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REVIEW THE EFFECTS OF SOIL STRUCTURE ON THE PUSHOVER ANALYSIS OF SHORT SPAN RC BRIDGES.

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Abstract
The earthquake that occurred in Gujarat in 2001 and the earthquake that occurred in Kashmir in 2005 have brought awareness to the danger that earthquakes pose to buildings all over the country. There is a wealth of information available on the evaluation of multi-story buildings for seismic activity that makes use of nonlinear static (pushover) analysis. In spite of the fact that bridges are among the most significant constructions in any nation, there hasn't been a lot of research done on how to analyse them for earthquakes. There are no comprehensive recommendations available at this time to assist structural engineers in the process of evaluating old bridges and coming up with design and repair plans. As a means of finding a solution to this issue, The goal of this research work to use an existing RC bridge as a case study for a nonlinear static (pushover) analysis. Bridges move in a different way than structures do because they move horizontally and have two fixed ends. From the three-dimensional model, you can see that the bridge is made in several different ways. More people than ever before are taking part in the higher modes. Because bridges are so complicated, it may not be accurate to do a pushover analysis with only one load pattern. Analysis of the effects of soil-structure interaction on short-span RC bridges

Introduction
Bridges are important parts of road networks because they let people get from one place to another. There are a lot of costs that come up right away when building a bridge. Also, the bridges can't be built quickly. Bridges and other structures can get broken when an earthquake hits. So, the design of the bridge should take into account the chance of an earthquake. During the last century, there were a lot of earthquakes in India. More than half of the time, an earthquake causes damage to property somewhere in the country. If the bridge gets broken, it will hurt the economy of the country in a roundabout way. There needs to be more research on how to stop bridge damage and how to fix it. Elastic analysis can be used to figure out how the bridge moves in the real world. It doesn't have a way to break or a way to move forces around, which are both things that plastic hinges do. Inelastic analyses, like nonlinear pushover analysis, can be used to figure out how things break. The force distribution and the target displacement are both based on the shape of the displacement that doesn't change over time. Non-linear pushover analysis was first used in the 1970s, but it has only been in the last ten to

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fifteen years that its full potential has been seen. The main goal of a pushover analysis is to figure out how strong and how much weight a structure can hold. This method can be used to build new buildings. The Indian code for building bridges does not have a requirement for how bridges should be built in case of earthquakes. Because of this, international codes like FEMA and ATC 40 are taken into account when figuring out capacity.

This article shows the results of a study on how the earth's nonlinear behaviour affects the bridge's ability to withstand earthquakes. [Quote needed] [Quote needed] Each of the three types of soil was looked at in its own way. It's possible that how flexible the soil is will have a big effect on how the system responds to earthquakes. This is something to keep in mind. In cohesive soil, plasticity spreads from the mass's base all the way to the top, where it slows the transfer of energy to the structure. A three-dimensional study of how earthquakes affect the soil, foundation, and structure system found that the structure's response to an earthquake depends on how the soil and structure interact. Based on what the study found, this is what was decided. This second method uses a number of complicated mechanisms that all depend on the frequency content of the load, the natural frequencies of the huge soil and the structure, and the fact that the soil doesn't behave in a straight line. Using a non-linear elastic model soil, which causes the response of the soil mass to have different frequencies, makes it possible to analyse a very complicated soil-structure interaction. Because of this, it is now possible to analyse how these two things interact. If these frequencies are far from the frequencies that are most important in the load, then it is likely that they won't have much of an effect. According to the results of a study that looked at how the flexibility of the soil affected how the soil and structure interacted, the flexibility of the soil has two effects. The first effect is that damping goes up because of dissipation caused by plastic deformation. The second effect is that the "natural frequency" of the soil-foundation system goes down because rigidity-induced plasticity goes down. Both of these results come from How much of an effect the plasticity was able to have is directly related to how long it took to work its way through the hard soil. In turn, this is determined by the amplitude of the loading, as well as the frequency content and natural frequencies of the structure of the soil-foundation system.

Related Work

M.ROUGUI et al[1] The ANSYS study showed that the delimitation, distribution of travel, and fundamental frequency of each type of soil are different depending on how it moves. In a number of situations, this was the case. The results of this article show that structural soil interaction needs to be taken into account when designing bridges. They also show that the closeness of the fundamental frequencies of the structure and soil has a big effect on soil-structure interaction. These results were found by looking at a model of a bridge that had structural soil interaction (SSI) happen to it.

Chaudhary, M.T.A et al[2] Most of the time, shallow spread footing foundations are used for bridges with medium spans that are held up by rock strata. Because of how the soil and the bridge work together, SSI is not taken into account when simulating these kinds of bridges. Instead, supports that are set up are used. In this study, five different types of rock were looked at, and real ground vibrations were put on a medium-span, four-span bridge. To look at how the bridge would act in these situations, a substructuring approach and a FEM model were used. Material and geometric nonlinearities were used to model how a reinforced concrete pier column doesn't behave in a straight line. A similar linear model was used to model the nonlinear behaviour, and Winkler springs were used to model SSI. This has to be done because the material and geometry are not straight lines.

Lyngs J. H et al[3] In this article, different types of elements, such as dashpots, gapping elements, and vertical and horizontal translational springs, are used to model how the gravel bed and the reinforced subsoil behave. The hyperbolic relationships are generalised in two dimensions and used as the basis for the nonlinear horizontal springs. They work together with the local vertical tension, and the expanded Masing rules say that this could cause hysteresis. The study shows a way of modelling that can be used in the real world, even though it is very complicated.

M. S. Patel et al., [4] Building bridges is a big part of how the country grows and changes. The bridge should be strong, cost-effective, and safe from earthquakes. In this work, a FEM software called MIDAS Civil is used to evaluate the pier of a slanted bridge. For the analysis of the pier, a nonlinear static pushover analysis with displacement control is used. The main goal of this study, according to the Applied Technology Council (ATC-19), is to look at the Response Reduction Factor on pile foundations with and without taking soil structure interaction into account.

Mohammad Farhan et al[5] The nonlinear static approach, which is also called the pushover method, is the main topic of this article. It is used to analyse RCC bridges for earthquakes. It is easier to understand and model in terms of ideas, and it doesn't take long to figure out. In the last ten years, pushover analysis techniques have made a lot of progress, which is why they are now part of international codes and recommendations for seismic analysis. The pier was built to meet the requirements of IRC-6 2012, and it has to withstand dead load, live load, and seismic loading. The goal of the study was to find out how a typical reinforced concrete bridge pier that was built according to Indian standards and used a pushover analysis method based on displacement would do in a strong earthquake.

Islam M. Ezz El-Arab [6] A three-dimensional finite element model of an RC bridge with round piers was made to show how the soil and the structure work together (SSI). One type of building part is a linear foundation spring model. A model of an RC pier is another example of something that is not linear. When SSI effects were taken into account, pushover analysis of short span RC bridges improved their dynamic features and displacement capacity by 11–20%, according to the paper. The study's results show that footings of bridge piers are more likely to move and have their bases shear when they are built on soils that are not as stable. Because of this, the rigidity of the footings is reduced by 12–18%. With this information, both new bridges and old ones that can be fixed or made stronger will be better off..

PUSHOVER ANALYSIS

In the 1970s, "pushover analysis" was created as a new name for nonlinear static analysis. On the other hand, it didn't reach its full potential until about ten to fifteen years ago. With this method, you can figure out how strong a building is, how much it can move, and how much stress an earthquake will put on it. This method could be used to find out if a newly built structure is good for the job it was made for. In the past few years, pushover analysis has been added to more seismic design recommendations (ATC 40 and FEMA 356) and building codes (Eurocode 8 and PCM 3274) because it is useful and easy to calculate. It is possible to simulate the inertia forces of an earthquake by using a mathematical model that directly includes the nonlinear load-deformation characteristics of each building component and element. The model is then subjected to increasing lateral loads until a "target displacement" is reached. As soon as this "target displacement" is reached, the building is said to have "pushed over." These kinds of analyses are done until a "target displacement" is reached. The goal displacement is the amount that the roof of the building is expected to move because of the chosen seismic ground motion (both elastically and inelastically). The pushover method is a nonlinear approach to static analysis that can be used to measure the performance of a structure. It looks at how well the structure can stand up to forces like wind and earthquakes. Find out how well the building can handle earthquakes. The seismic demand is made up of four parts: global displacements (at the roof or any other point of reference), storey drifts (storey forces), component deformations, and component forces. During the investigation, the nonlinearity of the geometry, the stiffness of the material, and how the forces inside the object are spread out are all taken into account. With the pushover analysis, you can figure out the following things about a reaction: As a first step, try to figure out how much force and movement the structure can handle. The output of each member and the movement of the capacity curve as a whole are shown one after the other. Forces and deformations that can be put on brittle or ductile materials are calculated (axial, shear, and moment). c) Estimates of the amount of movement needed around the world, drifts between floors, and damage to structural and non-structural parts that are expected because of the earthquake ground motion that was taken into account. d) The order in which different parts of the structure broke, as well as how this affected the stability of the whole thing. e) The identification of the crucial regions, which are the parts of the building where the amount of inelastic deformation is expected to be high, as well as the identification of any abnormalities in the building's strength, either in plan or in elevation. In comparison to linear static analysis, pushover analysis offers all of these advantages despite requiring a greater amount of computer work (in the form of modelling nonlinearity and altering the analysis technique) (in the form of modelling nonlinearity and altering the analysis technique). The pushover analysis process will be broken down step by step in the following discussion.

Proposed methodology

In this section, we look at how the nonlinear behaviour of the soil affects the way the soil structure system responds to a seismic event. For both of these groups, the investigation was done. Soil . There is a chance that the soil's ability to bend will have a big effect on how the system responds to a quake. In cohesive soil, plasticity moves up from the base of the massif. This slows down the transfer of surface energy and the movement of the superstructure. When the soil's flexibility is taken into account, the amount of work that needs to be done goes down. This is especially true for soils that don't stick together very well. The low soil around the area makes it easier for the structure of a rubbing ground to break down, which causes plasticity to spread from the top down. How a building reacts to an earthquake depends a lot on how well it is built and on the geotechnical soil layer that is close to the surface. On the other hand, soil might act differently depending on how much stress and deformation it is put through. Non-linearities show up in the soil as small changes in shape (10-6 to 10-4). But we need to tell the difference between elastic deformations that can be undone and those that are getting worse. Higher amplitudes mean that there is still some deformation (10-4 to 10-3). Using a non-linear elastic model soil makes the response of the soil mass have different frequencies. This makes it possible to do an analysis of a very complicated interaction between the soil and the structure. If these frequencies are far away from the frequencies that are most common in the load, they may not have much of an effect.

Modeling of RC bridge

In this study, the RC bridge is modelled using the FEM. The bent cap and abutment are shown by a brick element with 8 nodes. The pier and longitudinal girder are shown by a beam element with 2 nodes. Students can use Mander's model as a teaching tool to learn more about how concrete works. The study looked at a reinforced concrete bridge with three spans, two lanes, a width of 9 metres, and a length of 30 metres. A 1.5-m-deep T-shaped girder holds up the whole building. The transverse bent cap over the fixed bearing and latch holds the longitudinal girders in place. Round loading piers that are 8 metres tall and 1 metre in diameter are used to hold up the ship. First of all, they are near the bottom of the building. The end of the span is held up by an abutment that is 2 m wide. It is thought about how well a bridge structure can handle the IRC 70R design live load . Table 1 shows how the RC bridge that was looked at worked mechanically. Researchers have said that IRC 6-2014 and IS 1893-2016 [codes are used to figure out base shear force. The Medium soil type is used to figure out the spectrum acceleration (Sa/g) value.

Table 1. Material properties of the bridge component

Sl. No.	Parameter	Values
1	Modulus of elasticity, E (GPa)	$5000\sqrt{f_{ck}}$
2	Poisson's ratio of concrete, ν	0.2
3	Compressive strength of concrete (MPa)	30
4	Grade of reinforcement (MPa)	Fe415
5	Importance factor (I)	1.2
6	Response reduction factor (R)	5
7	Seismic zone	IV
8	Zone factor	0.24
9	Soil type	Medium
10	Damping ratio	5%

Conclusion

A structure is subjected to the force of gravity when undergoing a static nonlinear analysis using the pushover method. This method also features a lateral load pattern that is governed by a constant displacement. This load pattern will continue to steadily increase until the final condition is attained, during which time it will exhibit both elastic and inelastic behaviour. The magnitude of base shear brought on by earthquake loading can be illustrated by lateral load, and the shape of lateral load can be related to the manner in which mass is distributed along the height of the structure. [Case Study] One might refer to this as the "mode form." The result is a static pushover curve, which illustrates the connection between a strength-based metric and the amount of deflection. For instance, performance may plot bending moment against plastic rotation or link the amount of strength obtained in certain members to the amount of sideways movement at the top of the structure. Additionally, performance may plot plastic rotation against bending moment. One more illustration would be to link the moment of bending to the rotation of the plastic. The findings provide insight into the degree to which the structural system is flexible and demonstrate the manner in which, the degree to which, and the degree to which the structure can bend before it snaps. When a frame object is being evaluated, discrete hinge locations that experience plastic rotation are assigned material nonlinearity. This meets the requirements outlined in FEMA 356, so that's a good sign. The static pushover study takes into consideration strength declines, displacement controls, and all other nonlinear software properties. Included in this is the link assessment P delta impact, as well as phased structures. Analyses are carried out on the many models, each of which possesses distinctive spans, concrete properties, and steel grades. In this particular instance, the pushover analysis of the bridge is carried out with the assistance of the CSI Bridge programme. When conducting the analysis, each of the following loads—the gravity load, the push x load, and the push y load—are taken into consideration: Following the completion of the pushover study, we were able to get pushover curves.

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