An Experimental Study on Seismic Resistant Foundation

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Abstract*- Foundation is a sub structure built below the super structure. Purpose of the foundation is to transfer the structural loads safely to the underlying soil. Safe and economical design of a foundation under different loading conditions is the role of a geotechnical engineer. Earthquake loads are the most complicated and complex. Design of earthquake resistant foundation is highly challenging. Proper design of foundation against earthquake loading requires through understanding over the behavior of soil, response of structure and interaction of soil –structure under the earthquake loading. The material starts with few case studies on foundation failures due to earthquake loads to understand the mechanisms of foundation failure. Later, general requirements in the design of an earthquake resistant foundation such as selection of foundation material, selection of appropriate type of foundation, are presented. To reduce the effect of seismic waves .The elastic property of concrete is increased by using tires wrapped around the concrete, where the usage of tires as a basic material and Poisson's ratio of concrete is increased gradually which intern increases the affect of seismic waves.*

I. INTRODUCTION

Recently researchers have focused on seeking alternate ways to use wastes emerging in the world. The management of end-of-life tires is a great environmental challenge. In 2004, 120 million of scrap tires were generated in china and this number is increasing 12% each year.

Moreover, the United States alone generates about 300 million scrap tires across the country, with an increase of 290 million tires generated per year. Since waste rubbers are likely to generate toxic fumes, the storage of this type of wastes in landfills could be a serious issue.

Nowadays, there are different approaches to get rid of the waste tires: reuse, rethreading, recycling/ mechanical recycling, landfill engineering and energy recovery. Recycling of waste rubber tires in civil engineering is considered as ecological and economical solutions due to the advantages it can offer. It preserves natural resources and produces an eco-friendly material. In addition to great environmental benefits such as reducing harmful environmental pollution of disposing tires to landfill sites, the most significant advantage of PRC is its excellent energy absorbing characteristics.

Researchers have found that PRC can effectively improve the ductility, reduce weight, and prevent brittle failures. However, the strength reduction is one of the most significant disadvantages of PRC, which prohibits its applications to structural components subjected to impact and dynamic load. Many research efforts have been conducted in order to improve the performance of PRC through surface treatment, reducing the size of rubber particles or using supplementary cementations materials. Onuaguluchi and Panesar examined an approach to pretreat crumb rubber in conjunction with the addition of supplementary cementations materials in order to mitigate the loss of mechanical properties in rubberized concrete. Huang et al used two staged surface methods to treat rubber particles. In the first stage, they used silage coupling agent to modify rubber particle surface and develop chemical bonds between rubber particles and cement paste. In the second stage, cement was used to coat the saline-treated particles.

Segre and Joekes used Noah to treat the waste tire chips before incorporating into PCC. Lee et al applied HNO3 and a METHOCEL cellulose ethers solution. Li et al employed cement paste pre-coating of rubber particles. Rostamiet a simply washed rubber chips with water before applying them to the cement concrete. Tantala et al applied acidic and plasma etching to enhance the surface area of the rubber particles. The object of this review is to investigate different treatment methods for improving the performance of plain rubberized concrete (PRC), and its microstructure behavior.

II. SEISMIC ANALYSIS

HOW AN EARTHQUAKE BEGINS:

Most earthquakes occur along a fault. It is a fracture in earth's rocky outer shell where sections of rock repeatedly slide past each other. Faults occur in weak areas of earth's rock. Most faults lie beneath the earth's surface. Stresses in the earth cause large blocks of rock along a fault to strain or bend. When the stresses on the rock become great enough, the rock breaks and snaps into a new position, causing the shaking of an earthquake. Earthquakes usually begin deep in the ground. The point where the rocks first break is called the focus also known as hypocenter of the quake. The point on the earth's surface directly above the focus is known as the epicenter of the quake. The strongest shaking is usually felt near the epicenter.

From the focus, the break travels like a spreading crack along the fault. The speed at which the fracture spreads depends on the type of rock. It averages about 2 miles per second in granite or other strong rock. As the fracture extends along the fault, blocks of rock on one side of the fault may drop down below the rock on the other side move up and over the other side, or slide forward past the other.

HOW AN EARTHQUAKE SPREADS:

When an earthquake occurs, the violent breaking of rock releases energy that travels through the earth in the form of vibrations called seismic waves. Seismic waves move out from the focus of an earthquake in all directions. There are two chief types of seismic waves,

1. Body waves
2. Surface waves

Body waves:

These are the fastest seismic waves moving through the earth. These waves tend to cause the most earthquake damage. There are two kinds of body waves namely, compression waves and shear waves.

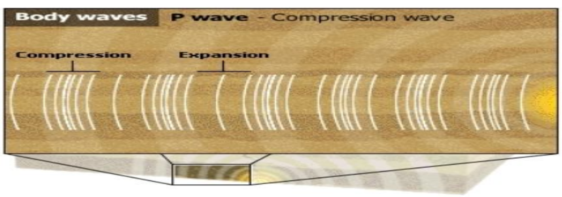


Figure 1. Compression waves

As the waves pass through the earth, they cause particles of rock to move in different ways. Compression waves push and pull the rock. These are longitudinal in nature like sound waves. They cause buildings and other structures to contract and expand. They can travel through solids, liquids or gases. These are also called primary or P waves and are shown in above fig.

Shear waves on the other hand, are transverse in nature like light waves. These waves make rocks move from side to side, and buildings to shake. They travel slower than compression waves and arrive later and are hence also called as secondary or S waves and are shown in below.

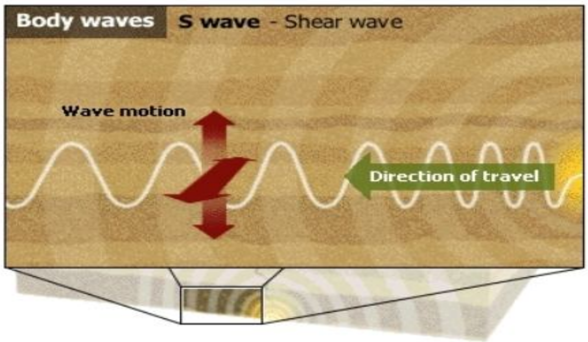


Figure 2. Shear waves

Surface waves:

These are long,slow waves which are transverse in nature. They produce what people feel as slow rocking sensations and cause little or no damage to structures.These are of two types namely, L waves and Rayleigh waves.

EARTHQUAKE HAZARDS:

Tsunamis: An earthquake on the ocean floor can give a tremendous push to surrounding seawater and create one or larger, destructive waves called tsunamis, also known as seismic sea waves. Tsunamis may build to heights of more than 100 feet (30 meters) when they reach shallow water near shore. In the open ocean, tsunamis typically move at speeds of 500 to 600 miles (800 to 970 kilometers) per hour. They can travel great distances while diminishing little in size and can flood coastal areas thousands of miles or kilometers from their source.

Ground motion: The most destructive of all earthquake hazards is caused by seismic waves reaching the ground surface at places where human-built structures, such as buildings and bridges, are located. When seismic waves reach the surface of the earth at such places, they give rise to what is known as strong ground motion. Strong ground motions cause's buildings and other structures to move and shake in a variety of complex ways. Many buildings cannot withstand this movement and suffer damages of various kinds and degrees.

Differential settlement: If a structure is built upon soil which is not homogeneous, then there is differential settlement, with some part of the structure sinking more than other. This induces excessive stresses and causes cracking.

Liquefaction: During an earthquake, significant damage can result due to instability of the soil in the area affected by internal seismic waves. The soil response depends on the mechanical characteristics of the soil layers, the depth of the water table and the intensities and duration of the ground shaking. If the soil consists of deposits of loose granular materials it may be compacted by the ground vibrations induced by the earthquake, resulting in large settlement and differential settlements of the ground surface. This compaction of the soil may result in the development of excess hydrostatic pore water pressures of sufficient magnitude to cause liquefaction of the soil, resulting in settlement, tilting and rupture of structures

- Rock movements during an earthquake can make rivers change their course.
- Earthquakes can trigger landslides that cause great damage and loss of life.

Structural hazards: Structures collapse during a quake when they are too weak or rigid to resist strong, rocking forces. In addition, tall buildings may vibrate wildly during an earthquake and knock into each other.

Other hazards:

During an earthquake include spills of toxic chemicals and falling objects, such as tree limbs, bricks, and glass. Sewage lines may break, and sewage may seep into water supplies. Some of these earthquake hazards are shown below.

Figure 3.

Ground sliding, Ground tilting,Differential settlement

During an earthquake, ground motions occur in a random fashion, both horizontally and vertically, in all directions radiating from the epicenter. These ground motions cause structures to vibrate and induce inertia forces on them. Hence structures in such locations need to be suitably constructed, designed and detailed to ensure stability, strength and serviceability with acceptable levels of safety under seismic effects. The principle of earthquake-resistant construction of buildings has two aims:

1. The building shall withstand with almost no damage to moderate earthquake which have probability of occurring several times during life of a building.
2. The building shall not collapse or harm human lives during severe earthquake motions which have a probability of occurring less than once during the life of the building. In the former case deformation of the structures remain within the elastic range.

In the latter case, they may exceed the elastic limit and the building should be designed with sufficient ductility to survive collapse.

In order to satisfy these aims, building construction and design should confirm to the following rules:

(a) The configuration of the building (Plan and elevation) should be as simple as possible.

(b) The formation should generally be based on hard and uniform ground.

(c) The members resisting horizontal forces should be arranged so that tensional deformation is not produced.

(d) The structure of the building should be dynamically simple and definite.

(e) The frame of the building structure should have adequate ductility in addition to required strength.

(f) Deformations produced in a building should be held to values, which will not provide obstacles to safety use of building.

CLASSIFICATION OF SEISMIC ZONES IN INDIA:

The earthquake resisting features specified to be incorporated while constructing any new building depend on the seismic intensity, zone in which the building is located, the base soil and the functional use of the building, whether considered important or ordinary. The extra cost of these resisting features will vary accordingly.

India is divided into 5 seismic zones in ascending order of magnitude of earthquake. The map was taken up for further revision after the Lathur earthquake of 1993. the resulting revised map published in IS:1893-2002(part I) where in the number of zones has been reduced to 4 i.e. II to V only, zone I being merged in zone II , and zone III now further expanded in the peninsular area. The seismic zone map shows that of the total land area of the country, seismic zone V covers 12%, zone IV 18% and zone III about 27%, thus 57% could be subjected to damaging earthquake intensity, masonry building in particular.

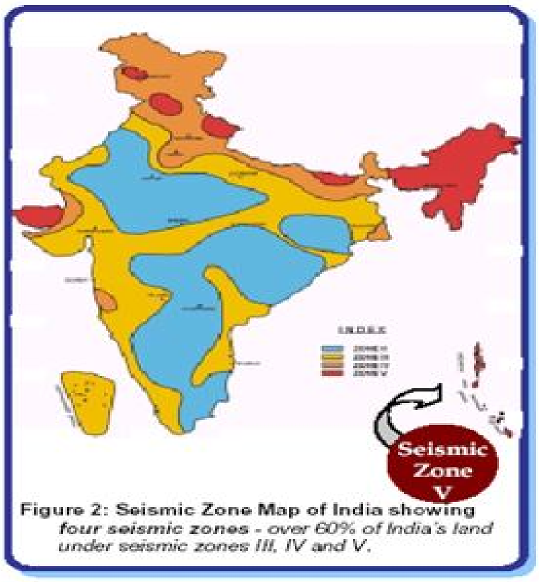


Figure 4. Seismic Zone Map

Indian Seismic Codes: The Indian Standard Codes to be followed for Earthquake resistant structures are as follows:

- IS 1893-2002, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision).
- IS 4326-1993, Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision).
- IS 13827-1993, Indian Standard Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings.
- IS 13920-1993, Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
- IS 13935-1993, Indian Standard Guidelines for Repair and Seismic Strengthening of Buildings.

WHERE TO BUILD EARTHQUAKE RESISTANT STRUCTURES.

Earth scientists try to identify areas that would likely suffer great damage during an earthquake. They develop maps that show fault zones, flood plains (areas that get flooded), areas subject to landslides or to soil liquefaction, and the sites of past earthquakes. From these maps, land-use planners develop zoning restrictions that can help prevent construction of unsafe structures in earthquake-prone areas.

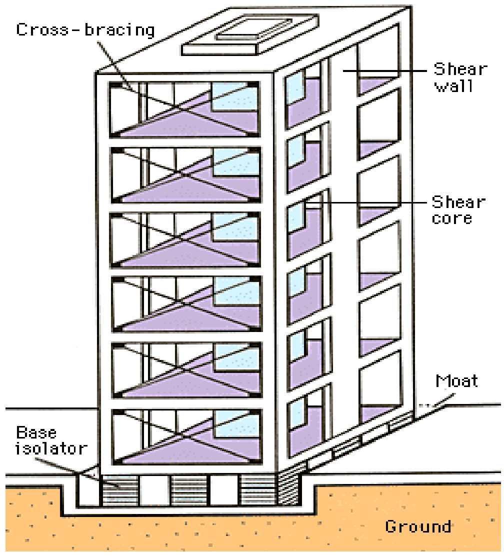


Figure 5. An earthquake-resistant building

HOW TO BUILD.

Engineers have developed a number of ways to build earthquake-resistant structures. Their techniques range from extremely simple to fairly complex. For small- to medium-sized buildings, the simpler reinforcement techniques include bolting buildings to their foundations and providing support walls called shear walls. Shear walls, made of reinforced concrete (concrete with steel rods or bars embedded in it); help strengthen the structure and help resist rocking forces. Shear walls in the center of a building, often around an elevator shaft or stairwell, form what is called a shear core. Walls may also be reinforced with diagonal steel beams in a technique called cross-bracing as shown in fig.

(g) Builders also protect medium-sized buildings with devices that act like shock absorbers between the building and its foundation. These devices, called base isolators, are usually bearings made of alternate layers of steel and an elastic material, such as synthetic rubber. Base isolators absorb some of the sideways motion that would otherwise damage a building.

(h) Skyscrapers need special construction to make them earthquake-resistant. They must be anchor deeply and securely into the ground. They need are in forced framework with stronger joints than an ordinary skyscraper has. Such a framework makes the skyscraper strong enough and yet flexible enough to withstand an earthquake.

(i) Earthquake-resistant homes, schools, and workplaces have heavy appliances, furniture, and other structures fastened down to prevent them from toppling when the building shakes. Gas and water lines must be specially reinforced with flexible joints to prevent breaking.

CATEGORIES OF BUILDINGS:

For categorizing the buildings with the purpose of achieving seismic resistance at economical cost, three parameters turn out to be significant:

(i) Seismic intensity zone where the building is located,
(ii) How important the building is?
(iii) How stiff is the foundation soil.

A combination of these parameters will determine the extent of appropriate seismic strengthening of the building.

SEISMIC ZONES:

In most countries, the macro level seismic zones are defined on the basis of Seismic Intensity Scales. The intensity of an earthquake is measured on the Richter scale.

Slight: Magnitude up to 4.9 on the Richter Scale
Moderate: Magnitude 5.0 to 6.9
Great: Magnitude 7.0 to 7.9

Very Great: Magnitude 8.0 and above

- An earthquake of magnitude below 2.0 on the Richter Scale usually can't be felt
- An earthquake of magnitude below 4.0 on the Richter scale doesn't cause any damage.
- An earthquake of magnitude over 5.0 on the Richter scale usually can cause minor damage.
- An earthquake of magnitude 6.0 and above is considered strong and cause substantial damage.
- An earthquake of magnitude 7.0 and above is a major earthquake and renders worst possible damage.
- The extent of special earthquake strengthening should be greatest in areas where the magnitude of earthquake is over 7 & can be decreased for areas with magnitude lesser than 6.

III. METHODOLOGY

USAGE OF TYRES

Used tires aren't only pretty cheap (in some cases, free); they're also ready to use for high insulation factor building projects. Michael Reynolds's Earth ship concept, for instance, uses old tires as "bricks": they're filled with earth that's pounded in to create strength and stability. It's a labor-intensive process, and no doubt the resulting bricks are pretty heavy; the result, though, is much more thermal mass than found in ordinary construction, which creates much higher insulating factor.

The tire bale concept also turns these "waste" materials into building materials with high thermal mass. Using a hydraulic press, tires are compressed into "big rubber bricks" of 2-1/2′ x 5′ x 4-1/2′ (which weigh about 2000 pounds). Walls built from these bales also have a high insulation value: a Colorado School of Mines study predicted an R-value of "40.0 – 41.6 for a 60″ tire bale wall… about 3x as much insulation as goes into a standard 4″ stud wall."

Tires aren't just strong and durable; they're also flexible, which makes them a good choice for disaster-resistant building (particularly for earthquakes).

An earthquake-resistant house designed by the Indonesia Aid Foundation, for instance, used tires for the home's foundation to provide a "buffer zone" between the shaking earth and the house. Colorado State University tested this design and another on a seismic shake plate, and the building was able to resist progressively stronger quaking.

The patented Tire Log by Re-Tread Products of Great Valley, New York, is another option for disaster-resistant housing that takes advantage of tyres' flexibility. In this case, designers use the logs as a ground-level buffer as in the Indonesia Aid Foundation design, but also for the walls of the building (much like a traditional log cabin). Take a look at how this building material is manufactured.

All of these uses take advantage of strong, durable, and readily-available material. They also require quite a bit of processing, though tires generally have to be ground up (though "rough shredded tires" can be used as-is for certain civil engineering projects). The strength and durability of tires also make them attractive as a building material… and, usually, this requires relatively minimal processing (if any at all). Forward-thinking designers and builders have used tires to meet a number of goals for greener, more resilient buildings.

SHAKE TABLE TEST

The use of shaking tables for the assessment of the dynamic and seismic behaviour of civil engineering structures is effective since the sixties. At the beginning, shaking tables had important limitations concerning the power available and they have been used to study the dynamic characteristics (natural frequencies and mode shapes) of small models behaving essentially in the linear range. Meanwhile, bigger and more powerful shaking tables have been put in operation allowing for the adoption of lower scaling factors and therefore involving very important dynamic forces.

Nowadays a significant amount of research using shaking tables can be found in the literature. This research has been oriented mainly for the ultimate behaviour of steel and RC building structures, structural elements (with a clear emphasis on RC and masonry walls, RC frames with in fills and dissipating devices) and global models of structures at smaller scales.

Among the most paradigmatic examples of the use of shaking tables are the two series of tests performed at the Tsukuba facility on 1:1 scaled models; the first one was performed in the framework of the US-Japan Cooperative Earthquake Research Program on a building model with 7 storeys more recently (Minowa et al, 1996) two 3-storey building models have also been tested to failure. In what concerns shaking table tests on bridge structures and bridge piers, information is rather scarce and just a few results are found in literature. The tests performed at LNEC (Carvalho et al, 1978), at the University of California (Williams and Godden, 1976) and at ISMES facilities (Casirati et al, 1996) are among the few papers published on the subject. Those tests have been performed on models at 1:100 scale (LNEC), 1:30 (UC) and 1:8 (ISMES).

In order to advance its experimental activity in engineering, which started in the late fifties, LNEC decided to study and build a new type of earthquake simulator mainly conceived for the testing of civil engineering structures, such as buildings and bridges, being, however, also useful for the validation of the dynamic behaviour of some mechanical and electrical equipment. This very particular simulator has three independent translational degrees of freedom which are driven by hydraulic actuators, whereas its rotational degrees of freedom are minimised by torque tube systems, one for each axis (roll, pitch and yaw). Under the horizontal cranks, either passive gas actuators, to cope with the dead weights of the shaking table and of the testing specimen, or rigid blocks, eliminating the vertical motion of the

Table, can be inserted. At each end, the torque tubes are linked, by means of a crank, with a stiff connecting rod between them and the moving platform. The vertical connecting rods are pinned at both ends, and horizontal motion of the platform is allowed.

Figure 6. Shake table testing machine

When the platform moves vertically, it either pulls or pushes the connecting rods, rotating both cranks by the same angular displacement, and the respective torque tube likewise. In fact, if there is an overturning moment inducing a rotation on the platform, then vertical movement in opposed directions appears at the upper end of the connecting rods, which, in turn, causes small opposite rotating forces in the cranks. However, this is resisted through a large reaction force generated by tensional stiffness of the concerned very stiff torque tube, resulting only in an insignificant platform rotation.

CONCRETE MIX DESIGN

1) An example on M30 concrete mix proportioning

- Stipulations for proportioning
- Test data for materials
- Target strength for mix proportioning
- Selection of water cement ratio
- Selection of water content
- Calculation of cement content
- Proportion of volume of coarse aggregate and fine aggregate
- Mix calculation
- Mix proportion
- Ratio of mix proportion

2) Stipulations for proportioning

- Grade -30
- Type of cement -53grade
- Exposure condition-very sever
- Minimum cement content-260kg/m3
- Maximum cement content-450kg/m3
- Type of aggregate- crushed angular
- Maximum size of aggregate-20mm
- Maximum water cement ratio-0.45
- Workability-100mm

- Method of concrete placing- normal
- Degree of supervision- good

3) Test data for materials

- Cement used - OPC 53 grade
- Specific gravity of cement - 3.15
- Specific gravity of Coarse
- Aggregate - 2.74
- Specific gravity of Fine Aggregate- 2.74

4) Water absorption

a) Course aggregates - 0.5%
b) Fine aggregates - 1.0%

Surface moisture
a) Course aggregate - Nil
b) Fine aggregate - Nil

Sieve analysis
A) Coarse aggregate - Confirming to IS: 383 table-2
b) Fine aggregate-Confirming to IS: 383 table-4

5) Target strength for mix proportioning

Target strength=fck+1.65s
=30+(1.65×5) = 38.25 n/〖mm〗^2

6) Selection of water cement ratio

From table-5 of IS 456 maximum water cement ratio for M20=0.45, hence adopt W/C=0.45

7) **Selection of water content**

From table-2 of IS:10262
Maximum water cement for 20mm aggregate=186liters for 25 to 50mm slump range
Estimated water cement for 100mm slump
=186+(6/100×186)
= 197 litres

8) Calculation of cement content

Water cement ratio W/C=0.45
Cement content C =W/0.45 = 197/0.45=437kg/m^3
From table-5 of IS-456 minimum cement content for very sever exposure condition=260kg/m^3
437kg/m^3>260kg/m^3
Hence OK

9) Proportion of volume of coarse aggregate and fine aggregate content

Correct proportion of volume of coarse aggregate for water cement ratio of 0.45=0.61
Volume of coarse aggregate=0.61×0.9=0.54
Volume of fine aggregate= 1-0.54= 0.46
54% of coarse aggregate
46% of fine aggregate
100% total volume of aggregates

10) Mix calculations

The mix calculations per unit volume of concrete shall be as follows:
Volume of concrete = 1m^3
Volume of cement = mass of cement/specific gravity of cement ×1/1000
= 437/3.15×1/1000= 0.138m^3
Volume of water = mass of water/specific gravity of water×1/1000 =197/1×1/1000m^3
Volume of total aggregate= 1-0.138-0.197
=0.665m^3
Equating all= 0.138+0.197+0.665= 1
Mass of coarse aggregate=0.665×0.54×2.74×1000=986kg
Mass of fine aggregate = 0.665×0.46×2.74×1000=838kg

11) Mix proportion

Cement=437kg/m^3
Water=197kg/m^3
Fine aggregate=838kg/m^3
Coarse aggregate=986kg/m^3
Water cement ratio=0.45

12) Ratio of mix proportion

Cement = 437/437=1
FA=838/437=1.91
CA=986/437=2.25
M30=1:1.91:2.25:0.45
CONCRETE PLACING

Materials used:

- Cement
- Aggregates
- Water
- Tyres
- Tamping rod
- Wrapping tape

Mix procedure:

- Calculate the quantity of materials required to fill the tyres, cubes and cylinders.
- Place all the materials in a nonporous tray, then mix thoroughly in a dry condition to obtain homogeneous mix.
- Add following quantity of water to the homogeneous dry mix.
- Fill the moulds of cubes and cylinders in a 3 layers by giving 25 blows and fill the tyres layer by layer by tamping.
- After filling the tyres wrap it with tape to prevent the spilling of concrete and after 24 hours remove the wrappings and keep the specimens for curing.

Figure 7. Concrete dry mix proportion

Figure 8. Concrete wet mix

Figure 9. Wrapped Tyres

CURING

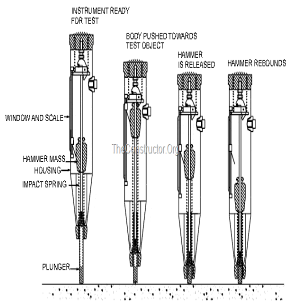
- **Immersion**: Immersion curing is usually done during concrete testing when curing concrete test specimens.
- **Ponding**: Used to cure flat surfaces on jobs or controlled areas where water can be easily retained on top of the concrete slab. Sand or earth dikes surround the slab and a layer of water is maintained on top of the slab.
- **Fogging**: Fogging or misting is used in circumstances where temperatures are above freezing and there is low humidity. Fogging raises the humidity above the curing concrete by spraying a fine mist of water regularly across it to maintain moisture.
- **Wet covering**: Curing concrete with wet covering is done after the concrete has hardened sufficiently and the water covering will not damage concrete's surface. A covering is usually sand, burlap, canvas or straw that is kept continuously damp during the curing process.

  Curing of tyre specimens cubes and cylinders by immersing in water tank for about 28days.

Figure 10. Concrete specimens

Figure 11. Concrete filled Tyre specimens

TESTING



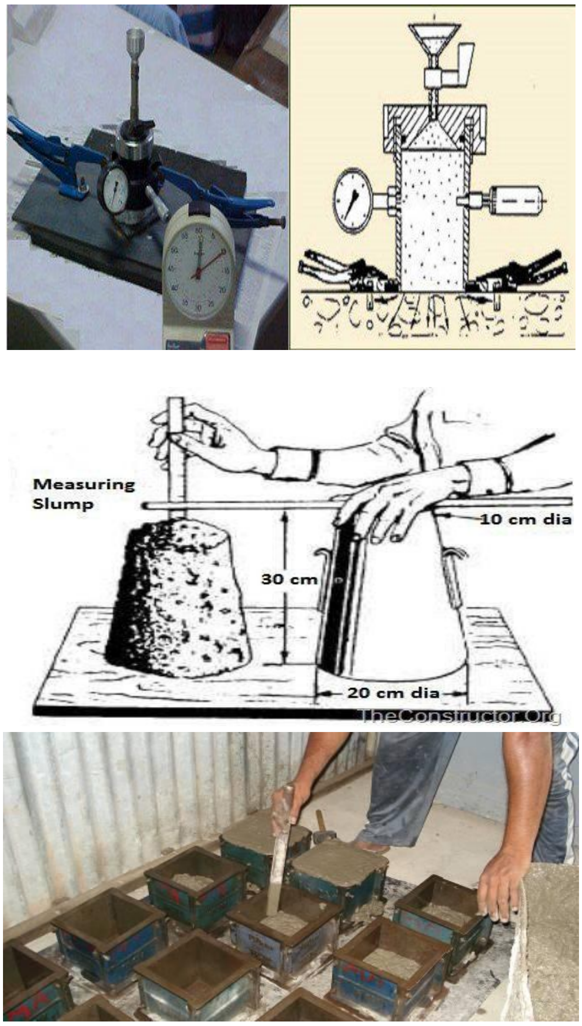


Figure 12. Testing on materials

Figure 13. Compression and tensile tests

Figure 14. Shake table test

IV. RESULTS AND DISCUSSIONS

TESTS ON MATERIALS

1. Cement

Table 1. Fineness of Cement

Sl no	Material	Weight (g)	Formula	Fineness (%)
1	Weight of cement (W_1)	100	$\frac{W_2}{W_1}\times 100$	2
2	Weight of Cement residue (W_2)	2		

2. Fine Aggregate

Table 2. Specific gravity

Sl no	Description	Weight (kg)	Specific gravity of FA
1	Empty Weight of Pycnometer (W_1)	0.64	2.50
2	Weight of Pycnometer + FA (W_2)	0.94	
3	Weight of Pycnometer + Water + FA (W_3)	1.71	

4	Weight of Pycnometer + Water (W_4)	1.53	

Formula: $G = \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)}$

3. Cement

Table 3. Sieve analysis

Sl no	Sieve size	Weight Retained	% Retained	Cumulative Sum	% passing (finer)
1	10	0	-	0	100
2	4.75	0	-	0	100
3	2.36	0.03	1.5	1.5	98.5
4	1.18	0.51	25.5	27	73
5	600	0.85	42.5	69.5	30.5
6	300	0.39	19.5	89	11
7	150	0.16	8	97	3
8	Pan	0.03	1.5	98.5	1.5

4. Cement

Table 4. compressive strength in cement concrete

Sl no	Age (days)	Compressive strength (Mpa)	Average compressive strength (Mpa)
1	7	29.10 29.30	29.20
2	28	38.00 40.00	39.00

5. Fine Aggregate

Table 5. split tensile strength in cement concrete

Sl no	Age (days)	Tensile strength (Mpa)	Average T ensile strength (Mpa)
1	7	2.54 2.23	2.38
2	28	3.86 3.99	3.93

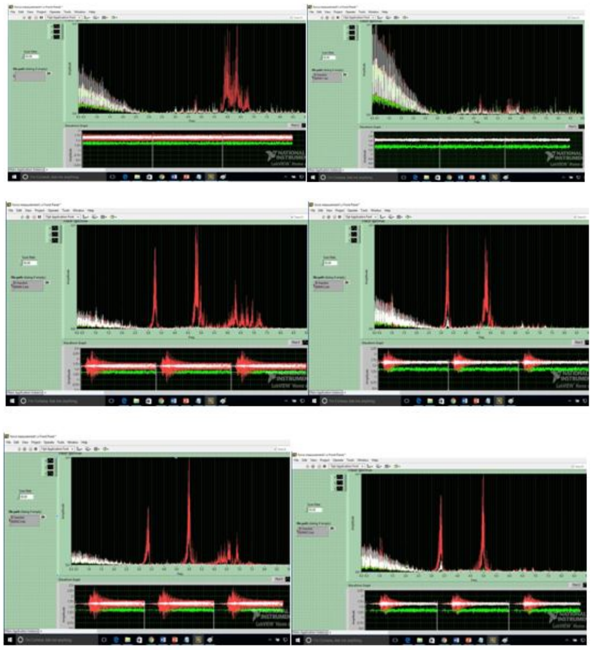


Figure 15. Amplitude v/s Frequency with Tyres

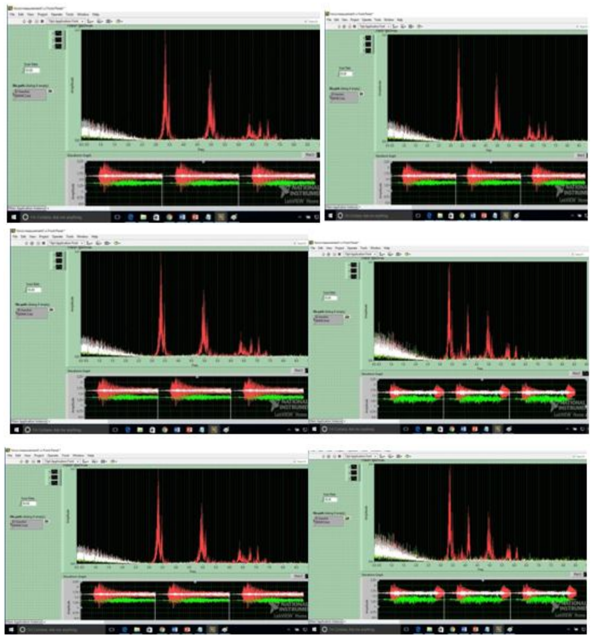


Figure 16. Amplitude v/s Frequency (Without Tyres)

Table 6. Resonance Frequency From Shake Table Test

Resonance Frequency With Tyres							
Sl no		Accelerometer 1			Accelerometer 2		
1	X	0.4	0.4	1.05	1.05	1.05	1.05
2	Y	6.35	0.4	4.85	3.25	5.0	5.0
3	Z	0.4	0.4	1.05	1.05	1.05	1.05

Resonance Frequency Without Tyres							
4	X	0.8	0.4	0.4	0.4	0.5	0.5
5	Y	3.3	3.3	3.33	3.32	4	3.4
6	Z	0.8	0.4	0.4	0.4	0.5	0.5

Table 7. Average Resonance Frequency

With Tyres	
Accelerometer	**Resonance Frequency**
1	5.6
2	5
Without Tyres	
1	3.32
2	3.7

V. CONCLUSION

- The effective analysis on the acceleration shows higher frequency with tyre filled with concrete in the range of 5.5-6 hertz.
- In case of the direct measurement without isolation shows 3.3-3.7 hertz.
- Higher the frequency leads to lesser acceleration, lesser acceleration which is due to isolation.
- The vibration with isolation shows higher frequency at the top level than the lower frequency, which shows reduction in seismic effect.
- In the other case less frequency obtained at the top level and frequency obtained at bottom level which is reflecting the application of seismic effect on structure.
- The new technique of seismic isolation proves better for the earthquake resistance.

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