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NATIONAL SCHOOL SEISMIC RETROFIT PROJECT IN ISRAEL

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Abstract

According to a decision made by the Government of the State of Israel in 2010, a $1,000,000,000 budget for a national project to retrofit thousands of public buildings was set for a period of 25 years. The Ministry of Education was presented the challenge of handling the evaluation and possible treatment of about 1,600 school structures. In order to overcome the hardships that were faced during the first 4 years of the project running, a unique procedure that allows rapid, efficient detection of the most vulnerable schools was adopted. Furthermore, advanced seismic engineering approaches, that allow smarter and more feasible design solutions, minimal interruptions to the ongoing functionality of the school structure, and more reliable performance of the structure during seismic action were adopted. This paper gives a general overview of the national program, introduces the difficulties that were faced in its first few years running, and discusses the approaches and solutions that were used in order to overcome them, while presenting several projects that were carried out in 2014-2016.

Keywords: Seismic Retrofitting, National Program, School Structures, Program Management

1. Introduction

The State of Israel is located in an area which is known to be a seismically active area, and is situated between the African, Asian and Euro-Asian tectonic plates. The eastern border of the State of Israel aligns with the African-Syrian fault line, which is the most active (but not only) fault line affecting the seismicity of the country. The two sides of the African-Syrian fault line transform one against the other, both moving north, with the eastern side moving at a faster pace than the western side, resulting in a relative velocity of about 4 mm/year.

The State of Israel is considered to be under a seismic threat of an expected medium to strong earthquake (estimated at a Magnitude of 6.5-7.5) which, based on historical records and evidence, occurs, in average, every 80-100 years. Considering the fact that the last strong earthquake to occur within the State dates back to 1927, statistically speaking, a strong earthquake may occur at any given time, and a stopwatch on preparedness and mitigation actions is clearly given.

Various bodies and agencies in Israel, such as the National Seismic Preparedness Steering Committee (NSPSC) appointed by the Israeli Government in 1999 (as part of Israeli Governmental Decision #209) have carried out studies over the last decade, so as to try and determine the impact that a strong seismic event may have on the State, and an official document published by the committee in 2010 estimated the following damages to occur if a strong earthquake (with a 5% probability of exceedance in 50 years) is generated along the African-Syrian fault line:

- Up to 28,000 buildings heavily or completely damaged (over 45% damage to building value)
- Up to 290,000 buildings lightly to moderately damaged
- Hundreds of thousands of buildings very lightly damaged (including nonstructural damage)
- Up to 7,000 casualties
- Up to 8,600 people severely injured
- Up to 37,000 people lightly injured
- Up to 9,500 people trapped in structures (not including casualties)
- Up to 170,000 homeless/ with no shelter
- Major damage to infrastructure

The estimate states that an unprecedented scenario (on a local level) is expected to occur, where a major part of the country's population is affected simultaneously, and up to 2% of the country's population is left without shelter. It shall be noted that the above reference scenario was later replaced by the NSPSC with a preparedness framework, which various agencies, ministries, and authorities should prepare for. This was decided on, as the reference scenario abovementioned was based on statistical parameters that cannot always be predicted in an accurate-enough manner, and, therefore, generates results that may be arbitrary to prepare for. A preparedness framework, on the other hand, generates a general scenario of damage to prepare for (this is not the expected damage, but rather the damage that should be prepared for, and is not based on the result generated by a specific earthquake scenario). This preparedness framework was later adopted by the Israeli Government in Decision #4505.

Israel has a seismic code for design of new structures- SI 413 [1], which was initially introduced in the late 1970's/ early 1980's. The code has been further updated over the years, however, it is considered a code that is not performance-based, and is compatible in its approaches to the previous generation of seismic codes, commonly used worldwide in the 1980's-1990's. The SI 413 code is based on fulfilling a life-safety performance objective under a design earthquake with a return period of 475 years (10% probability of exceedance in 50 years). The code offers a map for peak ground horizontal acceleration (PGA) on rock (classified as soil type B in SI 413) for 3 seismic hazard levels (see, for example, the PGA map for a design basis earthquake with a return period of 475 years, given in Fig. 1). Aside for the SI 413 code for design of new structures, a code for seismic evaluation of existing structures (SI 2413, [2]) also exists, however, this code is intended for rapid screening evaluation and not in-depth seismic performance evaluations, and does not offer design tools for retrofit of existing structures.

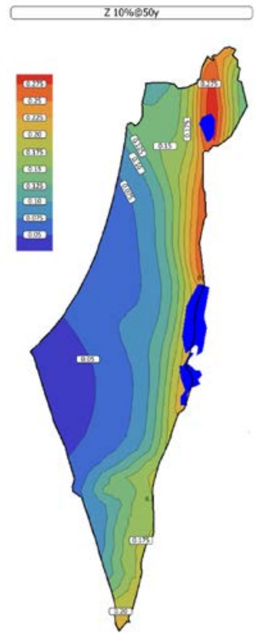


Fig. 1 – PGA map of Israel (on rock) for an earthquake with a 10% probability of exceedance in 50 years

As can be seen from the presentative map given in Fig. 1, the areas more affected by seismic events are located along the Eastern border of Israel (right-hand side of the figure). It so happens to be, that these areas are the social-economical peripheral areas of Israel, which are poorer, and not as well developed as other, richer areas of the country. This fact has challenged the bodies in charge of seismic preparedness, and required the need to come up with creative solutions and national plans, which has resulted in various programs that have been adopted over the years (such as the TAMA 38 plan). However, those are not within the scope of this paper.

In 2008, Israeli Governmental Decision #4331 allocated 3.5 Billion NIS (equivalent to about 1 Billion USD), to be used over a time period of 25 years, for the purpose of retrofitting public structures against earthquake threats. Together with this decision, a set of criteria to determine the priority of structures to be retrofitted was approved. The decision called for an individual engineering evaluation of every structure prioritized, so as to determine the need and feasibility of its retrofit. The responsibility to carry out this decision was assigned to the Chairman of the NSPSC.

Following this decision, in 2010, Israeli Governmental Decision #1623 approved steps that the Government and its Agencies must carry out in order to improve the seismic preparedness within the State of Israel, and called for the various Ministries to carry out actions, as assigned and detailed in the decision. As part of this decision, assignments in the breakdown to prevention, mitigation and preparedness, response, and rehabilitation stages where given to the Ministry of Education, mostly through the Ministry of Education Development Administration (MEDA). These include, as part of the prevention phase, responsibility to ensure that schools structures are compatible to up-to-date seismic codes, and enhance their performance if they are found to not be.

A list of 3,500 public structures at risk, all built before the year 1980 (the cutoff year decided upon as the year of the appearance of the Israeli seismic code) was created, out of which 1,600 are school structures. 200 of the 1,600 school structures were prioritized by the NSPSC, based on several parameters such as location, seismic hazard, number of students, etc., and were selected as the pilot structures for the National School Seismic Retrofit Project (NSSRP).

Based on the outcome of past earthquakes, where the lives of millions of children have been affected due to damage or collapse of school structures, it can be said that these structures are a very important and crucial category within the inventory of public structures [3]. Programs of the same nature as the Israeli NSSRP have been carried out in several places around the world (on a local or national level), including, for example[1]: Canada (British Columbia Province), Columbia, India, Indonesia, Iran, Nepal, New Zealand, Turkey, and the USA (Oregon State, Washington State).

The Country of Turkey, following the 1999 Izmit Earthquake, initiated a national seismic retrofit project, retrofitting or demolishing and reconstructing hundreds of schools structures in seismic zones over the last decade, improving the safety of over one million schools students [4]. In the case of the Turkish project, the works being carried out to seismically retrofit school structures were taken advantage of, so as to also renovate and enlarge the capacity of buildings and classrooms. As part of the project phases, prioritization criteria were formulated, and the parameters considered include accessibility, year of construction, number of floors, distance to fault lines, number of students, and operation hours [4]. The Turkish project was supported and funded by the World Bank[2]. The Venezuelan national school retrofit project was initiated in 2006, motivated by the 1997 Cariaco earthquake, which destroyed several school structures. The national program included building a national information system, built together with a Geographic Information System (GIS) system to support it. Information collected included parameters that may affect the potential seismic risk and performance of the structures, such as year of construction, number of stories, location, population, and construction type [5]. Italy also considered the retrofit of school structures as part of their national seismic prevention program. However, as retrofit costs were estimated at over 500 million Euros, only about 1,600 schools (out of about 26,000 schools built in areas of high seismicity) have been dealt with as of 2012, and an additional 50 schools, on average, are dealt with every year, using state contributions allocated to the retrofit works [6]. The national school seismic retrofit project carried out in the Country of Cyprus is considered a success. As of 2012, about 90% of the school structures were considered to be seismic resistant [7]. The national project in Cyprus, which was also initiated following the 1999 Izmit earthquake in Turkey, is funded by the Cyprus Government, as well as the European Regional Development Fund. However, it shall be noted that as opposed to other national programs mentioned, Cyprus is a relatively small country, which only has an inventory of several hundreds of schools. It shall also be mentioned that Turkish and Cyprian programs may be the most relevant to the Israeli case, due to their geographic proximity to the State of Israel, which, over the history of time, lead to similar architecture, building techniques used, and thus, similar building stock to be dealt with. The seismic hazard is also similar, in part.

This paper presents the Israeli NSSRP as of 2016, and gives a look inwards as of the project's successes, as well as shortcomings and difficulties encountered.

2. Old Program (up until 2010-2012)

Following Israeli Governmental Decision #1623, an initial budget was allocated to the MEDA so as to allow initialization of the NSSRP. In the years 2010-2013 a total of 145 Million NIS was allocated to the project. However, in those years, most the money was not actually utilized, due to several issues that will be discussed. The main argument was that the project was prematurely imposed on the various Ministries, without preliminary staff preparation. This caught the Ministries off-guard, where they were not prepared with adequate staff needed and trained for such a complex project. In addition, since the beginning of the NSSRP, it was identified that there is a very large gap in knowledge, especially engineering knowledge (since seismic engineering is a very unique field of specialty within the structural engineering field, and seismic retrofit has a very different practice than new construction practice). Also, it was recognized that there was a lack in tools (such as local codes and practices) available as far as seismic retrofitting is concerned. Therefore, the project was very slowly initialized, and a long phase of learning was needed.

One year into the project, the main gap recognized as slowing down the entire project was the lack of adequate seismic codes, as the available Israeli seismic codes are intended for design of new structures, or preliminary evaluation of existing structures. This meant that designers were left without tools to allow them to

[1] https://www.eeri.org/projects/schools/resources/seismic-school-safety-by-country/
[2] http://www.worldbank.org/en/results/2014/08/05/enhancing-seismic-preparedness-in-istanbul

realistically evaluate and retrofit existing school structures. Within the 2010-2012 period of the program, the design and retrofit of only a single school structure was carried out.

Due to the limping start to the NSSRP, it was decided to appoint an expert consultant to help guide and lead the project, so as to successfully overcome the abovementioned gaps and, hopefully, rescue the project from its halt. In 2012, a bid to select an expert consultant was published, and a consultant with vast expertise in the field of earthquake engineering was selected.

The first learning steps by the new professional NSSRP team included educational learning trips to Cyprus and British Columbia (Canada), so as to learn about the successful seismic school retrofit projects carried out in those countries, as well as meet with the project leaders and discuss the difficulties and solutions acquired, and the different learning experiences. Those two locations were selected as they have somewhat similar attributions to the state of Israel as far as population, seismic risk, governmental setup and hierarchy, types and cost of construction, etc.

3. New Program (2012 and onwards)

Lessons learnt from the two abovementioned projects lead to a shift in thought of the professional NSSRP team, and it was decided to write specific, adequate guidelines for the seismic evaluation and retrofit design of existing school structures in Israel. The professional team decided to base the new set of guidelines on performance-based design ideas, and adopt the main principles to seismic design introduced in the American ASCE 41 standard [8], as leading design principles, to which alternations based on local codes and needs were introduced. The American ASCE 41-13 standard addresses each structural element separately, as opposed to the Israeli SI 413 code, which addresses the building as a whole. This approach seems to be more suitable in the case of retrofit of existing structures. This also allows retrofitting the structure only in places that are beneficial to the local or overall behavior of the structure, and not waste retrofit measures where they are not needed, or not efficient. In addition, the American ASCE 41 standard designs for a range of properties and behaviors, so as to consider uncertainties involved when considering retrofit of existing structures. Therefore, the resultant design is expected to be more robust.

As part of the new set of guidelines, the design criteria selected for schools structures was Life Safety in a strong earthquake, with a return period of 2,475 years (2% probability of exceedance in 50 years). It shall be noted that, in any case, the guidelines fulfill the legal requirements set by Israeli SI 413 (mainly by use of the seismic load definitions and by limiting maximal resultant inter-story drifts).

After publishing the new set of working guidelines for the NSSRP in early 2013, the professional team started working and coaching design engineers from about 10 different engineering firms, so as to familiarize them with the new set of guidelines, and closely support the first set of schools retrofitted, as part of a needed learning curve.

In addition, a special workshop on the topic was given in early 2014, featuring a special invited keynote lecture given by Prof. G.M. Calvi. Several-dozen engineers, local authority officials, project managers and other professionals attended the workshop.

A pilot comparison between retrofitting a school structure with the old and new programs was carried out, and it was found that:

- Using the old program's guidelines resulted in the need to evacuate the schools for a year in order to allow retrofit works to be carried out. Using the new set of guidelines, only a minor interference to the schoolyear occurred (two days of closing down the school for heavy construction works).
- Retrofit measures based on the new guidelines cost an average 30% less, and no addition of walls blocking facades/ windows was needed.

Based on the abovementioned steps carried out, some preliminary recommendations were reached. These included:

1. Establishing a managing engineering and administrative body within the MEDA to lead the project, and help overcome both bureaucratic and scientific difficulties encountered along the

way. This body was to include an administrative/ managing body to manage the overall project and coordinate its various components, an academic/ scientific body to manage the professional aspects of the project, including writing guidelines and handbooks for engineers, support designers, lecture at workshops on the topic, etc, and a review body to review retrofit design calculations and plans.

2. Carrying out a national survey so as to update the initial list of schools to be examined, based on updated, more relevant, parameters. This survey is expected to most likely reduce the number of schools on the list, and help to better prioritize them.
3. Getting professional assistance and guidance from experts from countries that have carried out similar projects on a national scale (such as British Columbia or Cyprus), at least for the initial period of the program.
4. The program, as currently set up, forces designers and other consultants to directly deal with the engineering department of each local municipality (instead of directly with the Ministry Of Education). This is since schools in Israel belong to the local municipality, and not to the Ministry. Therefore, knowledge and experience gained by other local municipalities already involved in the project is often lost or overlooked. There seems to be no way to skip the local municipality's involvement in the projects being carried out in their local municipality, even though it would have been preferable to have a generalized process which does not include the involvement of each local municipality separately. This point must be rethought at the project progresses.

4. Process and results

The evaluation and retrofit process, as part of the NSSRP, is carried out in the following order of steps: first, an initialization phase is carried out, where the professional consultant engineer to MEDA, together with the MEDA administrative team, initiate tours in schools belonging to a certain local municipality. For this tour, the representatives of the Municipality must prepare, in advance, information regarding the schools, such as number of students, year of construction, type of construction, other special issues, etc. Based on the information gathered and the tour carried out, the professional team prioritizes the schools to be dealt with within the Municipality.

Next, the design phase starts, and a designer (or several designers) is selected by the Municipality. The Municipality then attempts to recover original architectural and engineering information and plans regarding the structures at hand. Any missing information is obtained by carrying out surveys such as soil surveys, site specific surveys, measurements, nondestructive and destructive testing, etc. Based on all information gathered, the designer evaluates the seismic performance of the existing structures, selects design alternatives for its seismic retrofit (if needed), creates a preliminary design for the selected alternative, and gives an initial estimate of costs. A detailed report describing the above-mentioned in submitted to MEDA. The consultant engineer to MEDA reviews the report and comments on it. If costs are lower than about 20% of new construction, the school is approved for retrofit. The designer then reviews the comments and alternates the design as needed. Once the design is finalized, the designer carries out a detailed retrofit design, including all structural drafts, plans, bills of quantities and execution timetables.

Finally, the execution stage is carried out: a bid for construction works is carried out, and a contractor is selected by the Municipality. Retrofit works are carried out with the support of the designer and MEDA's consultant engineer.

As of September 2016, the current status of the project is: 14 schools have been retrofitted, 20 schools are currently in the retrofit execution stage, 35 schools have been evaluated and designed, and are ready for retrofit works, to be executed based on available funds, 18 additional schools will be ready for execution during 2016. The process of evaluation and retrofit has been initialized, on some level, in an additional 150 schools, in 35 different local municipalities, In the case of four schools, it has been decided to rebuild instead of retrofit, as retrofit costs were too high (over 40% of rebuilding costs).

As can be seen, almost all schools in the first priority list of 200 schools have been dealt with, on some level. It is therefore necessary to prioritize a second list of schools out of the list of 1,600 defined by the NSPSC.

Some initial insights based on experience in the first 3 years of the new project include:

1) Retrofit of existing structures, and especially of functioning school structures is very different than other construction projects (and even rehabilitation/ renovation projects), as the preparation phase of these projects is critical. An action plan must be thought of and prepared in advance, and shall address issues (where needed) such as supplemental classrooms, transportable classes, safety certificates for operation, division of school grounds into separate working sites, etc.
2) The design solution must be carefully chosen based on engineering considerations, but should also be verified with school officials, and any constraints given by the schools must be considered. It is also important to compare expectations with school officials, and give them as much information needed so that they can communicate with school-parent associations, or with any other organizations that may have concerns with the project and work being carried out. Lack of coordination and communications can lead to substantial delays in executions due to halts on works being carried out.
3) It is generally not possible to carry out construction works during school breaks only, and it is therefore recommended to:
   a. Split construction work into phases and areas, isolating only small needed work areas at a given time.
   b. Concentrate major construction works (excavations, foundations, interior works) and carry them out during school breaks.
   c. Work in two working shifts (a third night shift was found to be not economical).
4) As abovementioned, one of the main problems to majorly slow down the project in its initial phases was the attempt to apply conventional strengthening solutions (mostly by the addition of major concrete walls to the structures). These solutions were expensive to apply, and required the school to be shut down due to extensive construction works required. With the passage to the new program, and the adoption of a new set of guidelines, it is recommended to apply performance-based design approaches, and select design solutions that are less extensive, sometimes even utilizing advanced design solutions such as energy dissipation devices (dampers) and base isolation systems. The design should insure the preferable seismic behavior of the structural system, i.e. ductility and energy dissipation, according to capacity design principles.
5) Design solutions should be reviewed by professional engineers (these can be part of the MEDA professional team), especially where advanced design solutions are being utilized (in which case it is recommended to use independent experts).
6) As part of the execution of seismic retrofit works, other structural rehabilitation measures should also be carried out, and any structural element that has been exposed, effected by corrosion, or otherwise damaged by time, should be rehabilitated.

5. Engineering solutions

Being a project that is different in nature than other seismic design projects, enforced the use of creative solutions, and sometimes an out-of-the-box thinking, so as to come up with solutions that could be applied to a working/ operational school, without overly interfering with its daily functioning. The design solutions include strengthening using concrete elements (frames/ shear walls), concrete foundations with steel upper-structure elements, fiber-reinforced polymer (FRP) strengthening of elements with and without steel plate reinforcements, advanced technologies (dampers, base isolation), and combinations of the above. A breakdown of the selected solutions in the projects that have been designed thus far is shown in Fig. 2. Examples of three projects and the different design solutions selected for retrofit are given below.

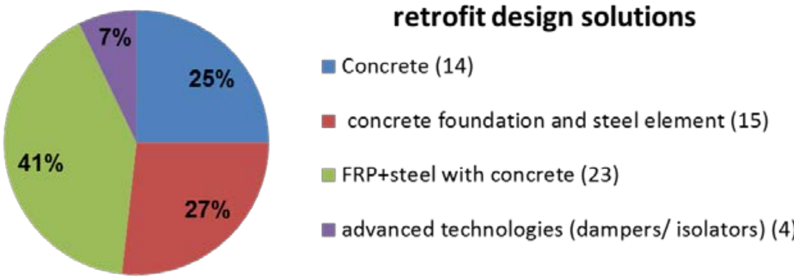


Fig. 2 – breakdown and statistics of retrofit design solutions used thus far in NSSRP

Ironi Gimmel School, Haifa (Fig. 3):

Ironi Gimmel School is a 5,700 square-meter school located in the Northern City of Haifa, and built in 1969, which comprises of several adjacent substructures separated by expansion joints. The school was built using "Debesh" concrete walls (a unique Israeli building method that was widely used in past decades, where the concrete contains very little amounts of cement, and is comprised mainly of sand, stone aggregates, and seashells, and contains almost no steel reinforcement), and minor additions of concrete shear walls. Retrofit of the 4-5 floor school structures, included:

- Use of FRP sheets and steel plates to strengthen and enhance the seismic behavior of problematic "Debesh" walls.
- Connection of adjacent substructures, using special seismic gap connectors, so as to reduce torsion (and thus reduce resultant forces).

(a) (b) (c)

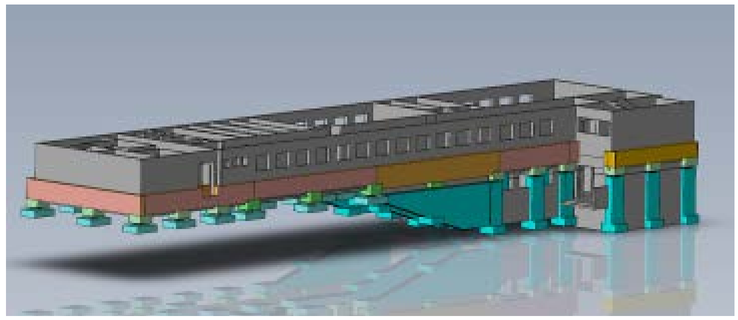
Fig. 3 – retrofit of Ironi Gimmel School (Haifa): (a) strengthening using FRP sheets and steel plates; (b) special seismic connectors between adjacent subsections; (c) FRP sheets to reduce the fallout of infill, so as to allow the safe escape of students in hallways during a seismic event

Ironi Hei School, Haifa (Fig. 4):

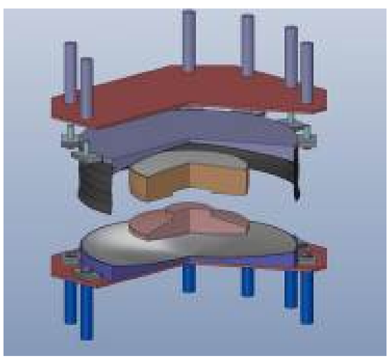
Ironi Hei School is a 9,700 square-meter school located in the Northern City of Haifa originally built in the 1950's, which laterextensions were added to. The school includes several adjacent substructures separated by expansion joints. The school is built on rocky soil. The structural system comprises of "Debesh" walls, constructed of concrete that was found to be of very poor quality. Retrofit of the 4-5 floor school structures included:

- Use of base isolation system between the upper and lower structure, to allow horizontal flexibility, while still supporting all vertical service loads.
- Local strengthening of elements.

(a)



(b)



(c)

(d)

Fig. 4 – retrofit of Ironi Hei School (Haifa): (a) structure to be isolated; (b) scheme of isolated structure with isolators between upper and lower structures; (c) base isolator slider detail; (d) strengthening of concrete column below isolation level

Meginim School, Kiriyat Shmona (Fig. 5):

Megimin School is a 3,000 square-meter school located in the Northern City of Kiriyat Shmona, originally built in the 1960's and 1970's (extensions to the school). The school includes several adjacent substructures separated by expansion joints. The 3-story school (plus a partial underground floor) is built on rocky soil. The structural system comprises of reinforced concrete frames, with block-panel infill walls. Retrofit of the school structures included:

- In one direction: addition of concrete walls.
- In second (perpendicular) direction: addition of yielding steel braces (hysteretic dampers).
- Addition of grade beam to connect individual foundations in order to reduce potential of damage due to ground rapture at surface level.

(a) (b)

Fig. 5 – retrofit of Meginim School (Kiriyat Shomna): (a) addition of yielding steel braces; (b) addition of grade-beam between foundation to reduce effects of potential ground rapture at surface level

6. Discussion and Future Steps

As can be seen in the description and results brought in sections 2-5, it is apparent that the steps taken to expedite the project as of 2013 have been fruitful, and allowed the retrofit of several schools in the period of four years, as opposed to a single school in the previous three years of the project running. Several dozens of additional schools are currently in some stage of the working process.

However, even though partial success has been attained, there is still work to be done, and improvements to the project to be made, so as to allow its successful continuation.

Future steps to be carried out as part of the successful continuation of the project include:

- A bid to expand the professional MEDA team. This bid has been published, and additional engineers and project managers will be selected in 2016. These will form the NSSRP managing/ engineering/ scientific/ administrative body abovementioned.
- It is expected that by the end of 2016 the NSSRP managing body will draft an updated list of schools prioritized for the next stages of the project. This list will be based on updated criteria, and will make use of the experience and valuable information gained over the span of 4 years the project has been successfully running.
- Based on the new prioritization, more schools will enter the project.
- Training of additional engineers and engineering firms, so as to expand the base of practicing engineers involved in the design stage of the project. Some of the training is given as part of a seismic retrofitting course offered by the Israeli Engineering Association and funded by the NSPSC, as part of its annual budget. The course is offered to engineers at no cost.

- Preparation of a new set of guidelines which will be based on the Eurocode 8.3 standard, instead of the American ASCE 41 standard (this is motivated by an Israeli Governmental Decision to generally adopt European codes in the State of Israel).

The crucial importance of continuous funding of the project must also be mentioned. The project is fully funded by the Israeli Government (and not by the schools or local municipalities), and any difficulty in the flow of money can lead to a slowdown or a put a halt to the project, and endanger the lives of thousands of school students. In 2014-2015 the NSSRP budget was drastically cut due to lack of adequate progress in previous years, however, the relative success of the project in those years has led to an increase of budget in 2016.

7. Conclusions

This paper presented the Israeli National School Seismic Retrofit Project, including its motivation, as part of a national decision to improve the seismic behavior of public structures in the country, difficulties in initiation of the project, challenges, decisions made so as to allow the continuation of the project, and its current success.

After a rough start to the project, it seems that decisions made in 2012 (see paragraph 3 for elaboration) have managed to push the project onto the right track, where every year since then the project has been accelerated, with a substantial peak in 2015. It is anticipated that with the growth of the professional, managing, and practicing teams, and with lessons learnt and processes improved (see paragraph 4 for elaboration), the project will continue to positively evolve, and will be determined successful, with meeting the objectives and goals set by the Israeli Government, and with helping to protect the lives of tens-of-thousands of kids. This, of course, is very much dependent on the available budget, and on continuous funding.

We believe that NSSRP model and process described herein can be used as a base-reference for project in countries with similar seismic hazards, building stocks, and local and national government structures, by applying modifications in relation to the local conditions. Lessons learnt, as described herein, should be addressed in the initial stages of such projects, so as to avoid potential setbacks.

8. References

[1] SI 413 (2015), Design provisions for earthquake resistance of structures, amended in May 2016. *The Standard Institution of Israel*, Tel Aviv, Israel (in Hebrew).

[2] SI 2413 (2003): Guidelines for seismic resistance assessment for strengthening of existing structures. *The Standard Institution of Israel*, Tel Aviv, Israel (in Hebrew).

[3] WSSSC (2012): Washington State school seismic safety project- providing safe schools for our students. *Washington State Seismic Safety Committee*, Washington, USA.

[4] ISMEP (2014): Retrofitting and reconstruction works. *Istanbul Seismic Risk Mitigation and Emergency Preparedness Project* (ISMEP).

[5] López OA, Hernández JJ, Marinilli A, Bonilla R, Fernández N, Domínguez J, Baloa T, Coronel G, Safina S, Vielma, R (2008): Seismic evaluation and retrofit of schools building in Venezuela. *14th World Conference on Earthquake Engineering*, October 12-17, 2008, Beijing, China.

[6] Dolce M (2012): The Italian national seismic prevention program. *15th World Conference on Earthquake Engineering*, Lisbon, Portugal.

[7] Chrysostomou CZ, Kyriakides N, Kappos AJ, Georgiou E, Vasiliou O, Milis M (2012): Seismic retrofitting of school buildings in Cyprus. *15th World Conference on Earthquake Engineering*, Lisbon, Portugal.

ASCE/SEI 41-13 (2014), Seismic evaluation and retrofit of existing buildings, *American Society of Civil Engineers*, Reston, Virginia.