KAUNAS UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING AND ARCHITECTURE

VIGNESH JAYAKUMAR

CONSTRUCTION TECHNOLOGY OF FLOATING BUILDING WITH MAGLEV FOUNDATION

Master's Degree Final Project

Supervisor
Assoc. prof. Dr. Mindaugas Dauksys

KAUNAS, 2018

KAUNAS UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING AND ARCHITECTURE

CONSTRUCTION TECHNOLOGY OF FLOATING BUILDING WITH MAGLEV FOUNDATION

Master's Degree Final Project

Structural and Building Products Engineering, (621H20001)

Supervisor
Assoc. prof. Dr. Mindaugas Dauksys
(date)

Reviewer
(signature) Assoc. prof. dr.
(date)

Project made by
(signature) Vignesh Jayakumar
(date)

KAUNAS, 2018

KAUNAS UNIVERSITY OF TECHNOLOGY
FACULTY OF CIVIL ENGINEERING AND ARCHITECTURE
(Faculty)
Vignesh, Jayakumar
(Student's name, surname)
Structural and Building Products Engineering, (621H20001)
(Title of study programme, code)

" CONSTRUCTION TECHNOLOGY OF FLOATING BUILDING WITH MAGLEV FOUNDATION"

DECLARATION OF ACADEMIC INTEGRITY

____ _________________ 2018 _____
Kaunas

I confirm that the final project of mine, **Vignesh Jayakumar**, on the subject "**Construction Technology of Floating Building with Maglev Foundation**" is written completely by myself; all the provided data and research results are correct and have been obtained honestly. None of the parts of this thesis have been plagiarized from any printed, Internet-based or otherwise recorded sources; all direct and indirect quotations from external resources are indicated in the list of references. No monetary funds (unless required by law) have been paid to anyone for any contribution to this thesis.

I fully and completely understand that any discovery of any facts of dishonesty inevitably results in me incurring a penalty under procedure effective at Kaunas University of Technology.

____________________________________ ____________________
(name and surname filled in by hand) *(signature)*

Jayakumar, Vignesh. Construction Technology of Floating Building with Magnetically Levitating Foundation. *Master's* Final Project / supervisor Prof. Dr. Mindaugas Daukšys; Kaunas University of Technology, Faculty of Civil Engineering and Architecture.

Research field and area: Civil Engineering.

Keywords: *Floating Building, Maglev Foundation, Earthquake Resistance Structure, Light Weight Construction, Innovative Foundation*

Kaunas, 2018. 56 p.

SUMMARY

The purpose of this thesis work is to design and study about magnetically levitating foundation to make buildings float at times of natural disasters such as earthquakes and floods. Although there are different technologies that aid in the construction of earthquake or flood resistant buildings, the concept of magnetic levitation is the area of research for this dissertation. Various literature was studied, and the design methodology is outlined. The construction technology and methodology were researched, and a design was proposed. Based on the proposed design, a small-scale model building was constructed and analyzed. The model building was tested for artificially induced earthquake vibrations. The scientific principles behind the working of the Magnetic levitation was discussed and calculations of the magnetic strengths were made.

Light-weight materials were recommended for the constructions of magnetic levitation buildings. The project concludes that with more in-depth research on using of powerful superconducting magnets, magnetic levitation foundation for floating buildings is a viable choice for future hazard resistant construction designs.

The work consists of Introduction, Research Methodology, Design the Structure and Result, conclusions, bibliography and annexes. Thesis consist of 55 pages, 35 pictures, 02 tables, 02 formulas, 30 bibliographical entries and 2 supplement.

Jayakumar, Vignesh. Pastato su magnetinės levitacijos pamatais statybos technologija. *Magistro* baigiamasis projektas / vadovas prof. dr. Mindaugas Daukšys; Kauno technologijos universitetas, Statybos ir architektūros fakultetas.

Mokslo kryptis ir sritis: Statybos nžinerija.

Reikšminiai žodžiai: *plūduriuojantys pastatai, magnetinė levitacija, žemės drebėjimui atspari konstrukcija, lengvosios konstrukcijos, inovatyvūs pamatai*.

Kaunas, 2018. 56 psl.

SANTRAUKA

Šio baigiamojo projekto tikslas – apžvelgti plūduriuojančių pastatų statybos principus ir suprojektuoti pastatą su magnetinės levitacijos pamatais, kuris leistų pastatui plūduriuoti ant oro pagalvių žemės drebėjimų bei potvynių metu. Nors yra įvairių statybos technologijų, įgalinančių pastatyti žemės drebėjimų ar potvynių poveikiui atsparius pastatus, magnetinė levitacija yra pagrindinė šio baigiamojo projekto tyrimų sritis. Nagrinėjamu klausimu atlikta literatūros šaltinių analizė bei pateiktos projektavimo metodikos. Išnagrinėta pastato su magnetinės levitacijos pamatais statybos technologija ir pasiūlyta jo konstrukcija. Sukurtas pastato su magnetinės levitacijos pamatais modelis, kuris išbandytas dirbtinai imituojant žemės drebėjimą. Atlikti magnetinio lauko stiprumo skaičiavimai ir aptarti mokslinių tyrimų rezultatai.

Pastatų su magnetinės levitacijos pamatais statybai rekomenduotinos lengvosios konstrukcijos. Remiantis atliktu projektu daroma išvada, kad pasinaudojus galingų superlaidinių magnetų tyrimais, pastatai su magnetinės levitacijos pamatais yra vienas perspektyviausių ateities sprendimų, statant žemės drebėjimui atsparius plūduriuojančius pastatus.

Darbas susideda iš įvado, 4 skyrių, išvadų, literatūros sąrašo bei priedų. Darbo apimtis – 55 puslapiai, 35 paveikslų, 02 lentelių, 02 formulių, 30 literatūros šaltinių ir 2 priedo.

CONTENT

LIST OF FIGURES

LIST OF TABLES

ABBREVIATION

%	-	Percentage
€	-	Euro
Eps	-	Expanded Polystyrene
P.C.	-	Picture Credits
R.C.	-	Reinforced Concrete
P.C.C.	-	Plain Cement Concrete
D.L.	-	Dead Load
L.L.	-	Live Load
I.S.	-	Indian Standards
LEED	-	Leadership in Energy and Environmental Design
HVAC	-	High-voltage Alternating Current
kg	-	Kilograms
kg/m^2	-	Kilogram-force per square meter
lbs	-	Pounds
kN	-	kilonewton
kN/m^2	-	kilonewton per square meter
m	-	meter
m^2	-	Square meter
m^3	-	Cubic meter
mm	-	millimeter
thk	-	Thickness
Nos	-	Numbers
etc.	-	et cetera, and other things
i.e.,	-	That is

CHAPTER 1

1. INTRODUCTION

Our World is not the world once it was to be. Speaking of Human Civilization, World has changed a lot more in the last 200 years than it had in the last 5000 years. It is in our nature, a basic instinct of all species, to live in a smarter way. It is the quest for this smartness that started the birth of all civilizations and that led to the world we are in today. The first humans started to settle inside caves, the first of “Engineered homes”. Then from small thatched huts to Modern Reinforced Glass Domes in today’s world, Civil Engineering, the Primordial Engineering field has seen amazing scientific and technological uplifts in the field of Construction.

One of the greatest challenge for a constructed building is to stand still facing severe natural calamities like Earthquake and flooding. Earthquake resistant designing is not a new area of research for Engineers and architects alike. While high rise buildings and enormous structures represent the grandeur in construction industry, a safer construction represents the intellectual marvel in it. This research proposes a unique idea of using magnetic levitation as a practical alternative for an Earthquake cum Flood resistant structure. With the rise in sea-levels and high rate of continental plate tectonics in the last few decades, levitating buildings will be a promising area in the future construction industry. In the mid of 19th Century the literature was published the concept of magnetic levitation. Although magnetic levitation in various forms have already been patented, this project proposes a unique way of combining base isolation technique with magnetic levitation.

The purpose of this thesis work is to design and study about magnetically levitating foundation to make buildings float at times of natural disasters such as earthquakes and floods. Although there are different technologies that aid in the construction of earthquake or flood resistant buildings, the concept of magnetic levitation is the area of research for this dissertation. The project deals with Designing of An Eco-friendly Smart Building with magnetically levitating base as an Earthquake Resistant Structure. This project incorporates multiple approaches towards Earthquake resistant designs and tries to avoid the traditional approach of using only dampers or using base isolators.

1.1. BACKGROUND HISTORY

In the year 2013-2014 Henderson and his friends was Registered as a Patent of the "First Magnetic Levitation Foundation" under different Patent numbers in USA [1]. The concept of Magnetic Levitation predates their Patent though, the study around the concept started in the early 18th Century. In 1839, Earnshaw's theorem showed electrostatic levitation cannot be stable. Then in March 1912, Emile Bachelet was awarded a patent for his "levitating transmitting apparatus" (patent no. 1,020,942) for electromagnetic suspension system. In 1933, the concept of Super diamagnetism was developed by Walther Meissner and Robert Ochsenfeld as the Meissner effect. In Germany Hermann Kemper filed patent for "(Placeholder1)" in the year of 1934. (Reich Patent number 643316, now as German Patent and Trade Mark Office). In 1939, Braunbeck's extension showed that magnetic levitation is possible with diamagnetic materials as well. Then In 1939 the two concentric cylindrical coils stable levitation showing 6-axis using levitation aluminium plate was developed by Bedford, Peer and Tonks. In the 1970s, Spin stabilized magnetic levitation was developed by Roy M. Harrigan. In 1997, Andre Geim diamagnetically levitated a live frog. In China HTS maglev test vehicle with man loading it was successfully developed in 2000 and it named as "Century". In March 2005, Japan began operation of its relatively low-speed HSST "Linimo" line in time for the 2005 World Expo.

1.2. RESEARCH SCOPE

This research project proposes a Research Centre building that would incorporate magnetic levitation with base isolation technique. The project aims to make the proposed design both earthquake resistant and flood resistant. The future scope of the proposed technology could be extended to a multi-storey building. It should be noted that the proposed building is not a concrete structure as levitating a concrete building is not a feasible option technically and economically. Light-weight building, and light-weight appliances are suggested for this unique design. Unique plan and designing is adapted for the proposed technology. The base of the building columns is uniquely designed for this project.

It should be observed that only earthquake induced vibrations are calculated. A model of the building is built and tested. However, for measuring the “Critical weight: the excessive weight after which the magnetic levitation ceases either by the contact of the repulsive magnets or by polar realignment”, the entire live load and dead load of a building must be calculated on real time buildings and tested.

1.3. LITERATURE REVIEW

Learning from the April 25, 2015, Nepal earthquake:

Mapping the deformation and site response learning from earthquakes: Every earthquake gives us different experience, even though the researchers to be prepared for future events. In Nepal April 25,2015 the magnitude of 7.8 earthquake rained avalanches on Mount Everest and it devastated Nepal. What exactly is going on underground when the earth moves so Violently? The Science behind the Earthquakes the theory of plate tectonics was put forward in the mid-20th century based on decades of earlier research. One scientist, Alfered Wegener First Suggested the concept of continental drift in 1912 the Idea that land masses can move across the earth surfaces. But he didn't know the mechanism behind the movement. Throughout the 50s, 60s and 70s more pieces of the puzzle fell into place. Including ideas like sea-floor spreading, and global crustal motion. But now the Scientists know that the earth is made up of several layers, the mantle, curst and core, and the outer most shell, the Lithosphere. The crust is broken up into 7 or 8 major tectonic plates which float on top of layer which is called the asthenosphere. The molten rock beneath them move them around like a Conveyer belt. Sometimes the plates meet up and move towards each other forming a convergent boundary, when they move apart, it's a divergent boundary, when they slide past each other it's a transform. When plates slide over, under or past each other it creates a lot of pressure which can be released as a volcanic eruption or an Earthquake. The Nepal sits on a Volatile Zone. The Indian plate broke off from Madagascar 90 million years ago. Around 50 million years ago it hit the Eurasian plate. This forced the Indian plate to take a dive, While the other plate thrusted upwards creating the Himalayas. When the two plates meet like this, it's called a thrust fault. Millions of years later, they are still crashing into each other. The Indian plate subducts, or is sliding beneath the other plate, and moves North 2 inches (5 centimeters) in a year. This builds up enormous amounts of pressure. When all that pressure is released, it can mean disaster. This region is weirdly used to earthquakes, for some reason. They seem to experience large quakes every 75 years or so, like clockwork. And this one was right on cue, the last major Earthquakes struck in 1934. But this recent earthquake was shallow, at only 15-kilometers deep. While a 7-magnitude earthquake is devastating on its own, a shallow depth means more shaking at the surface and more damage. At the time of this taping, the death toll from this catastrophic earthquake's death toll is over 4 thousand and is expected to rise. Buildings, Temples and homes have been toppled as many remain in need of help.

Through a specific project to facilitate field studies helps to know the real effect of earthquakes. This brief report presents the Nepal that were affected by the earthquake. Our observations are presented in the general background of the seism tectonic setting of the Himalaya.

Courtesy – A Report on 2015 Nepal Earth quake by Center for Earth Sciences, Indian Institute of Science [2].

The above report from CEaS, IISC gives a clear report on how RC Structures, Brick Masonry Structures responded to the earthquake. Below are some pictures from their report. This helps to find an alternate approach to Base Isolation methods.

Figure 1 "The Photograph shows how a row of buildings are fell against each other, P.C: Matthew Wood".

Figure 2 : “This building shows how it damaged the adjacent building due to earthquake, P.C: Matthew Wood.”

Figure 3 This picture show how the whole Street was damaged due to earthquake 7.8 magnitude PC: Friends service Council Nepal

Learning from the September 7, 2017, Chiapas, Mexico earthquake:

No one can prevent the earthquakes, but they can take some ideas to minimize the deaths and damage. Many more people might have died in Mexico City this week had the country not invested in an early warning system that rang alarm just before the catastrophic earthquake struck. But some countries like United states, which has been slow to finish a similar system on the west Coast, can learn from Mexico's example.

The Earthquake alarm sensing on September 4, 2017 before few days the daily express can give some of the preplan statement of earthquakes and video forecast of space what they overlook here is with this big 8.0 magnitude and everyone is focused on this big earthquake of course and aftershock here including a 5.7 magnitude but the fact is 4.3 magnitude on the North American crate on a couple of minute after the 8 point struck here to the south this is connected and this also means that we may see a larger seismic activity coming in the North America it is also interesting to not that we had a very deep of 6.1 and that was only if trench and that was one day before it was very deep 470 Kilometers and that one preceded the big a pointer in East Pacific and this was also sort of expected the Philippine Sea plate was very quiet before two days in fact the whole Pacific was way too quiet so this is the big activity that suddenly make people to panic no one should do anything at the moments, Because it's the planetary influence of the electromagnetic between the planets.

Dual Strong earthquakes, has shook-up Mexico on September 2017, Crumpling Buildings are sending the realization of danger for people into the road, and concurrently Massacring hundreds of people who are all helpless to avoidance the amusement. On Sep.7, a magnitude-8.1 earthquake was the most powerful to delivered Mexico in a century related the country, accomplishing the impact of the damage to the southern part, which was nearly to the quake's epicenter off the Pacific Coast. Then, after 5 days the rescuers worked and continued their cleanup and recovery efforts, again the Preliminary magnitude of 7.1 was battered about 100 miles southeast of Mexico City, it caused severe quaking in the capital. It occurred on the anniversary of a quake in 20^{th} century that destroyed as many as 10,000 people in Mexico.

Even through in Might seem Uncommon dual strong earthquakes to deliver a powerful blow to suddenly and sharply, near together within a short duration.

Courtesy – A Report on 2017 Mexico Earthquake by The New York Times [3].

The above report from The New York Times gives a clear report on how RC Structures, Brick Masonry Structures responded to the earthquake. Below are some pictures from their report. This helps to find an alternate approach to Base Isolation methods.

Figure 4 The Photograph shows a row the 4 story Building collapsed due to 8.1 Magnitude.

Figure 5 The Sensacion Hotel, which collapsed after the earthquake in Matias Romero, Oaxaxa. (PC:Victoria Razo/Agence France Presse – Getty Images)

Automatic generation of smart earthquake-resistant building system: Hybrid system of base-isolation and building-connection

In the seismic resistant architecture of building framework, the abstraction of flexibility is becoming expanded more and more important and it's awfully desired to the architecture of building framework securely for a boundary of the class is possible in earthquake landscape motions [21] [22]. This is pervading on the habitual benevolent that earthquake ground motions are awfully ambiguous both in its appearance and property. It arrives consequently ambitious to adumbrate the approaching occurrence accurately in time, scope and appearance [23] [24]. It is also remembered that the acreage of building a structural component (especially the properties of base-isolation systems and passive control systems, etc.) [25]. Are not deterministic and their changes bring miscellaneous adversity in the seismic resistant architecture of building structures in terms of robustness and prolixity [26]. It is code determined in Japan to accomplish into account the changeability of mechanical acreage of isolators and depressant in the architecture of base-isolated buildings and calmly composed buildings. In this design process, the inferior combination of mechanical components of divide and depressant is checked, and all the design conditions are analyzed for this inferior case. although base-isolated buildings are implied to be productive for high-frequency (impulsive) land space motions and base-isolation arrangement was recycled for moderately stiff glorious structures in an ancient level they are not necessarily resistant for enlarge-period ground motions with the distinguishing period of 5–8[27]. It is broadcast that a reverberation of the base-isolated buildings with as long-period ground motions where they ascertained during the 2011 Tohoku (Japan) earthquake. even though, the base-isolation system is recycled(used) latterly even for a moderately very high building especially in Japan and the long-period ground motions with the characteristic period of 5-8s are of excessive interest in the architecture design of base-isolated buildings and incomparable high-rise buildings. On the other side, it is also well analyzing that, even though building structures contain inactive energy expending system should be persuasive for long-duration, long-period ground motion [21]. They are not certainly adequate for around-fault (rather high-frequency) in ground motions. This is because the acquiescent damper systems may not acknowledge adequately to abrupt the loadings [28].

In this, an advanced compensate compensation passive reserved system is considered in which a base-isolated building is combined to another non-base-isolated building (free wall) with oil hindrance. An agnate type of buildings without base-isolation is establish the designed and constructed by Obayashi Corporation in Japan as an apartment house with a car parking tower and buildings combined such composite system is under construction in Tokyo by Obayashi Corporation and Shimizu Corporation. I if the free wall becomes inflexible, the combine damper system harvests a building with dampers connected directly to the ground [29].

A basic elements investigation was conducted; However, it appears that more accurate and extending very far investigations are required. An automatic generation algorithm of this kind of smart structures of base-isolation and building-connection in the hybrid systems.

Base-isolated building interconnected to outer frame

A base-isolated building and they were connecting with dampers are two representatives of passive controlled buildings (see Figs. 6(a), (b)). A new hybrid passive control system accomplishes with multi-story base-isolated (apartment house), a free wall (car parking tower) and accumulation of anastomotic oil dampers as shown in Fig. 6(c). Oil dampers are usually installed as combined dampers because of their sufficient accomplishment and damping performance. The general earthquake response elements of these buildings under aside-fault and long-duration, long-period ground motions are explained in Fig. 6. While the base-isolated building is accessible to the long-period ground motion and the connected

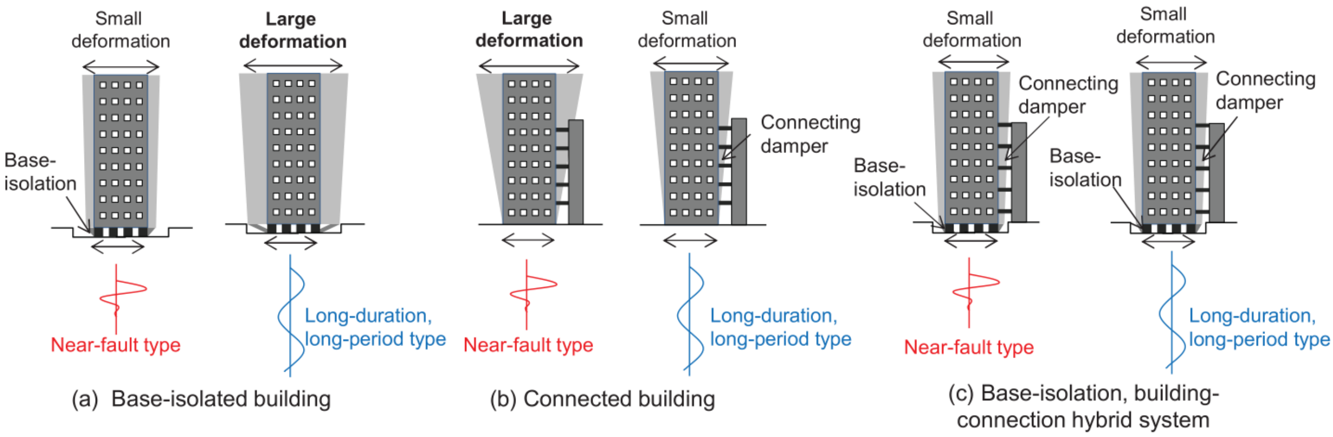


Figure 6 Earthquake response properties under near-fault and long-duration, long-period ground motions: (a) Base-isolated building, (b) Connected building, (c) Base-isolation, building-connection hybrid system.

building is vulnerable to the near-fault ground motion, the building with the proposed hybrid system is effective for both types of ground motions. The hybrid passive control system can resist the near-fault ground motion via the base-isolation mechanism and respond effectively to the long-duration, long-period ground motion via the building connection mechanism. Furthermore, the base-isolation mechanism is quite advantageous for the energy consumption at the connecting dampers in all stories as shown in Fig. 7.

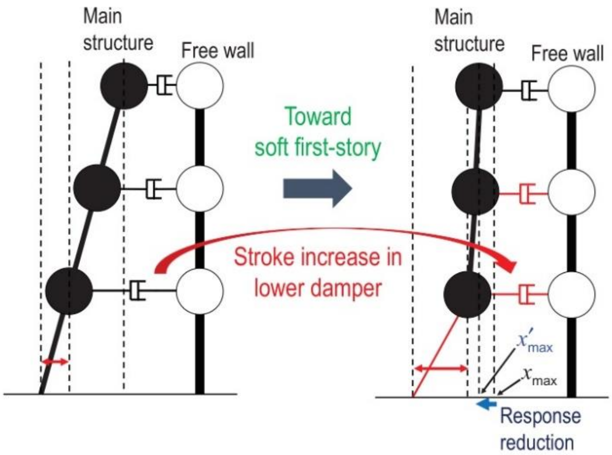


Figure 7 Figure Shows Beneficial Characteristic of base-isolation for the energy consumption at the connecting dampers (x_{max}: top displacement of initial model, x′max: top displacement of hybrid system).

Automatic generation algorithm of hybrid control system

In this section, an automatic generation algorithm should be considered base-isolation and building-connecting hybrid system is conferred. The main purpose of passive control systems is to decrease the acceleration and deformation of the main buildings. Let $y^{DIS}{}_{max}$ and $y^{ACC}{}_{max}$ represent the maximum top-mass displacement relative to the ground and acceleration of the main building and let $y^{DIS}{}_{max}$ and $y^{ACC}{}_{max}$ denote the maximum top-mass displacement and acceleration of the main building for the beginning model. announce the following impartial function in terms of distortion conquest and acceleration reduction indices.

$$f(Y^{DIS}_{max}max, Y^{ACC}_{max}) = a\frac{y^{DIS}_{max}}{Y^{ACC}_{max}(ini)} + b\frac{y^{ACC}_{max}}{Y^{ACC}_{max}(ini)}$$

where a and b are the weighting coefficients.

To obtain a better design with a lesser objective function, a sensitivity- based method is behind. The stiffness of the free wall is constant and only the firmness of the main structure is treated as the design variable. The isolation-story firmness can also be behaving towards as a design variable by concerning this story stiffness as the isolation-story stiffness (insert of the isolation system at any floor is possible). If the gradient-based algorithm is not recycled, the structural designer cannot acquisition directly the most suitable location to decrease the stiffness at the initial stage.

Furthermore, each set of stiffness's of the main structure at each step accomplished by the gradient-based algorithm accommodate the structural designers with valuable information on structural design (the efficient location of stiffness). One of the well-known sensitivity-free methods is GA (genetic algorithm). When GA is used, a Byzantine setting of GA specification is essential, and this process may be embarrassing for most of the structural designers.

The algorithm of the proposed method is very simple and can be summarized as follows.

1. Model the connecting building system into N-story clip buildings with connecting dampers

2. Consider N candidates with an inconsiderably compressed story stiffness in only one adventure.

3. Compute the acknowledgment of the above N candidates below a design ground motion and evaluate the objective function in terms of top acceleration and top displacement

4. acquisition of the design with the shortest objective function among the above N candidates (the stiffness reduction is alternatively applied to each floor)

5. If the minimal story stiffness is agreement a determined smaller constraint, stop the procedure.

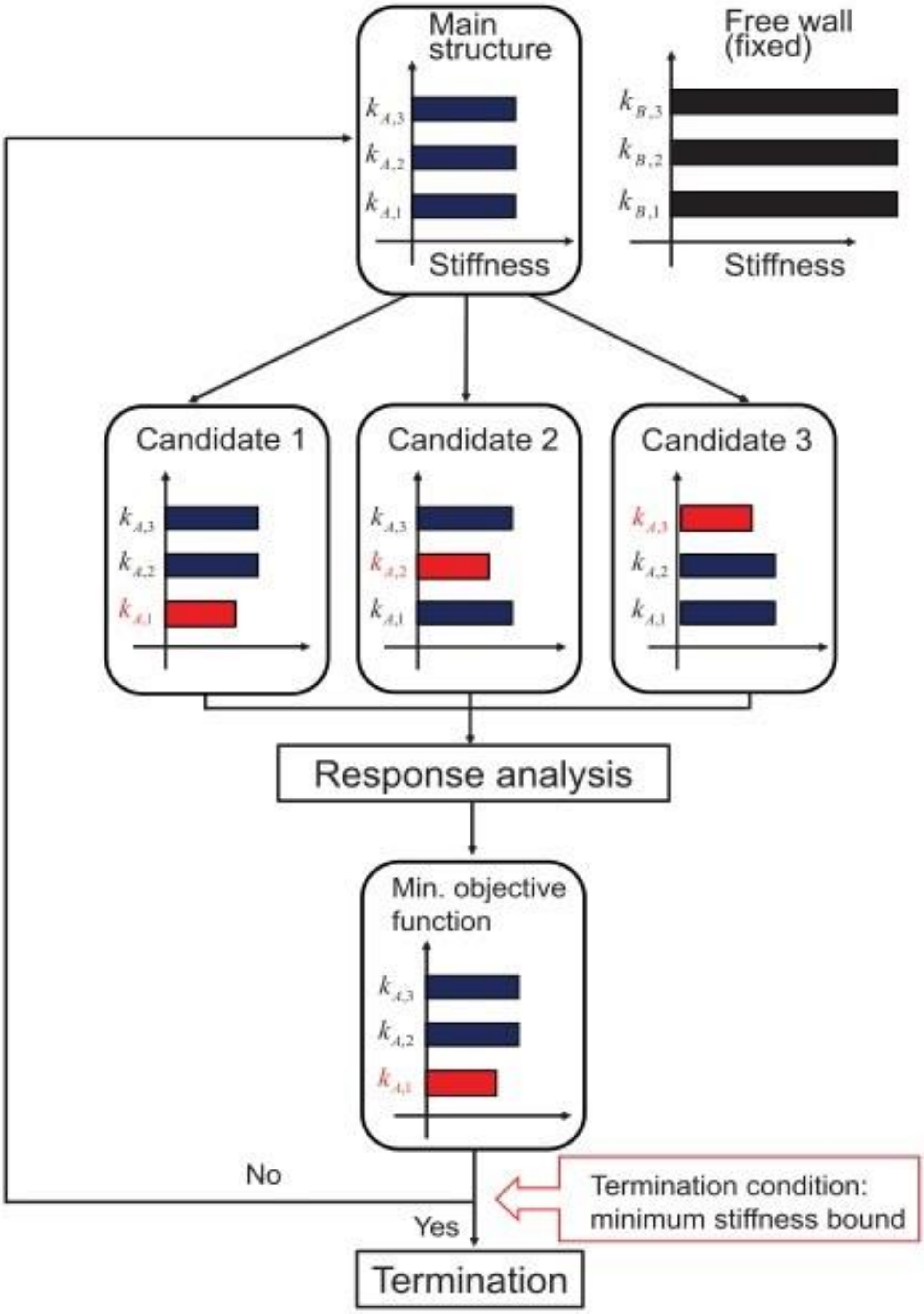


Figure 8 The Schematic Diagram of automatic generation algorithm of smart hybrid system.

Examples:

1. Earthquake Ground motions.
2. Hybrid Building System.
3. Application of Sensitivity-based algorithm to non-connecting building.
4. Energy response to artificial high-frequency ground motion.
5. Overall assessment of proposed hybrid system opposite to single-mechanism models via transfer function.

Earthquake Ground motions

The general properties of this hybrid system under near-fault (rather high-frequency) and long-duration, Earthquake motion occurs in a variety of periods. Some earthquakes rumble harshly, and some sway gently. Gentle swaying over relatively long periods is referred to as long-period earthquake ground motion. This kind of motion is amplified by depositional plains such as those our cities are build on. The period depends on how much soft ground has accumulated. A thin layer of soft ground means short-period motion; long-period motion is more likely to occur if this layer is thick. Ultra-tall high-rise buildings don't handle this motion very well. The high-rise buildings range from 60m right up to 200m or more, experiments have concentrated on shaking the frame of relatively common high-rise buildings measuring around 80m or so. The 21st floor upward of this ultra-tall high-rise building is beginning to resonate. The swaying gradually gets larger and larger, reaching the level where the cupboards are fall down. Unlike regular earthquakes, this swaying continues for several minutes and has the potential to cause serious causalities. The purpose of mounting a damper is for it to absorb seismic energy in place of the building frame. The frame is susceptible to damage or failure due to deformation, but the mounting a damper reduces the period to two thirds of its original amplitude.

Firstly, we need to understand that Ultra-tall high-rise buildings really do sway quiet dramatically. Everything inside these buildings needs to be securely fastened. And there is some time after the building starts swaying before it begins resonating. So, it's also possible effectively evacuate before the swaying becomes violent. Heightened everyday awareness can go a long way to increasing safely.

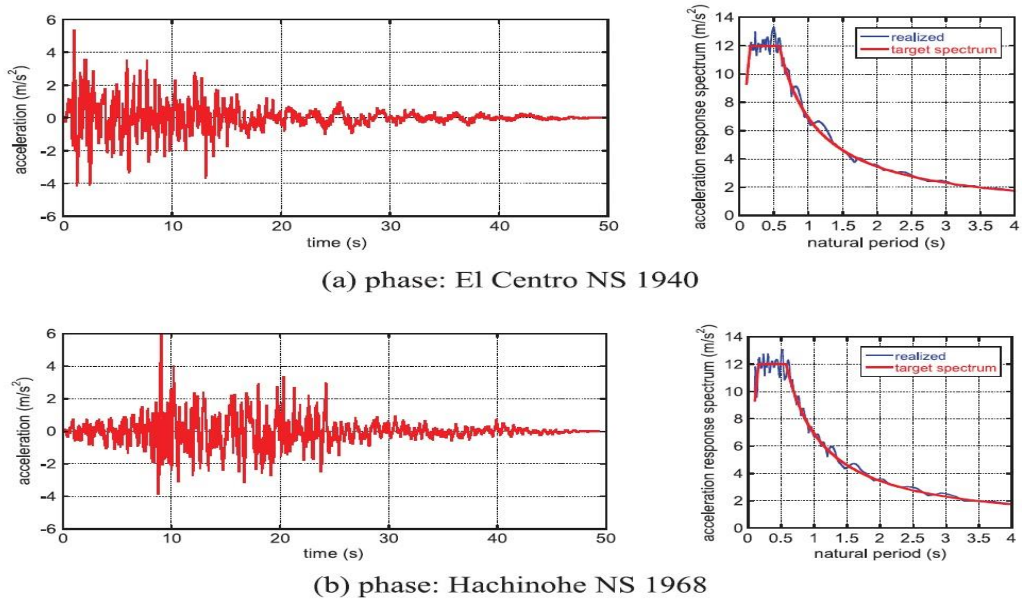


Figure 9 This Graph shows the of ground motions “Source: Heliyon.2016 by Elsevier Ltd.,”

Conclusions

The following conclusions have been derived.

(1) An automatic generation algorithm of the considered acute base-isolation and building-connection hybrid system has been advanced.

(2) It has been authenticated that, once an objective function in terms of top displacement and top acceleration under a design ground motion is introduced and a sensitivity-based algorithm is conceived, a smart hybrid system consisting of a base-isolation system and a building connection system can be generated automatically.

(3) While the proposed algorithm does not work well in a building without the connecting-damper system, it works well in the proposed smart hybrid system with the connecting damper system. The smart hybrid system has a soft initial-story mechanism and the mechanism denotes that the automatic introduction of the base-isolation system is possible and aspire to in the main structure from the viewpoint of performance upgrade.

(4) It has been made clear from the energy analysis that the advanced smart hybrid system makes the connecting damper at every floor level effective [31].

PATENT US 8777519 B1 - METHODS AND APPARATUS OF BUILDING CONSTRUCTION RESISTING EARTHQUAKE AND FLOOD DAMAGE

ABSTRACT

A three-part foundation system for supporting a building is described. Three-part foundation systems can include a containment vessel, which constrains a buffer medium to an area above the containment vessel, and a construction platform. A building can be built on the construction platform. In an embodiment, during operation, the construction platform and structures built on the construction platform can float on the buffer medium. In an earthquake, a construction platform floating on a buffer medium may experience greatly reduced shear forces. In a flood, a construction platform floating on a buffer medium can be configured to rise as water levels rise to limit flood damage [1].

The above Patent is the first of a Building with floating foundation. The proposed idea in my Project differs significantly and tries different ideas on Magnetic Levitation. A Magnetically Levitating Basement is not technically a Base Isolation technique but rather a Base Separation technique. The above Patent gives the idea of what a floating Base means.

"MATERIAL INNOVATIONS: Transparent, lightweight, malleable & responsive" – Filiz Klassen, Associate Professor, Ryerson University, Ontario, Canada.

"***Lightweights***

…………..Physical qualities of lightweight structures on the other hand tend to concentrate on structural ingenuity and better technical performance of structural members by use of lighter material substances or structural compositions……."

The paper by Prof. Filiz Klassen discusses the lightweight materials as an alternate to Reinforced Concrete constructions. This paper helped to propose floating foundation for houses built using such light weight compact construction materials. Apart from the magnetically levitating base, the project also uses Piezoelectric Tiles, a concept based on PAVEGEN© Technology developed in London, UK [4].

"*What if every step you took created power for the future? Pavegen is dedicated to shifting how we think about energy by using smart flooring surfaces that capture energy, collect data and curate information to transform how we relate to our future cities. One step at a time.*" – PAVEGEN© [5].

This entry was posted on November 13, 2014 by Apex Magnets.

The largest magnet on Earth is, in fact, the Earth. Our planet acts like one big bar magnet, with a magnetic north and south pole. However, it is not the strongest one on the planet [6]. The most powerful, non-destructive magnet resides in New Mexico and was made by humans. In 2012, researchers at the Los Alamos Laboratory in New Mexico built one that could generate a record-setting magnetic field of 100 Tesla, a unit used to measure magnetic field strength.

To put that in perspective, the huge lifting magnets that swing cars around like they are mere toys are only around 2 Tesla. The magnet created by the researchers at Los Alamos National Laboratory in New Mexico clocks in at 100 Tesla—a magnetic force that is 2 million times stronger than Earth’s magnetic field. The magnetic energy is so intense that it even emits a shrieking sound when turned on. Because it is so powerful though, it can only be turned on for a few seconds, then it must be turned off.

The magnet isn’t necessarily the strongest that has ever been created either. However, it is the first that does not involve destruction or explosions in the process. With magnetic fields that strong, even the magnet needs help managing the strength of them [6]. Before, powerful man-made magnetic fields were generated by using some form of explosives to compress the field inside the magnet as it pulsed. Using this method, researchers could reach measurements as high as 1,000 Tesla, but only for a few microseconds. With the 100 Tesla magnet, researchers can use it again and again.

So, what’s the point of creating a super powerful magnet beside the fact that it sounds cool? The man-made magnet is a valuable resource in furthering research on superconductors, quantum behaviors, and several another magnetic phenomenon [6].

1.4. OBJECTIVE OF THE PROJECT

The project's objectives are as follows:

i.) To design an effective earthquake cum flood resistant structure using magnetic levitation,

ii.) To create a model of the structure based on the proposed plan,

iii.) To test the Earthquake induced vibrations of the created model

iv.) To analyze the feasibility of the proposed design

CHAPTER 2

2. RESEARCH METHODOLOGY

The methodology part involves the plan and design of the magnetically levitating house and the science involved it, calculation of the Earthquake-induced vibration on the designed model. Since the structure is designed to counter earthquake vibrations and flood effect, it is proposed to have the house not hovering in mid-air all the time but instead, to levitate at the time of calamity. Earthquake and Flooding are two entirely different natural calamities. However, in both the cases, as long as the house is on the ground, then it is affected. Having said that, it is to be noted that the duration of levitation will change in both the cases once the calamity strikes. An earthquake is usually momentary and requires levitation from few minutes to few hours. In case of flooding, the duration of levitation may exceed. Additional supports need to be incorporated in such cases.

For this project, normal magnets have been taken to create the model, but the proposal is for a superconducting electromagnet.

PROPOSED MAGLEV STRUCTURE

Science Involved:

Magnetic levitation works on the idea of repulsion of like poles and attraction of unlike poles. In this case, the magnetic levitation is achievable through repulsion of same poles. As mentioned earlier, magnetization is achieved by passing electricity. The concept is called Magnetic Field Architecture, which is based on Lenz’s law. However, there are certain restrictions or limitations of the Lenz’s law. Also, not all materials can exhibit this tendency. The longer same poles have repelled each other, the sooner is the chance of polar reversal. This occurs when the motion of the magnet is arrested on its axis. Usually, though repulsion is observed, the magnetic face tilts to the opposite pole to attract each other during such induced levitation. Usually, Circular magnets with a central hole for arresting the twisting motion levitates without any problem.

One of the added advantages of using electromagnets is that the height of levitation can be controlled through the current supply.

There are different methods used to achieve Magnetic Levitation.

Figure 10 Methods of Magnetic Levitation

2.1. CONSTRUCTION TECHNOLOGY

Construction Conditions of the Building:

There are certain conditions that involve in construction of buildings with magnetically levitation. They are as follows,

1. Only compact lightweight building materials should be used in this construction,
2. During levitation, the external electricity lines to the house will be disconnected, however, electricity through solar panels on roofs can offer power,
3. Lightly weighted furniture is to be used in these buildings.

Figure 11 Example compact light weight buildings “EPS Panels, Geodesic Dome Structure in Pinterest”

2.1.1. Light Weight Construction Materials

Since the project proposes a Magnetic Levitating foundation or a non-contact base separation technique, Construction of building using lightweight materials as an alternate to Reinforced Concrete Structures are proposed. In the following pages, some of the promising alternative materials are listed with their pros and cons.

a.) Structural Insulated Panels (SIPs)

What They Are:

Fiberglass panels are made from insulating foam sandwiched between 2 layers of fundamental material.

- **Advantages:**

Walls can be erected easily, usually within hours, compared with about two weeks for classic stick (lumber) framing. The panels are lightweight and are previously filled with insulation when they enter on the site. For the insulation is connected in a controlled environment and is calculated to fit accurately, the house is likely to be more airtight than a commonly built home -- an energy-efficiency plus.

- **Disadvantages:**

This method is about 10% more costly than stick building. And a builder wants to be well skilled in the process to make sure the panels fit together accurately.

b.) Engineered Wood

What It Is:

To form large, solid planks and beams by glued the thin layers of wood together, then micro cured.

- **Advantages:**
  The method offers more dimensional stability than conventional lumber.
- **Disadvantages:** It costs 5 -- 10% more than stick building and early engineered-wood products raised concerns because of out-gassing problems. However, the microwave curing has essentially eliminated those [8].

2.2. MATERIAL USED FOR THIS CONSTRUCTION

EPS PANELS FOR WALLS AND ROOF

What It Is:

In Finally a Revolution in Construction the latest innovation after The Wood, Iron, Concrete comes a fourth-Generation Building Materials Expanded Polystyrene approved by Japanese Ministry of Land and Transport. Introducing a new Habitat for the 21st Century the polystyrene Material Houses in the shape of Dome, Long Dome and Connecting Dome house. The first in the history of construction A Revolutionary new building material [10].

Figure 12 It Show the Raw Beads of Eps & Expanded Beads “Insulation Corporation of America”

Cost-effective & Energy Efficient

MSIP - metal sleeve structural insulated panels for constructing frameless buildings. For create an airtight structure the metal sleeves are fit into each other tongue-and-groove style and it is a self-load bearing structure. It strengthens the overall rigidity by the panel sleeves with an insulating core in the inside and which works as a web and strengthens the overall rigidity.

When compared to traditional method of wood-frame, concrete-block, steel-frame or other masonry construction it is little high in cost, but the value of high insulation, durability and minimal maintenance provides exceptional value for money, both initially and over the 50 years plus guaranteed life of the construction, from saved heating costs [11].

Heating and Cooling Cost Savings

Studies prove that up to 75% of a traditional building's thermal energy is lost through framing members (Heat Bridges). The frameless construction does not provide a conductive path for thermal energy, which results in substantially higher overall thermal insulation values than other forms of construction [11].

This Panel gives practical thermal insulation than the traditional building construction, thus drastically decrease the heating & cooling costs. It reduces cost of 10-40% HVAC and it supports LEED Green certification. This EPS panel's insulation core requires no additional insulating materials or vapor barriers. Even in the most extreme climates - hot, cold, windy, or wet.

Waterproof & Durable

- The core is tightly bound and water impermeable inside the wall, roof and floor assemblies; ideal for flood-prone regions and coastal homes where moisture is a problem.
- The average water absorption rate by volume is less than 0.7%, meaning the panels are essentially "waterproof". Water penetration through the 4" thick panel is zero [11].
- Even when left bare (unfinished), the standard surfaces resist acids, bases, moisture and all other sources of corrosion [11].

Mold and Mildew Resistant

Eps panels create an airtight and water impermeable bond that virtually eliminates the mold and mildew that can destroy a home or business in particularly humid and flood-prone regions, this construction may also reduce insurance costs and sick days associated with mold growth [11].

Dramatically Lowers Construction Costs

By using this pre-designed structure can be assembled as a building in a days, (not a months) slashing labor costs. Besides the competitive component price, & substantial savings in labor and construction time, further reducing total costs. Unlike traditional construction, this building is erected without wood studs, heavy metal frames and/or concrete blocks, by small, quickly trained crews in far less time than other forms of construction.

It is easy to move into a required place for construction because of this lightweight capacity. For example, the two- story building can be easily shipped a single truck for that no need of heavy metal and wood frame from loading and unloading because the weight per square meter is not more than 14 kg (3 pounds/square feet). It is easier to transport over highways and to remote areas because of this high-strength lightweight and feature of the panels are great than the traditional building materials. May be delivery of entire buildings through helicopter is most practical for very remote sites.

Combustibility

This EPS panels confirms to ASTM E-84 (Class 1). In addition to providing extra safety to people and assets, this feature makes the building material ideal for arid or remote areas with limited water supply.

Builder Friendly & Corrosion Resistant

- Dramatically faster and lower construction costs mean lower labour, site insurance, equipment rental and shipping costs.
- Energy efficient, durable and low maintenance, means lower HVAC and insurance costs for owner/occupants or increased bottom line profit for landlords.
- These material surfaces are Acid, Base & solvent resistant.

Virtually Soundproof

This Eps is virtually soundproof environment, even when used in the noisiest industrial and urban environments [11].

2.3. TYPES OF CONSTRUCTION

This Building is constructed in Two Different ways there are:

1. On Site Construction (For Large Building)
2. Off-Site Construction (Modular Construction)

On Site Construction (For Large Building)

For the construction, I took expended polystyrene because of this advantages in mainly this low weight properties and low-cost material. This Eps is available in numerous sizes according to the customer wishes and demand, Insulation Corporation of America give some standard details about the EPS, by absorbing those details let confirm the Eps is not only for insulation by using this material we can easily construct the wall for the building too. So, for Long panel construction wall, we can arrange the panel in the place of construction by using on-site construction methods.

Steps Involved:

a. Clean the site, as per plan first construct the Base slab which is rest on the ground, before that pore 50mm thickness of sand for uniformity and to minimize the resistance of foundation bed, construct a 150mm thk of PCC Slab Bed on the Ground.
b. Mark the place of Magnet to Fix, make a Border for fixing the Magnet on the ground, then fix the magnet with careful in poles of the magnet are placing.
c. Holding the magnet which gives repel force on the top of base magnet foundation and places the Flat slab on the top of the magnets.
d. Now start the construction of the EPS wall panel on the top of the flat slab and finish it.
e. After that Constructs a Building as per requirement on the base slab & fix Rubber columns for arresting the magnetic Gyration in a single axis preventing Sliding or Toppling.
f. Finally, remove the scaffolding from the bottom of the slab.
g. Now the Building is Floated on the Mid-Air.

Off-Site Construction (Modular Construction)

What It Is:

Homes are constructed in a factory, then drop and taken to the home site and it can be erected by using cranes. Though mobile homes are most often join with this type of construction, the market has developed to include homes that very closely rearrange conventionally built structures [20]. It is easier to transport over highways and to remote areas because of this high-strength lightweight and feature of the panels are great than the traditional building materials. May be delivery of entire buildings through helicopter is most practical for very remote sites [11].

Figure 13 It Show the Erection of Building Part by part by using Crane "Source: Containex.co.uk, Modular Building"

Steps Involved

a. Clean the site, as per plan first construct the Base slab which is rest on the ground, before that pore 50mm thickness of sand for uniformity and to minimize the resistance of foundation bed, construct a 150mm thk of PCC Slab Bed on the Ground.
b. Mark the place of Magnet to Fix, make a Border for fixing the Magnet on the ground, then fix the magnet with careful in poles of the magnet are placing.
c. Holding the magnet which gives repel force on the top of base magnet foundation and places the Flat slab on the top of the magnets.
d. Now with the help of Cranes directly place the home structure on the top of the flat slab shown in the figure.
e. After that Constructs a Building as per requirement on the base slab & fix Rubber columns for arresting the magnetic Gyration in a single axis preventing Sliding or Toppling.
f. Finally, remove the scaffolding from the bottom of the slab.
g. Now the Building is Floated on the Mid-Air.

Advantages:

By this method the homes are transported through Vehicle, then it is easy to erect within a hours by using cranes. Now a day the modular homes designed the staircase, beams and ceilings with different kind of styles according to the Customers requirements. At the same time the materials which is used for building is also Eco-Friendly.

2.3.1. Smart Sensors

The application of smart sensors at buildings can be broadly classified as

Figure 14 Image Shows the types of Sensors can be used in construction

Intelligent sensors are an appliance that takes the source from the real habitat from house door open by mobile access, and smart lock helps to keep safe our home and it is connected with security alarm and wireless lighting control system, automatic curtain system to make linkage effect when the daylight is strong the lights get darker or closed. The blind window adjusts its blade angle closes by itself. The smart Environment Sensors used for knowing the environment and to know the natural calamities like earthquake, cyclone and flood. Automatic water alarm system is used for trun on and off the water automatically according to the usage. These components can be including transducers, amplifiers, excitation control, analog filters, and compensation. An Intelligent sensor also incorporates software-defined elements that provide functions such as data conversion, digital processing, and communication to outer devices [7].

2.4. PROPOSED STRUCTURE

Foundation for the Building

The Plan for the building depends upon the Owner's requirement. This project on theoretical basis proposes of a residential building. Since the buildings are designed with lightweight materials, compact modern houses are suggested. With the growing population and limited land area, such compact houses become the need of the hour. The foundation can be laid in different approaches as mentioned in the earlier chapter for achieving Magnetic Levitation.

Using Ordinary Powerful Magnets as Footing with a Rubber Column to arrest the upper floating magnet from sliding or toppling

In this method, the Magnetic Levitation is achieved through Mechanical constrain or Pseudo-Levitation. A Base floor with a lightweight material is supported by supporting frames and can rest on a similar like poled Magnet to that of the footing magnet is placed over the rubber footing column. This type of Magnetic levitation makes the building to hover over the supported Rubber Columns. To reduce the friction from the magnet from sliding over the rubber column, friction resistant hydraulic oil may be used. Apart from the corner and edge placed magnetically levitating Footings, magnets are laid on the ground and a similar like poled magnet facing the ground magnets are attached to the base floor. Because like poles repel each other, these magnets though are not connected by rubber columns are restrained because they are fixed and cause a pseudo levitation to happen. These unsupported repelling magnets are used to evenly support the Dead and Live load to the magnetically levitating footings at corners and edges. Thus, the entire load (D.L + L.L) rests on the Magnetic repelling force causing levitation.

What happens when earthquake strikes?

When the earthquake strikes, the earthquake load causes the Rubber footing column to sway, which in turn moves the hovering magnetic base of the Base floor to sway. Since the building is not connected to the ground, the damage of the earthquake is much reduced. The basement is dynamically isolated with a heavyweight rubber column which is placed in the center of two electromagnets. The bottom magnet is connected to the ground and the top magnet below the floor level of the building. At normal time, these are placed over each other through the rubber column connecting them to the center. While the top electromagnet is per se not connected to current, the bottom magnet is connected. In case superconducting magnets are used, it must be ensured that coolant liquid covers the column area as they tend to get heated up through levitation for a longer time. The bottom magnet's power supply is triggered both manually and using an Earthquake vibration sensor. The manual operation is aimed at times of flooding. As for the design of the proposed model for testing, the magnets are placed as shown in the plan below. The modeling is done based on Law of Similitude.

Figure 15 Image Shows the base Isolation of Building "Source: Civil Digital.com"

2.4.1. Vibrations Calculation

The testing is carried out using Shaking Table Apparatus. The shake table simulates a seismic vibration. This table which is connected to a computer can also be used to imitate a real-time "worst case" earthquake activity to the model. For the purpose of testing, a Schierle Shake Table was used. This is a single degree of motion shake table, i.e., the table moves only in one lateral direction.

The shake table includes,

- Steel frame
- A Computer
- Suspended aluminum shaker platform
- APS systems Electro-seis 113 shaker component
- Digital/analog converter
- Amplifier component (Model 114)

An electronic input is given using a digital-analog converter, which is attached to the computer. The amplifier takes +/- 2 volts from a digital/analog converter and amplifies the voltage up to a maximum of 220 volts. Using LabVIEW 8.0, data is fed, and the output voltage is controlled, simulating an actual earthquake waveform. This software provides examples, one of which was used to run a sine wave-induced vibration. The Front panel and block Diagram are the two components of controlling software.

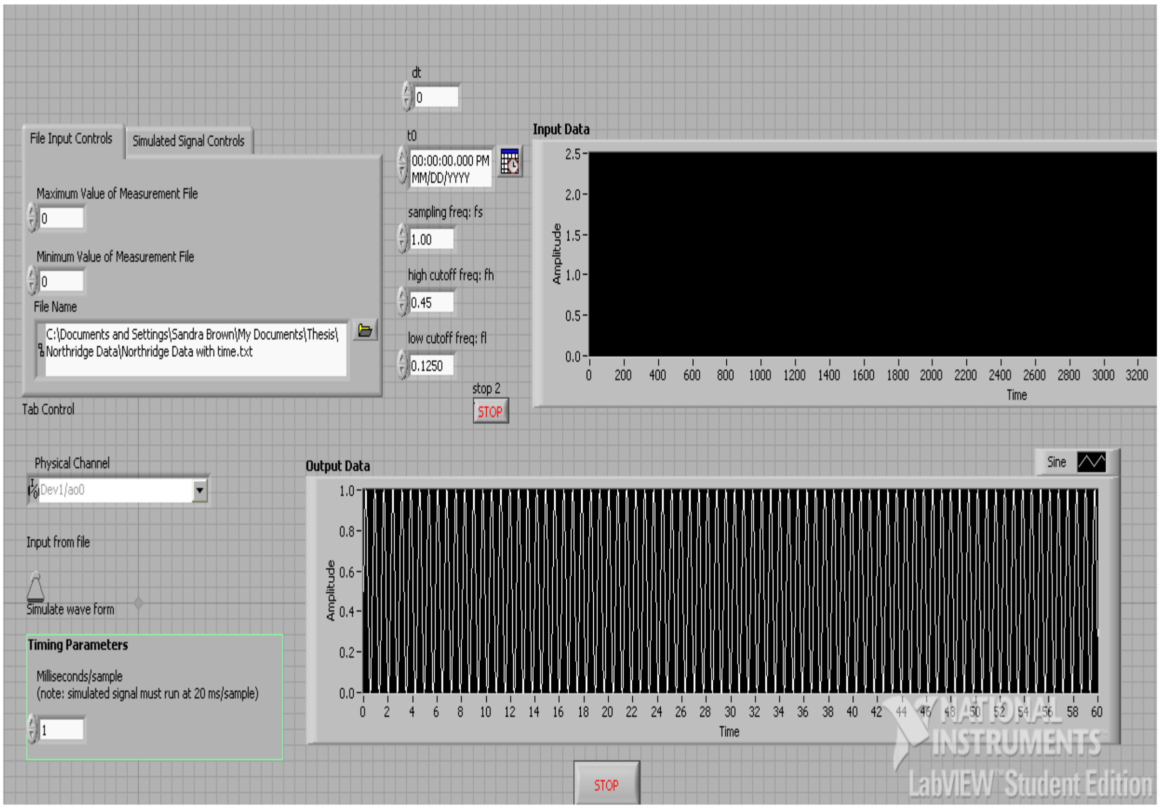


Figure 16 Image Shows the Block Diagram of Earthquake waveform

The Front page permits the user to alter the constraints of the test. The block diagram is instructing the computer and the DAC. A signal is specified and sent to the DAC. The signal is scaled so that it will run on the shake table. The amplitude of the signal going to the shake table is shown in the Output Graph. After the shake table induces the vibration, the amplitude of the sent back signal through the accelerometer is observed on the Input Graph. See Appendix for a printout of the block diagram. It should be noted that the testing was carried out only on the single degree of motion. In case of a real-time earthquake, vibrations of motions are in three degrees, i.e. building moves in all three directions.

Although the computer calculates the frequency of the vibration, other data such as the dimension of the model was noted.

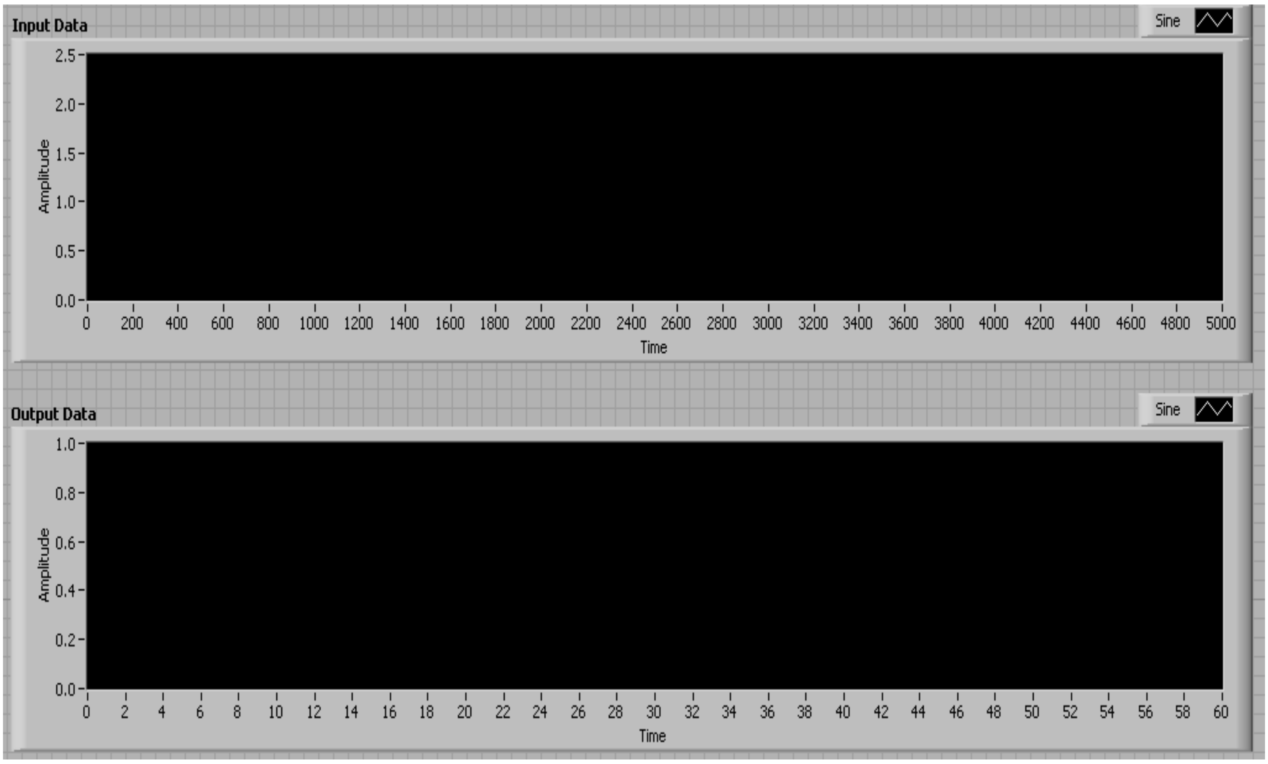


Figure 17 Image Shows the Frequency of the Vibration Data

The materials used in the model are as follows,

2.5. MATERIALS USED FOR PROTOTYPE BUILDING

Figure 18 Image Shows the Various of materials used for Prototype Model

Prototype Model of the building with Earthquake Resistant Magnetic Floating Building Picture is attached in Annexes.

2.6. EARTHQUAKE RESISTANT DESIGN

The earthquake resistant design utilizes the dynamic base isolation technique combined with magnetic levitation. Rubber Base isolation is one of the recent base isolation technique which has been tested to be an effective earthquake resistant design. Incorporating magnetic levitation to this significantly improves the earthquake resistant design.

Base Isolation Lead Rubbers

The rubber is very flexible horizontally and to an extent rigid vertically. The rigidity is achieved due to the steel shims reinforced thin layers of rubber. This uniqueness makes the isolator to shift laterally with almost no inflexibility, at the same time taking high axial loads. Lead is placed at the bearing's core to provide a damping mechanism. These Rubber isolators usually are very efficient with long-lasting performance and little maintenance. The corner and edge load bearing rubber columns are exposed outwards above the ground. In these Rubber lead columns, the electromagnets are placed on such a way that there is no actual contact between the interior of inner circular hole of the magnets. A lubricated valve is placed between the rubber column and the inner area of the magnet, for the free up and downward motion of the top magnet respective to the ground fixed bottom magnet.

The bottom magnet is connected to an electrical source which can be triggered manually and with earthquake vibration sensor. When the sensor senses the earthquake vibration, it supplies power to the bottom electromagnet. Because of Eddy current production because of Lensz's law, a magnetic field same to that of the top magnet creates a repulsion, making the whole building to levitate. With the rubber column arresting the turning motion of the top magnet on the corner and edges, the building hovers freely. The other magnets under the building aids in the hovering. It should be observed that the inside magnets are placed in a similar way using highly compressed springs in the center of the top and bottom magnets. While the building levitates, the springs release that of the levitation. The most important design feature is that the corner and edge magnets are larger in size and bear loads of the whole building while the interior ones are smaller in size. The height of these corner edge columns protruding above the ground must be at least 2 m in height. The electric power makes a levitation to only a few centimeters.

3. DESIGN THE STRUCTURE & RESULTS

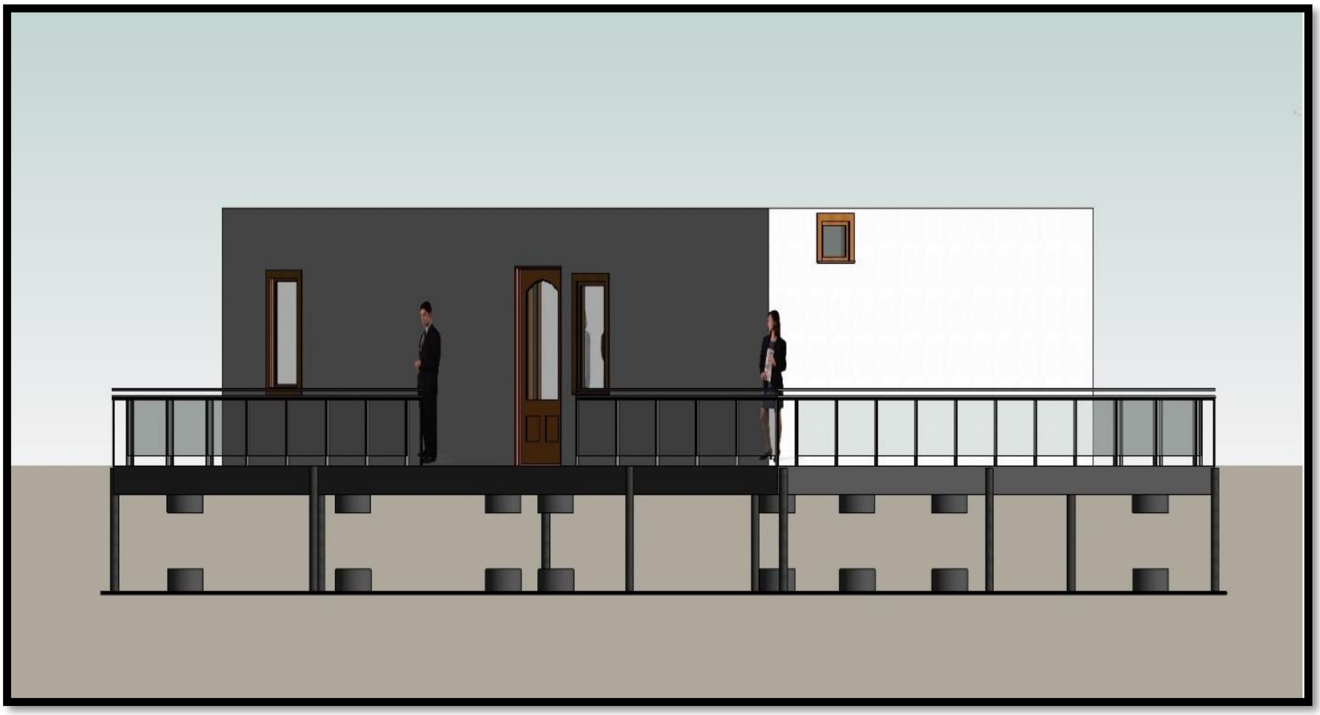


Figure 19 3D View of Proposed Construction Building Front View

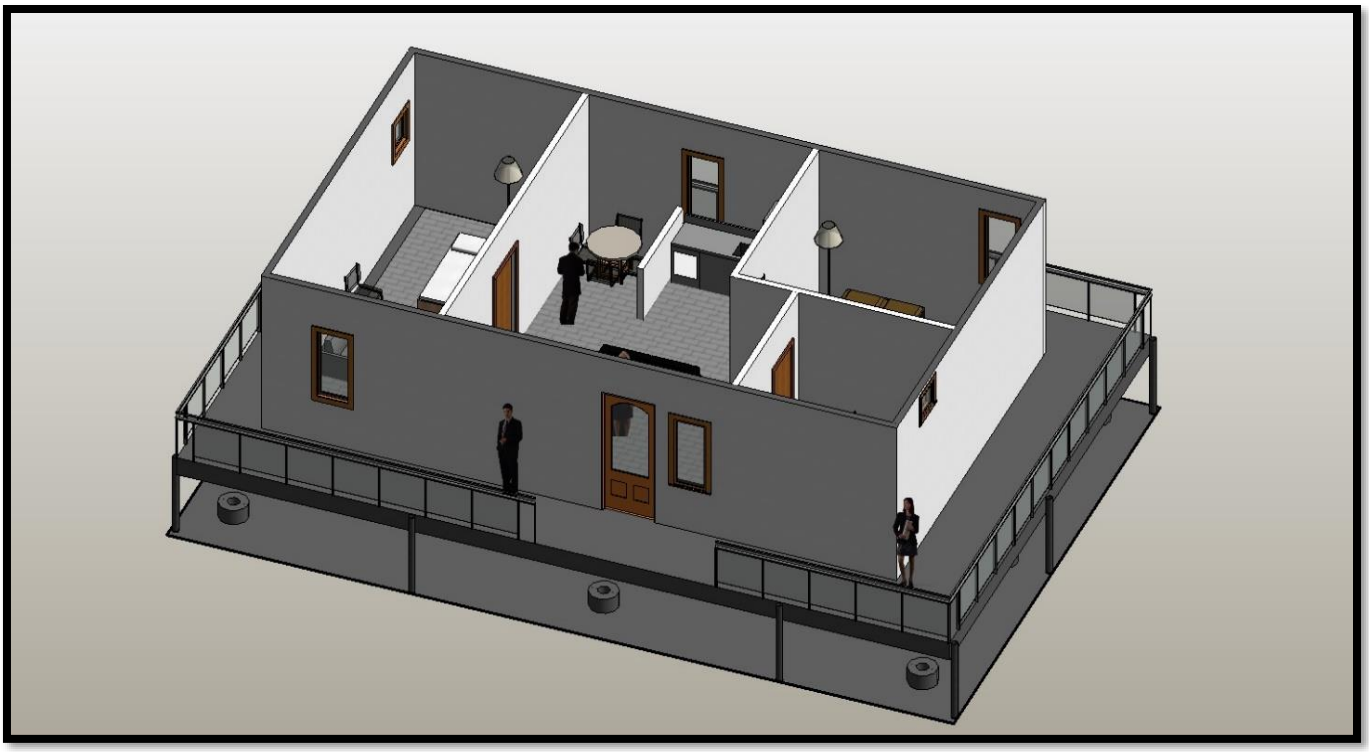


Figure 20 3D View of Proposed Construction Building Top View

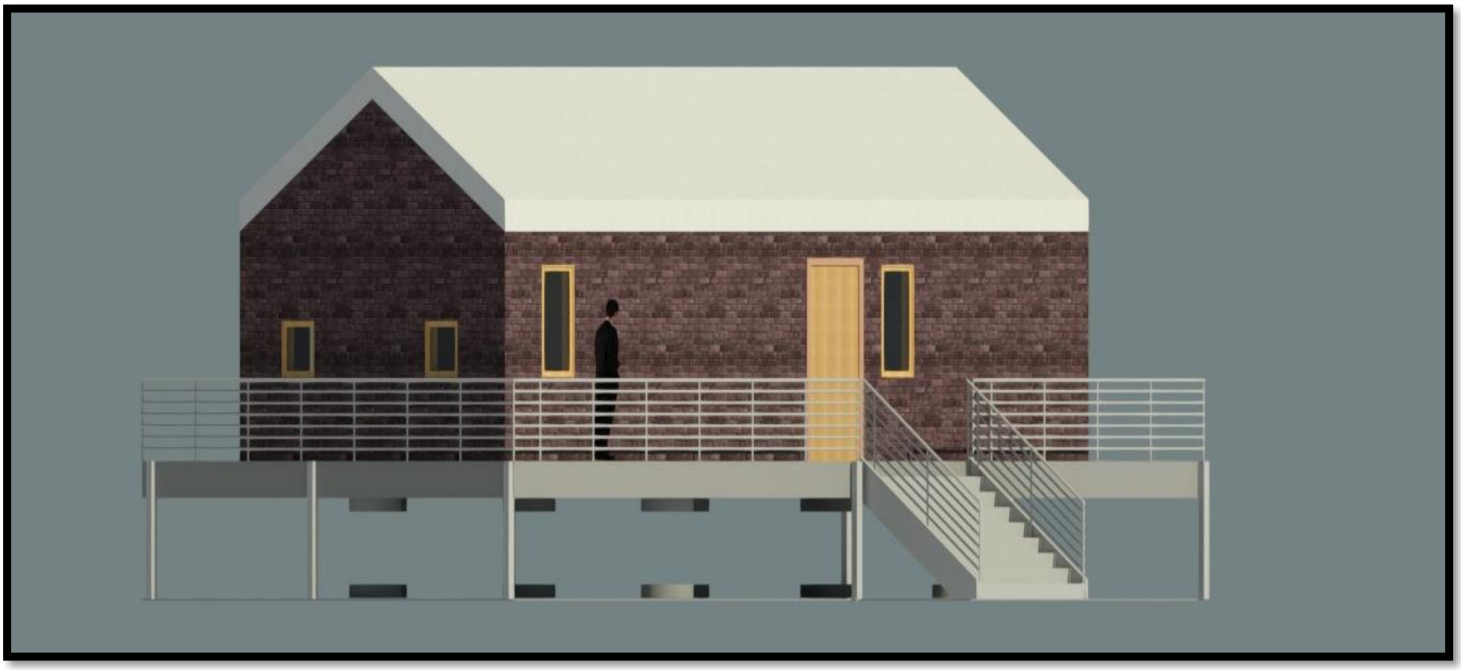


Figure 21 3D View of Proposed Construction Building with Finishing & Finalize model

Figure 22 3D View of Proposed Construction Building Final Model with 3d Rendering Image

Plan Elevation and Section and some of the Specifications is attached in Annexes.

Design of Flat Slab:

a. Data Taken:

Size of the Floor	: 9.14m x 6.707m
Size of Panels	: 3.04m x 3.35m
Live Load	: 2 kN/m^2 (Category A)

"All Assumption Values were taken using Euro Codes" [15].

b. To Find:

Thickness of slab according to IS456:2000 for two-way continuous slab

Since drop is not provided and HYSD bars are used span to thickness ratio shall not exceed (1/0.9x25) = 22.5

Thickness of slab = [span / 22.5] = 3350/22.5 = 148 mm

Provide 150 mm thickness. Let the cover be 30mm

Overall thickness of Slab D = 180mm and d = 150 mm

c. Loads on slab:

Self-Weight of slab	= 0.18 x 18	=	3.24 kN/m^2
Finishing Load		=	1 kN/m^2
Live Load		=	2 kN/m^2
∴ Total Working Load		=	6.24 kN/m^2

Dead Load on slab, the total weight of wall of building

150mm thk wall	=	16.72m^2 x 2	= 33.45m^2
		26.02 m^2 x 2	= 52 m^2
100mm thk wall	=	16.72m^2 x 2	= 33.45m^2
		9.29m^2 x 1	= 9.29m^2

(Weight of EPS Panels Specification Data Collected from Various EPS Production Company and get average of all data's)

Weight of 100 mm thk wall = 12 kg/m^2 = 0.11 kN/m^2

Weight of 150mm thk wall = 12.7 kg/m^2 = 0.12 kN/m^2

The Weight of the panel specification data taken from EPS Panel company [11].

Weight of 150mm wall in total = 85.45m^2 x 0.12 kN/m^2 = 10.25 kN

Weight of 100mm wall in total = 42.74m^2 x 0.11 kN/m^2 = 4.70 kN

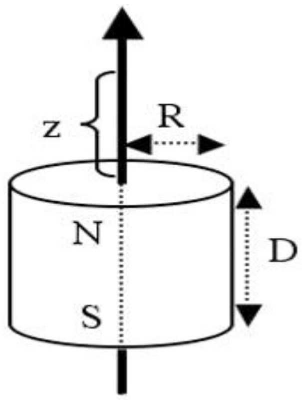
Dead load on Slab = 15 kN x1.5 = 20kN

Factored Load = 1.5 x 6.24 = 9.36 kN/m^2

"All Calculations were made using Indian Standard Codes" [17].

Formula for cylinder magnet flux density

Formula for the cylinder magnet (disc or rod) B field on the symmetry axis of an axially magnetized:



$$B = \frac{B_r}{2}\left(\frac{D + z}{\sqrt{R^2 + (D + z)^2}} - \frac{z}{\sqrt{R^2 + z^2}}\right)$$

B_r: Remanence field, free of the magnet's Calculation

z: Interval from a pole face on the symmetrical axis

D: Height of the cylinder

R: Radius of the cylinder

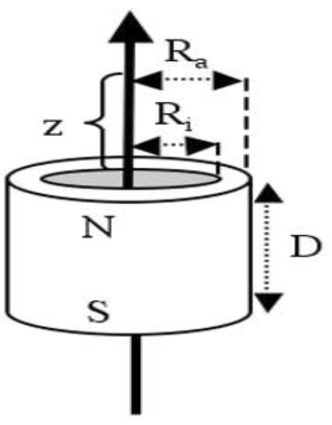
The unit of length can be selected Summarily, if it is the equal for all lengths [9].

Formula for ring magnet flux density

Formula for the B field on the symmetry axis of an axially magnetized ring magnet:

$$B = \frac{B_r}{2}\left[\frac{D + z}{\sqrt{{R_a}^2 + (D + z)^2}} - \frac{z}{\sqrt{{R_a}^2 + z^2}} - \left(\frac{D + z}{\sqrt{{R_i}^2 + (D + z)^2}} - \frac{z}{\sqrt{{R_i}^2 + z^2}}\right)\right]$$

B_r: Remanence field, independent of the magnet's Calculation



z: Interval from a pole face on the symmetry axis

D: Height of the ring

R_a: Outer radius of the ring

R_i: Inner radius of the ring

The unit of length can be selected summarily as long as it is the equal for all lengths.

The formula for ring magnets shows that the B field for a ring magnet is composed of the field of a larger cylinder magnet with the radius R_a minus the field of a smaller cylinder magnet with the radius R_i [9].

Strength of Magnets

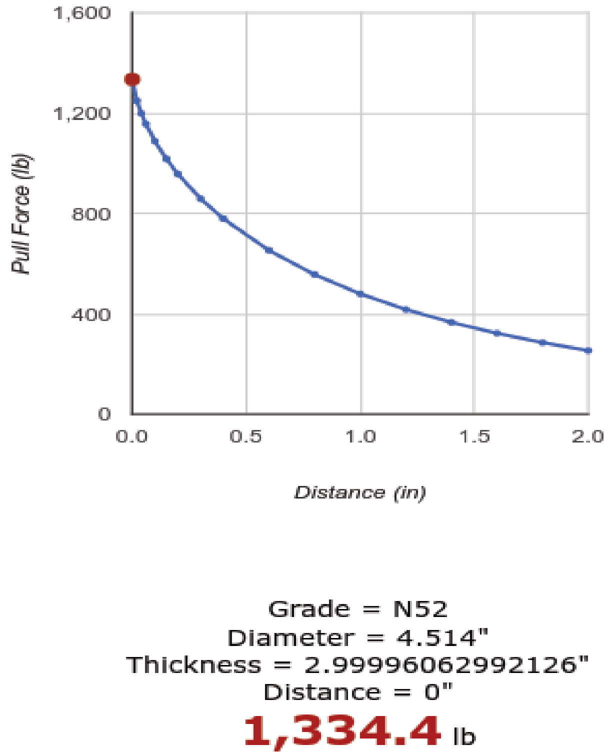


Figure 23 This Graph Show the Repels Power of magnet. "Source: K&J Magnetics"

By Using N52 (Neodymium Magnet) Calculating for Single Magnet Repelling Power of the Magnet was calculated using the application of the K&J Official Calculator and graph above, the repelling power of One Magnet it shows 1334.4lbs = 605.27 kg = **6 kN.**

Result:

The Maximum strength of a Magnet is that it can carry a load of 6 kN. This means it can easily carry the total weight of the building as per design. If we increase the load on the building, then, then appropriate magnets of higher strength can be used.

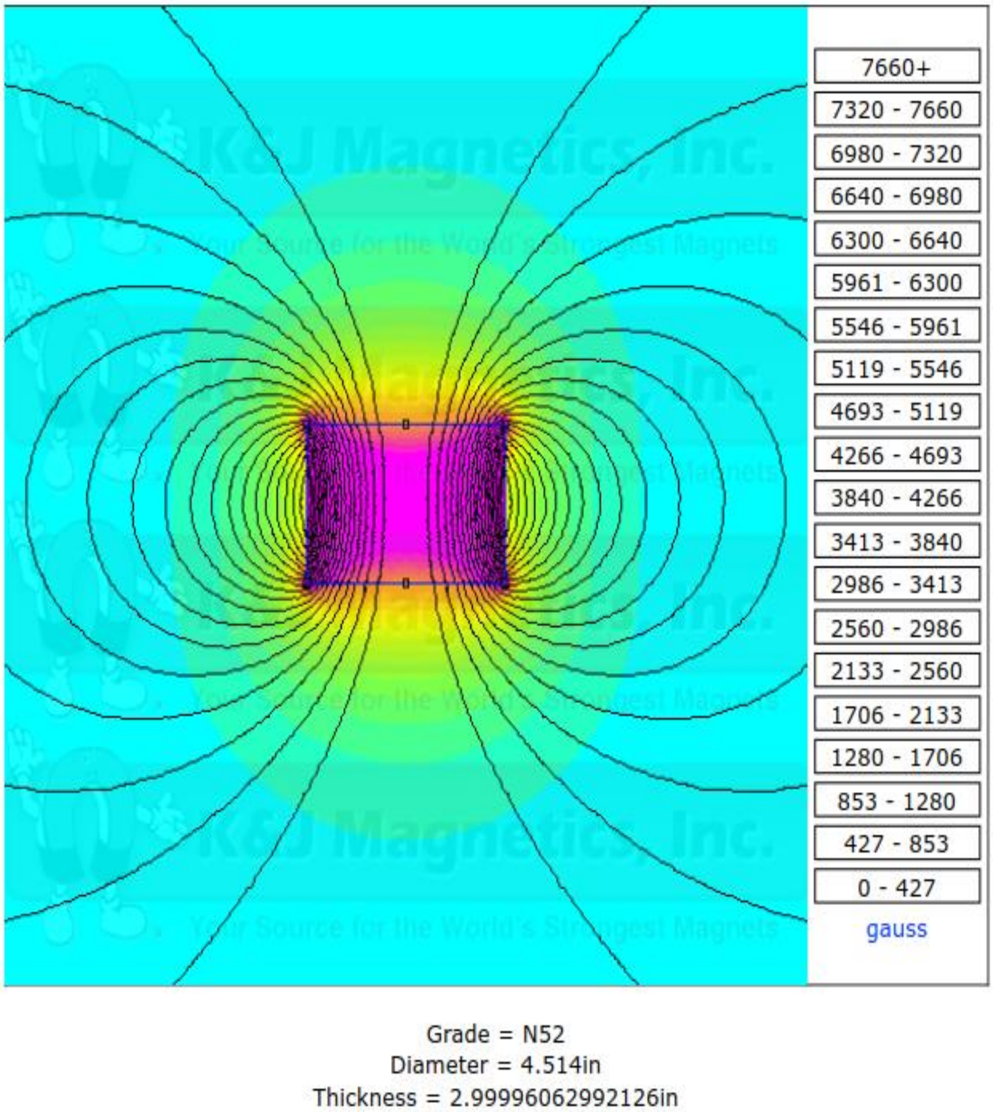


Figure 24 It Shows the Magnetic Field Visualization of Single Magnet in open space. "Source: K&J Magnetics"

3.1. ECONOMIC DIFFERENCE

Traditional Building Rate

In Lithuania House prices rise continuously amidst modest economic growth. And the demand of property is also rising quickly and strongly, not only property the construction of residential building cost also growth suddenly, In Vilnius, the capital state of Lithuania the have risen by 24.4% (11.2% inflation-adjusted) since the post-crisis low of May 2010, in a slow and steady rise.

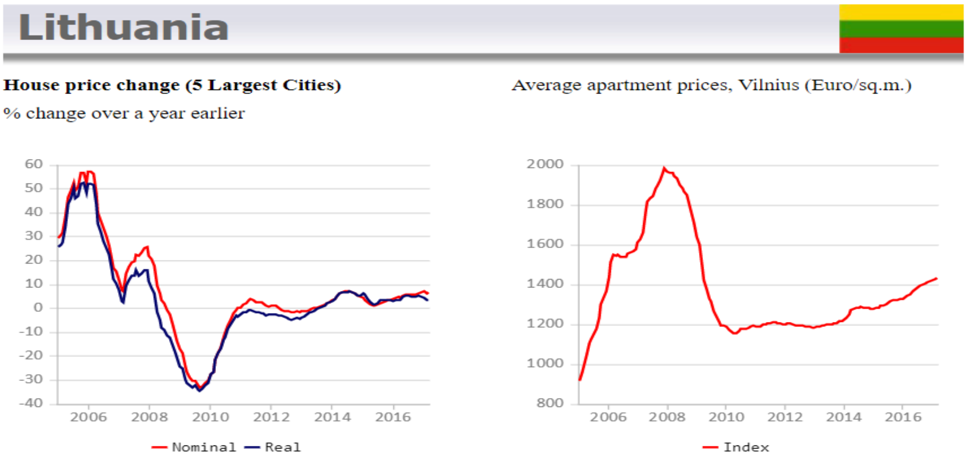


Figure 25 It Shows the house prices in Lithuania. "Source: Ober Haus Real Estate Advisors"

	Q1	**Q2**	**Q3**	**Q4**
2017	1.27			
2016	1.36	2.38	1.67	1.29
2015	0.23	1.17	1.69	0.45
2014	2.71	2.56	0.23	-0.47
2013	0.51	0.59	0.50	1.16
2012	0.17	-0.66	-0.50	-0.42
2011	-0.17	1.43	0.08	-0.58

Table 1 The table shows changes of House price over a year earlier (% change over a Quarter)

The five major cities in Lithuania' the price of apartment index (covering Vilnius, Kaunas, Klaipėda, Šiauliai and Panevėžys) rose by 5.56% during the year to Q1 2017(2.38% inflation-adjusted), according to Real Estate Advisors [12].

All of Lithuania's major cities saw balanced house price rises during the year to end-Q1 2017:

- In **Vilnius** average apartment prices rose by 6.8% y-o-y in 2017 Q1, to €1,435 per square metre (sq. m.).
- In **Kaunas**, apartment prices rose by 4.5%, to €993 per sq. m.
- In **Klaipėda**, apartment prices increased 2.9%, to an average of €1,019 per sq. m
- In **Šiauliai**, apartment prices increased 5.2%, to an average of €601 per sq. m [13].

<u>Magnetic Levitation Building Cost</u>

Cost of Magnet for Basement [14]	=	435 Euro x 20 Nos	= € 8700 /-
Cost of EPS Panel [11]	=	200 Euro x 62 sq.mt	= € 12,400 /-
Cost of P.C.C & Flat Slab [15]	=		€ 500 /-
Miscellaneous & Finishing	=	Approx	= € 6000 /-
Total Cost of Building	=		= € 28,000 /-

(Twenty-Eight Thousand Euros Only for 62 sq.mt)

Cost Variance Between Traditional and Floating Building

Description	Rate Per Square meter €	Building constructed area	Sub-Structure Cost (Approx.) in €	Super - Structure Cost (Approx.) in €	Interior & Maintenance cost (Approx.) in €
Traditional Construction in Lithuania	993	63	11500	51000	3100
Magnet Floating Building	445	63	15000	13000	600

Table 2 Cost Variance Between Traditional and floating Building

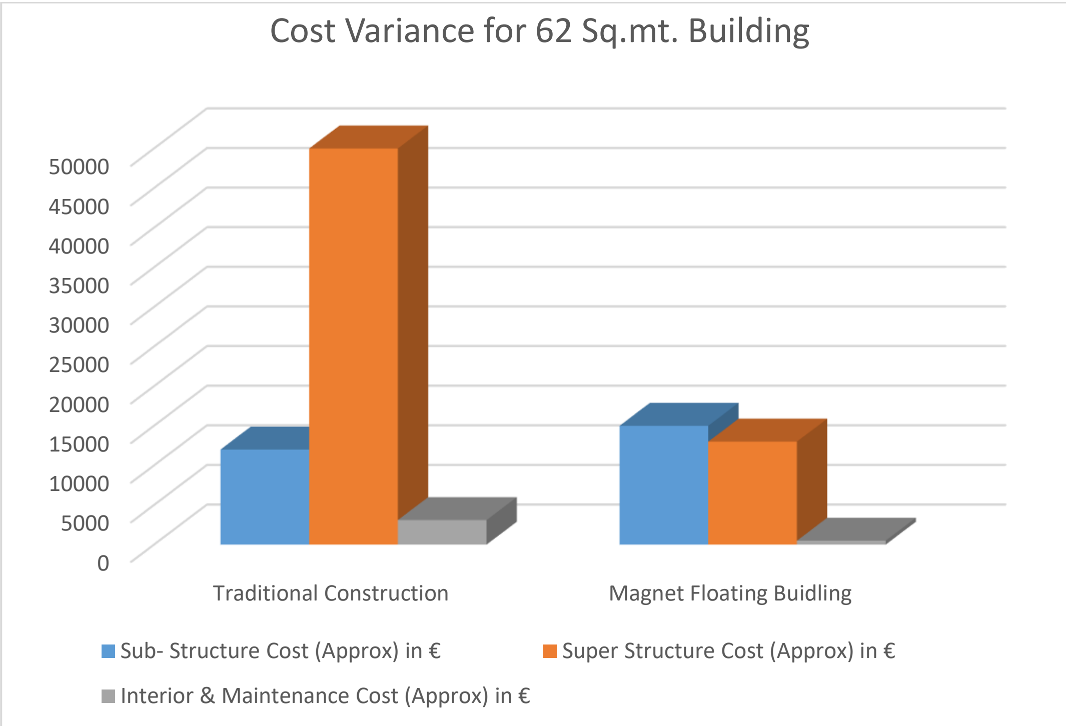
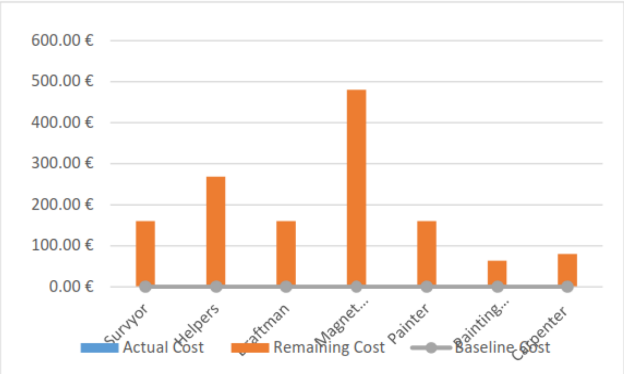


Figure 26 The Graph Shows the Cost Variance between Traditional and Floating Building.

RESOURCE COST OVERVIEW

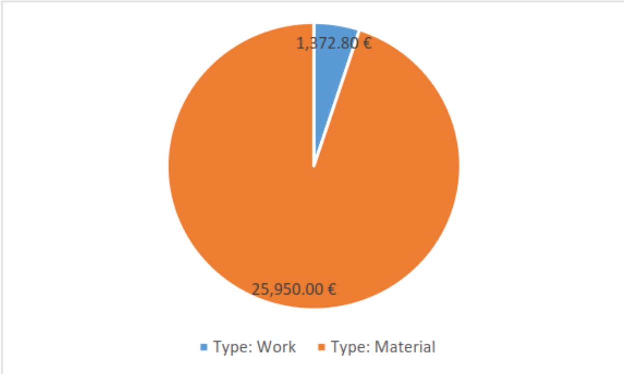
COST STATUS

Cost status for work resources.



COST DISTRIBUTION

How costs are spread out amongst different resource types.



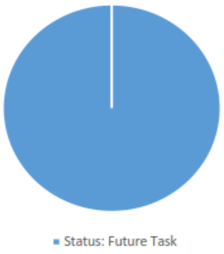
COST DETAILS

Cost details for all work resources.

Name	Actual Work	Actual Cost	Standard Rate
Survyor	0 hrs	0.00 €	10.00 €/hr
Helpers	0 hrs	0.00 €	3.50 €/hr
Draftman	0 hrs	0.00 €	10.00 €/hr
Magnet Engineers	0 hrs	0.00 €	12.00 €/hr
Painter	0 hrs	0.00 €	5.00 €/hr
Painting Equipment	0 hrs	0.00 €	2.00 €/hr
Carpenter	0 hrs	0.00 €	5.00 €/hr

Figure 27 The Graph & Pie-Chart Shows the Resource Cost Overview of Construction Building

CRITICAL TASKS



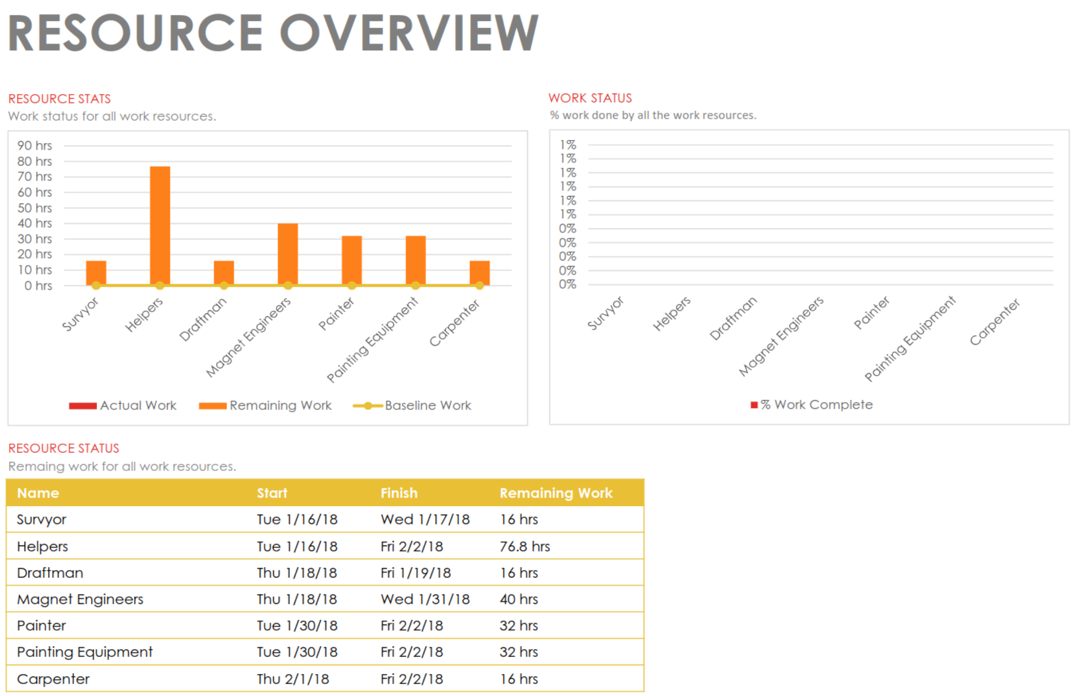
A task is critical if there is no room in the schedule for it to slip.

Learn more about managing your project's critical path.

Name	Start	Finish	% Complete	Remaining Work	Resource Names
Start	Mon 1/15/18	Mon 1/15/18	0%	0 hrs	
Site Cleaning & Marking	Tue 1/16/18	Wed 1/17/18	0%	28.8 hrs	Helpers[80%],Survyor
Sand Filling,PCC& Mark the Magnet Place	Thu 1/18/18	Fri 1/19/18	0%	44.8 hrs	Draftman,Concrete[1],Magnet Engineers,Helpers [80%]
Place the Magnet	Mon 1/22/18	Mon 1/22/18	0%	14.4 hrs	Magnets [1],Helpers[80%], Magnet Engineers
Make a Temperoary Scaffolding for holding upper magnet and Slab	Tue 1/23/18	Thu 1/25/18	0%	19.2 hrs	Concrete[1],Helpers[80%],Scaffolding & flatslab shuttering work[1]
Erect Eps Panel on Flat Slab	Fri 1/26/18	Mon 1/29/18	0%	12.8 hrs	EPS Foam Sheet [1],Helpers[80%], Panel Transportation[1]
Finishing Interior & Exterior Painting	Tue 1/30/18	Wed 1/31/18	0%	48 hrs	Magnet Engineers,Painter, Painting Equipment,Paint[1]
Interior Design & Remove Scaffolding	Thu 2/1/18	Fri 2/2/18	0%	60.8 hrs	Helpers[80%],Paint[1],Painter,Painting Equipment,Carpenter ,Light weight materials [1]
Finish	Fri 2/2/18	Fri 2/2/18	0%	0 hrs	

Figure 28 The Image Shows the Critical Path & Critical task of Construction Building

The critical path of the project is attached in Annexes.



Name	Start	Finish	Remaining Work
Survyor	Tue 1/16/18	Wed 1/17/18	16 hrs
Helpers	Tue 1/16/18	Fri 2/2/18	76.8 hrs
Draftman	Thu 1/18/18	Fri 1/19/18	16 hrs
Magnet Engineers	Thu 1/18/18	Wed 1/31/18	40 hrs
Painter	Tue 1/30/18	Fri 2/2/18	32 hrs
Painting Equipment	Tue 1/30/18	Fri 2/2/18	32 hrs
Carpenter	Thu 2/1/18	Fri 2/2/18	16 hrs

Figure 29 The Image Shows the Resource Overview of Construction Building

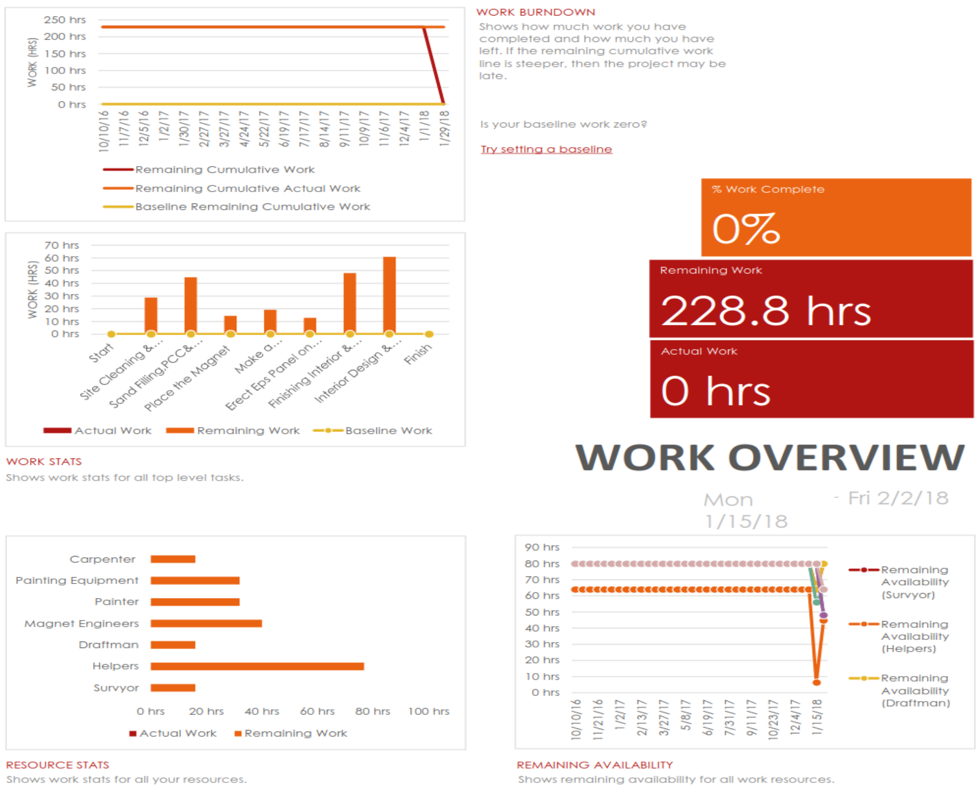


Figure 30 The Image Shows the Work Overview of Construction Building

3.2. PROS & CONS OF FLOATING BUILDING

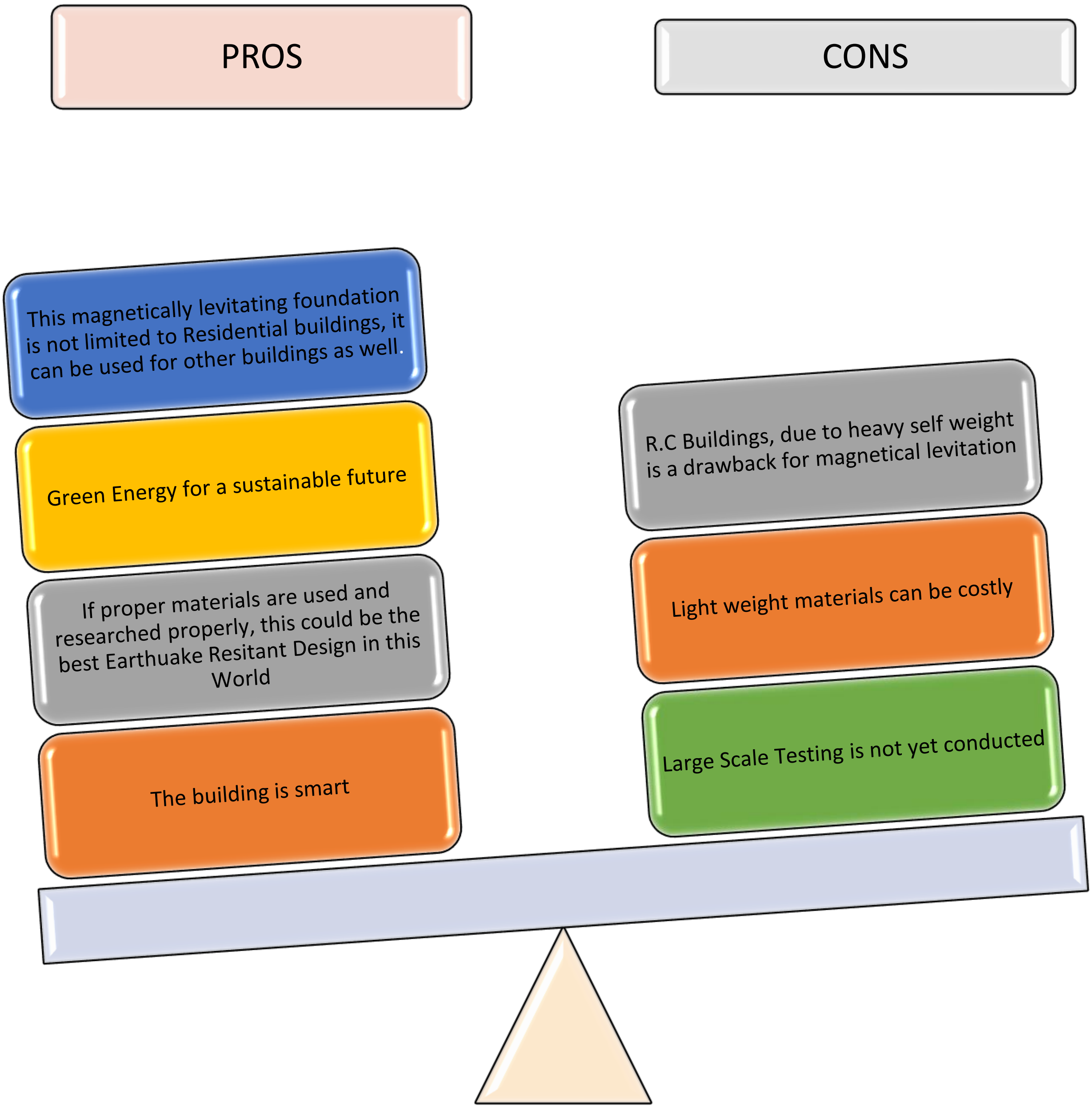


Figure 31 It shows the Advantages & Disadvantages of Magnetic Levitating Building

3.2.1. In Physically Is It Safe for Human Body

After a Small Research the Truth was confirmed the magnet is not affected Human body because, In Basically the Human Blood Repelled the magnet because of Diamagnetic Reaction, but how it is possible with Iron in Hemoglobin.

Because Magnetism is quantum – Mechanical effect, scaled up to be noticeable to us, Iron is not present like this in Real blood, instead, it is the parts of a Big molecule; The metalloprotein in Hemoglobin.

Very Simplified Magnetism is an Interaction between the Unpaired Electrons moving in the materials.

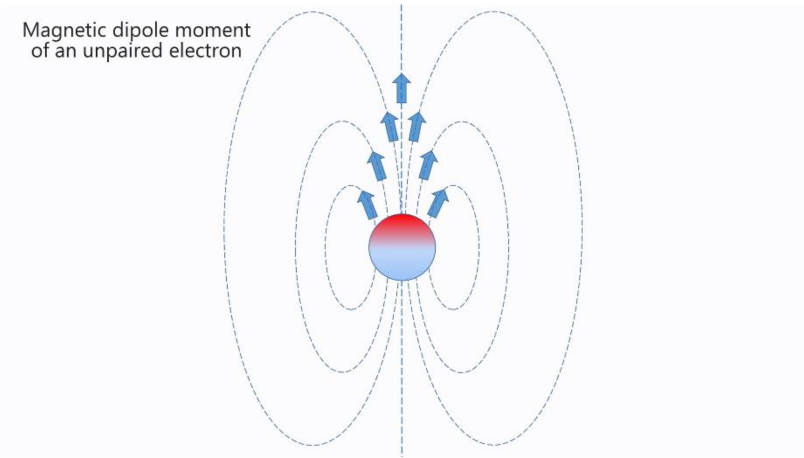


Figure 32 The Image Shows the Dipole moment of an unpaired electrons

Paired Electron will sort of cancel out their magnetic dipole moment by having opposite, spins in the atoms and molecules, only unpaired Electrons will have a not magnetic moment.

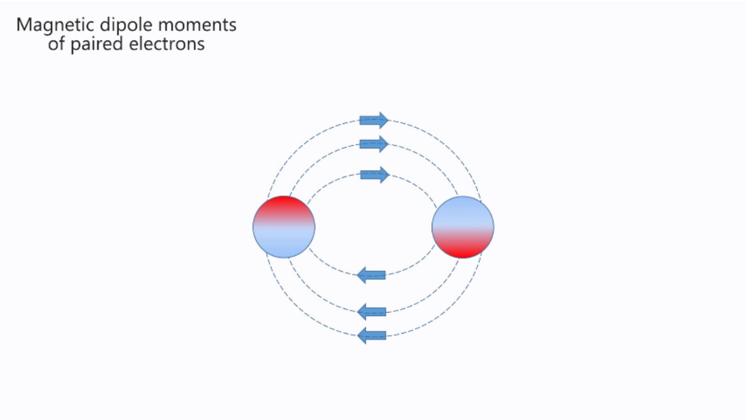
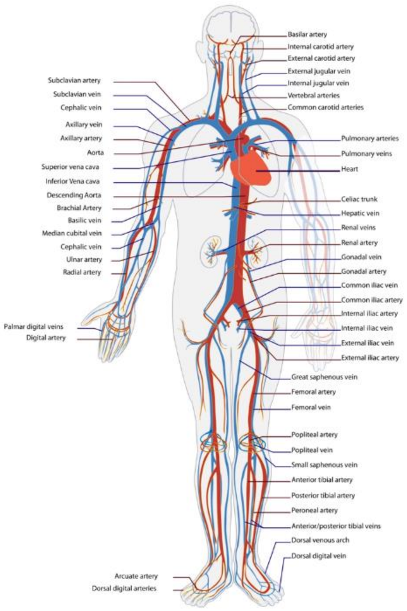


Figure 33 The Image Shows the Dipole moment of a paired electrons

The Iron atoms in oxygenated Hemoglobin turn out to have only paired electrons, No Unpaired. This only gives oxygenated hemoglobin a diamagnetic reaction.

It is repelled by a magnet despite the Iron content,

The Ratio Between the Oxygenated and Deoxygenated Hemoglobin in human body is shown below:



	Oxyhemoglobin (diamagnetic)	Deoxyhemoglobin (paramagnetic)
Arterial blood	96-99%	1-4%
Venous blood	~60-80%	~20-40%

Figure 34 The Image Shows Oxygenated and Deoxygenated Hemoglobin in human body, “Source: Article of Encyclopedia Britannica Aug 23,2016”

So, most of the Hemoglobin in our Body is in Diamagnet, Oxygenated state, being repelled by a magnet. The water making Up half of our blood is also diamagnetic, so let it be confirmed that blood is repelled by a magnet.

So, I concluded don’t worry about the Iron content in your blood near to a magnet, even very strongest magnets, like the superconducting electromagnet in MRI scanners will not be a problem, So the Iron is not in a Ferromagnetic state in the blood [19].

3.3. DISCUSSION

From the tests conducted, it was observed that the designed model withstood the earthquake-induced vibration without collapsing. The advantages of using magnetic levitation as a possible alternative to Earthquake cum flood-resistant design are as follows,

- This technology uses lightweight construction, most materials are which eco-friendly,
- The buildings using this technology utilizes ready to fit fabrications,
- The building when fitted with multiple sensors can be a promising futuristic building technology,
- With more powerful magnets utilized, a long-time levitation of the building is possible,
- During the flood, the house could be temporarily raised so that flood water doesn't enter the house.
- Dynamically rotating buildings are possible when corner and edge rubber columns aren't used, however, the magnetic alignment is the foundation must be planned and laid out in a special design to levitate the building to freely rotate,
- The other areas of application of magnetic levitation can be lifted technology, floating furniture,

However, there are certain limitations when using this technology which is as follows,

- Heavyweight constructions like concrete buildings can't be used,
- While using Superconducting magnets, coolant liquid is very much required to dissipate the heat from the magnets,
- At present, superconducting magnets are not economical,
- Tall building or more than 3-storey buildings may not be protected using this technology.

4. CONCLUSION

From the tests conducted, it was observed that the designed model withstood the earthquake-induced vibration without collapsing. The advantages of using magnetic levitation as a possible alternative to Earthquake resistant design are as follows:

1. This technology uses lightweight construction, most materials are which eco-friendly;
2. The building when fitted with multiple sensors can be a promising futuristic building technology;
3. With more powerful magnets utilized, a long-time levitation of the building is possible.

I hope to realize this conceptual project as a real-time construction soon in the best possible way. I believe in doing so, that my “Next Generation” Buildings will be a part of Smart Sustainable Eco-Friendly Cities of the future.

BIBLIOGRAPHY

[1] Henderson, D. (2014). Methods and apparatus of building construction resisting earthquake and flood damage. US8777519 B1.

[2] Revathy, M., Thulasiraman, N., Rishav Malik, (2015). Learning from the April 25, 2015, Nepal Earthquake: Mapping the deformation and site response.

[3] James Bennet, Editorial Page Editor, & Matt Stevens (2017). Mexico Has Some Lessons for the U.S. on September 2017, Mexico Earthquake: Why Mexico is so prone to strong Earthquakes.

[4] Klassen. F, "MATERIAL INNOVATIONS: Transparent, lightweight, malleable & responsive",

[5] PAVEGEN© - Copyright © 2015 Pavegen Systems Ltd. All rights reserved. All trademarks of PAVEGEN reproduced in this Project Report are duly acknowledged.

[6] Strongest magnet in this world (English Source). Access from internet: <https://www.apexmagnets.com/news-how-tos/what-is-the-strongest-magnet-in-the-world>

[7] Details about Smart Sensors (English source). Access from internet: <http://internetofthingsagenda.techtarget.com>

[8] Zhou, Xiangming ; Li, Zongjin "Light Weight wood–magnesium oxychloride cement composite buildings products made by extrusion"

[9] Calculation for Magnet Repelling power (English source). Access from internet: <https://www.supermagnete.de/eng/adhesive-force-calculation/result>

[10] EPS Panel Definition (English Source). Access from internet: <http://Insulation Corporation of America/eps.>

[11] Eps Panel Specification (English Source). Access from internet: <http://www.sparkhomes.com.au/eps-panels-cool-room-panels>

[12] Property Details in Lithuania (English source). Access from internet: <https://www.globalpropertyguide.com/real-estate-house-prices/L#lithuania>

[13] Apartment & Property rate in Lithuanian Cities in 2017 Q4 (English source). Access from internet: <https://www.globalpropertyguide.com/Europe/Lithuania/Price-History>

[14] Cost of Magnet Basement (English source). Access from internet: <https://www.apexmagnets.com/6-x-2-disc>

[15] Estimation of Flat Slab (English source). Access from internet: <http://www.autokausta.lt/betonas-duk.html#2>

[16] Dr-Ing. Nikolaos E. Malakatas Head of Department - Ministry of Environment, Planning and Public Works - GREECE Chairman of CEN/TC250/SC1 "Eurocode 1991-1-1 Eurocode 1: Actions on structures – Part 1-1: General actions - Densities, self-weight, imposed loads for buildings"

[17] IS456:2000 Fourth Revision 'Indian Standard Plain and Reinforced Concrete Code of Practice'

[18] N. Krishna Raju 'Design of Reinforced Concrete Structures' 3rd Edition 2003.

[19] Diamagnetic Reaction on Human Blood (English source). Access from internet: <https://brilliant.org/?utm_medium=sponsor&utm_source=youtube&utm_campaign=brainiac75_1017>

[20] Modular buildings. RYTERNA MODUL (English source). Access from internet:

< http://www.rmodul.com/ >

[21] Takewaki, I., 2006. Critical excitation methods in earthquake engineering. Elsevier Science, Amsterdam.

[22] Takewaki, I., 2013. Toward greater building earthquake resilience using concept of critical excitation: a review. Sust. Cities Soc. 9, 39–53.

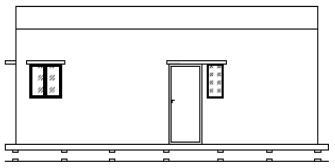
[23] Takewaki, I., Murakami, S., Fujita, K., Yoshitomi, S., Tsuji, M., 2011. The 2011 off the Pacific coast of Tohoku earthquake and response of high-rise buildings under long-period ground motions. Soil Dyn. Earth. Eng. 31 (11), 1511–1528.

[24] Takewaki, I., Moustafa, A., Fujita, K., 2012. Improving the earthquake resilience of buildings: The worst-case approach. Springer, London.

[25] Ben-Haim, Y., 2001. Information-gap decision theory: Decisions under severe uncertainty. Academic Press, London.

[26] Architectural Institute of Japan (AIJ), 2011. Structural design with higher robustness and redundancy. J. Archit. Build. Sci. 126 (1624), 73–79 (in Japanese).
[27] Kamae, K., Kawabe, H., Irikura, K., 2004. Strong ground motion prediction for huge subduction earthquakes using a characterized source model and several simulation techniques. Proceedings of the 13th WCEE, Vancouver.
[28] Koo, J.-H., Jang, D.-D., Usman, M., Jung, H.-J., 2009. A feasibility study on smart base isolation systems using magneto-rheological elastomers. Struct. Eng. Mech. 32 (6), 755–770.
[29] Trombetti, T., Silvestri, S., 2004. Added viscous dampers in shear-type structures: The effectiveness of mass proportional damping. J. Earth. Eng. 8 (2), 275–313.
[30] M. Kasagi, K. Fujita, M. Tsuji, I. Takewaki * Dept. of Architecture and Architectural Eng., Kyoto University, Nishikyo, Kyoto 615-8540, Japan "Automatic generation of smart earthquake-resistant building system: Hybrid system of base-isolation and building-connection, Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

ANNEXES

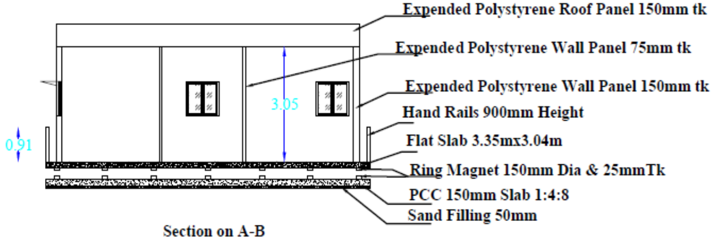


Elevation

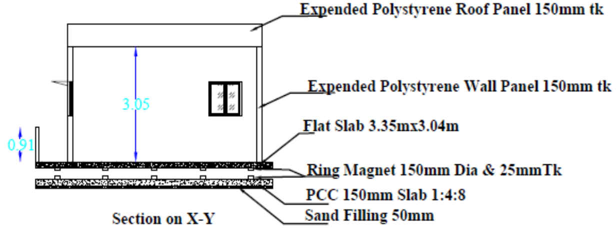
Expended Polystyrene Roof Panel Specification

Core Thickness (mm)	R Value (m^2K/W)	Weight (Kg/m^2)	Max.Internel Wall not supporting Ceiling (m)	Ceiling Max.Span(m)
75	1.92	11.6	5.5	4.8
100	2.63	12	6.4	6.0
150	3.95	12.7	7.7	7.6

MA	Reference	IN MT	IN FT
M/D	Main Door	0.90 x 2.10	3'0" x 7'0"
D1	Door	0.75 x 2.10	2'6" x 7'0"
S/D	Slide Door	0.60 x 2.10	2'0" x 7'0"
W	Window	0.90 x 0.90	3'0" x 3'0"
W1	Window	0.60 x 0.90	2'0" x 3'0"
M/V	Ventilator	0.90 X0.60	3'0" x 2'0"

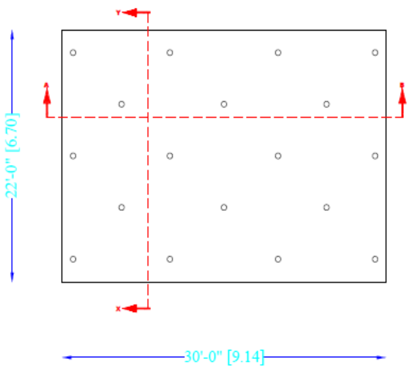


Section on A-B

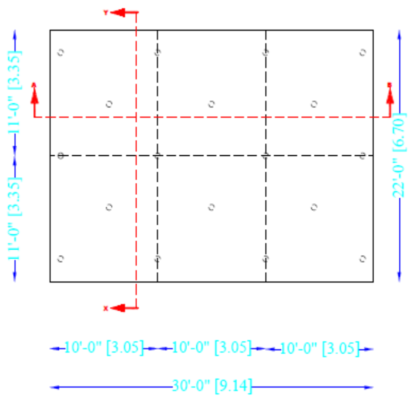


Section on X-Y

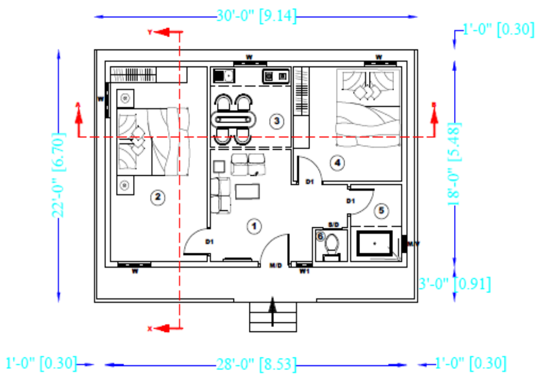
NO	Description	Sq.Mt	Sq.Ft
1	Hall	9.18	98.80
2	M.Bed	14.21	153.00
3	Kitchen/Dining	4.87	52.50
4	Bed	9.29	100.00
5	Bath	2.97	32.06
6	Toilet	0.77	8.25



Plan for Slab Rest on Ground



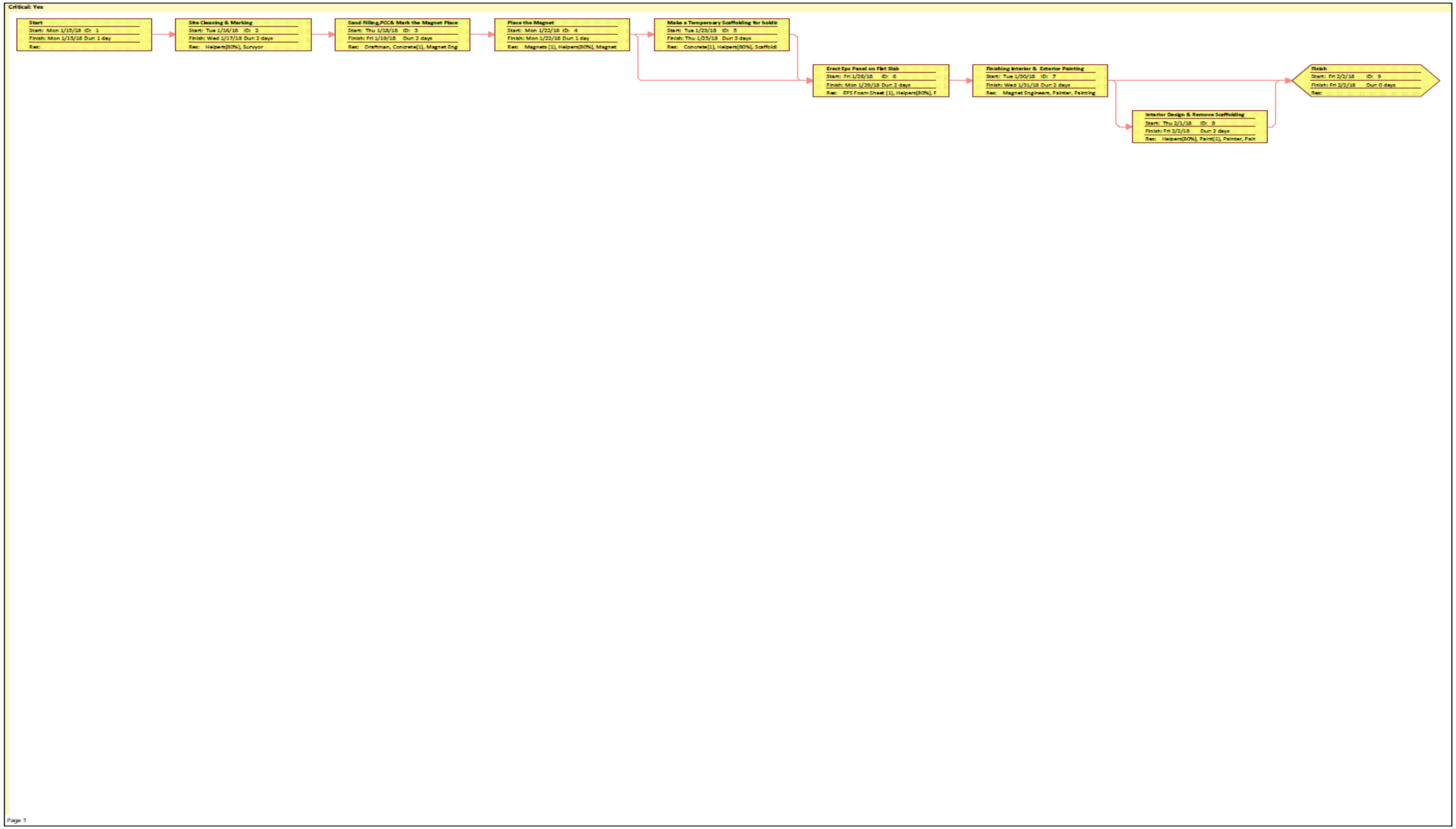
Plan for Slab Hang on Air



Plan for Building On Hang Slab

Group: STMA-6; Student: J.Vignesh; Supervisor: Mindaugas Daukšys	KTU Civil engineering and Architecture	CONSTRUCTION TECHNOLOGY OF FLOATING BUILDING, WITH MAGLEV FOUNDATION.
		Building Plan, Section, Elevation
	Department of civil engineering technologies LT - 51367 Studentų 48, Kaunas	2017-2018; Sheet 1; Pages 1

The plan, Section & Elevation of Proposed Designed Building with specifications



Critical: Yes
Start
Start: Mon 1/15/18 ID: 1
Finish: Mon 1/15/18 Dur: 1 day
Res:
Site Cleaning & Marking
Start: Tue 1/16/18 ID: 2
Finish: Wed 1/17/18 Dur: 2 days
Res: Helpers[80%], Survyor
Sand Filling,PCC& Mark the Magnet Place
Start: Thu 1/18/18 ID: 3
Finish: Fri 1/19/18 Dur: 2 days
Res: Draftman, Concrete[1], Magnet Eng
Place the Magnet
Start: Mon 1/22/18 ID: 4
Finish: Mon 1/22/18 Dur: 1 day
Res: Magnets [1], Helpers[80%], Magnet
Make a Temperoary Scaffolding for holdir
Start: Tue 1/23/18 ID: 5
Finish: Thu 1/25/18 Dur: 3 days
Res: Concrete[1], Helpers[80%], Scaffoldi
Erect Eps Panel on Flat Slab
Start: Fri 1/26/18 ID: 6
Finish: Mon 1/29/18 Dur: 2 days
Res: EPS Foam Sheet [1], Helpers[80%], F
Finishing Interior & Exterior Painting
Start: Tue 1/30/18 ID: 7
Finish: Wed 1/31/18 Dur: 2 days
Res: Magnet Engineers, Painter, Painting
Interior Design & Remove Scaffolding
Start: Thu 2/1/18 ID: 8
Finish: Fri 2/2/18 Dur: 2 days
Res: Helpers[80%], Paint[1], Painter, Pain
Finish
Start: Fri 2/2/18 ID: 9
Finish: Fri 2/2/18 Dur: 0 days
Res:
Page 1