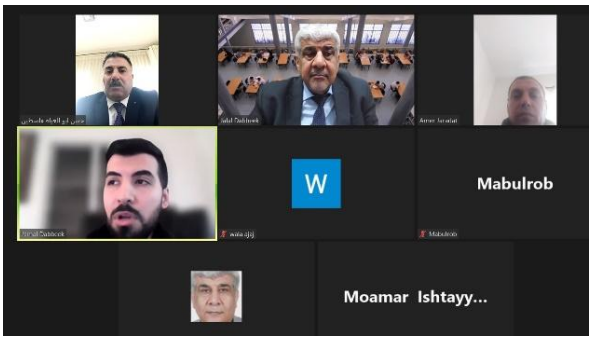
Such meetings incorporated extensive discussions on the concept of resilience, besides its relevance and importance for the Palestinian community. Those meetings also introduced the objectives of the current project to facilitate effective interaction and improve the contribution provided by the aforementioned stakeholders. Figures A4 to A7 show photos of meetings conducted with several stakeholders (e.g., the Engineers Association, NDRMC, MDLF, and Municipalities).

Meeting with the Civil Defense

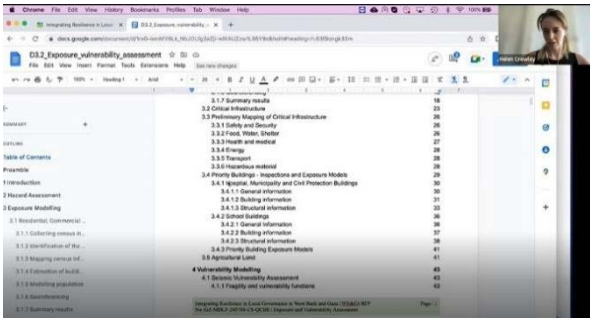
Meeting with NDRMC

11 https://docs.google.com/forms/d/e/1FAIpQLSc6Af0A14T-pPnrPXvYgmKjnASBwn2EFh0zpi2m0GrmPtNFww/viewform

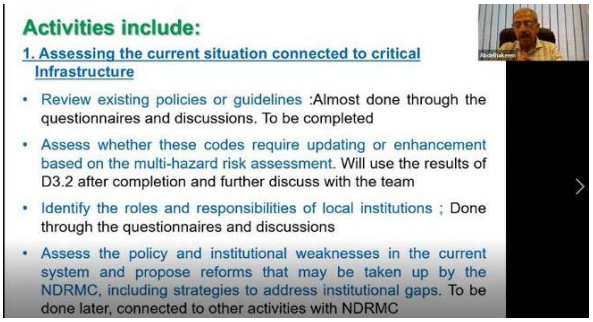
Meeting



Zoom Meetings



Zoom Meeting



Zoom Meeting

Figure A4: Meetings with NDRMC, MDLF, UPDRRC

Figure A5: Workshops with Municipalities

Figure A6: Workshops with Municipalities

Figure A7: Meeting with the head of technical department at the Engineers Association (left); and a workshop organized by APLA following that meeting (right)