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BRIDGE ANALYSIS UNDER EARTHQUAKE MOTION

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ABSTRACT

In Nepal earthquake, in a bridge was developed crack in beam. Dislocation of the beam was also cause of earthquake. In study earthquake motions records from the bridge site and help of motions record can analyse the bridge's with time history analysis. Stresses of the beam are taken into account in the bridge model. Crack process and effects of crack held in discussion. For high stress zone different motion records are taken. The result show that fracture develop when the beam's tensile stress surpasses concrete tensile strength during earthquake excitations.

Keywords: Earthquake Record, Beam And Uplift, Shear Key, Friction Bearing.

I. INTRODUCTION

Over past decades, several bridges with piers and lengthy spans have been built in India's Himalayan areas, which present a significant danger of earthquakes. It is usually accepted that the main beam would remain elastic throughout an earthquake, whereas the damage from it will mostly affect the bridge piers. It should be mentioned that the design of pre-stressed concrete bridges frequently ignores the effects of earthquakes on their primary beams.

The bridge, which was less than 100 kilometres from the epicentre of the 2008 India earth-quake, sustained clear damage. Both the approach bridge and the main bridge were harmed. The ap-proach bridge's tenth span, which was only supported, had lost a beam. It is important to note that the bridge's beam suffered from substantial cracking, and there was also substantial lateral residual displacement in the side span. This incident shows that greater attention must be paid to the bridge's damage mechanism. Field examinations and study have been done for the Bridge following the earthquake. In the closing portion of the side span of the bridge during the earthquake. It is thought that the tensile stress at the beam's bottom plate beat out the tensile strength of the concrete.

In general, there is still a dearth of numerical computation-based comparison examination of the beam fracture caused by genuine earthquake damage to the Bridge. There hasn't been a good explanation of the cracking process, influencing variables, or control of beam seismic damage. The primary stress along the section of the beam is determined based on the real earthquake damage to the bridge's beam sustained in the 2008 earthquake by taking into account the process of construction using a model created by Midas Civil software. Next, a time history analysis using records from 2008 India earthquake close to the bridge site is completed.

II. METHODOLOGY

Beam Failure due to EQ Motion

A prestressed concrete bridge with a span of 40 metres served as the primary bridge. With Beam, 3D prestressed technologies were used to design the primary bridge beam. The beam was built using a full-pre-stressed design, therefore tensile stress was not permitted during bridge operation. The beam was cast by M-45 grade of concrete. The bridge's two-way moveable basin rubber bearings are located on top of the piers on each side of the span with a 20,000 kN vertical bearing capacity were placed. 20 cm of displacement could be made longitudinally and 4 cm of displacement could be made laterally. There have been reports of a number of typical technical issues with prestress concrete bridges, including main beam prestress loss, web cracking, and mid-span bending.

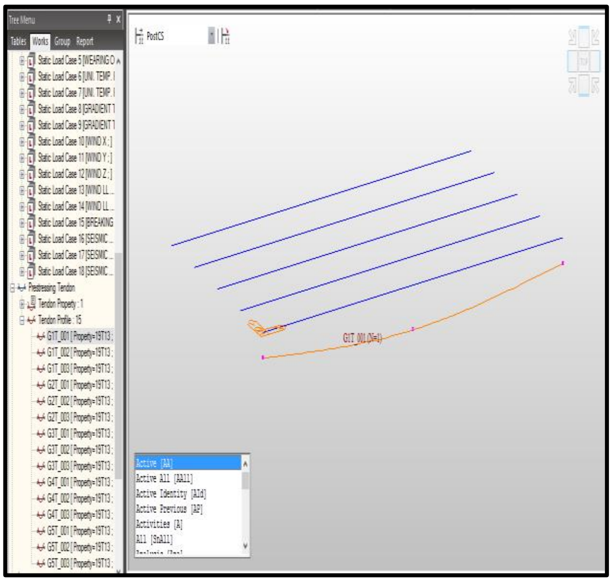
Figure depicts longitudinal fracture distribution along the bridge beam and images of seismic damage. The majority of the fractures in the beam's web are angled cracks created as the sec-tion ascended from bottom to top. The number of fractures throughout the bridge are almost evenly distributed on the upstream and downstream sides. The closure portion of the construction is where has the most cracks.

They can be found in the middle or end spans of the bridge. The neighbouring parts of the closing section have cracked. The concrete in the mid-span and side-span of the closing por-tions looked to have collapsed in the area directly beneath the structure's beam.[16] Additionally, concrete extrusion and spalling are evident. Because the pavement was completed before the earth-quake, the fissure on the top of the portion cannot be seen clearly.

Figure 1. Longitudinal Crack in web of Beam from bottom to top face

Finite elemet model using software

Using Midas Civil software, finite element modelling is carried out. On-site, the cantilever cast pro-cess was used to build the main bridge. According the technique, the initial stress under the dead load for the beam section is present in the starting phase. The building process is numerically simu-lated utilizing a suspended basket, wet weight acting, deck concrete loading, and prestressed loading using 402 prestressing tendons.The distance between the beam and the shear keys in the transverse direction of the bridge is just 12 cm (including the rubber block), which limits the transverse dis-placement. Furthermore, when the friction factor equals 0, the constraint on the bridge's longitudi-nal orientation is removed.



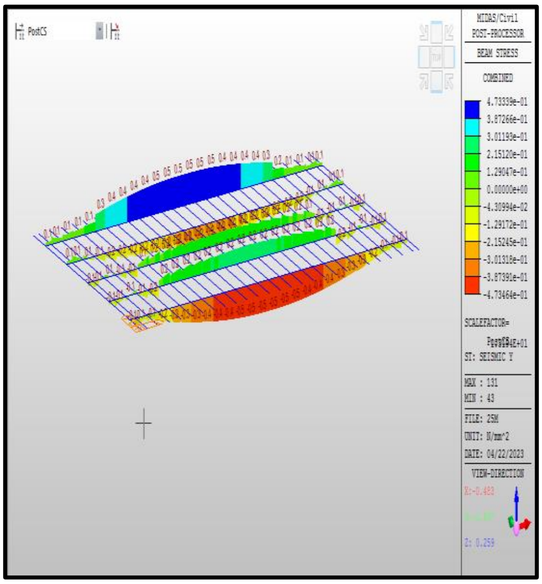


Figure 2: 19T13 Tendon Beam **Figure 3:** Stress in Beam

Despite the fact that the outcomes of the computation in this study are somewhat lower than the actual data collected during the cantilever casting process, the stress levels at the point of closing (the condition of the bridge's completion) is just under 2 MPa lower than the genuine monitoring data. It demonstrates how well scientific calculations link to the real building process and proves the accuracy of the bridge's main beam's initial stress.

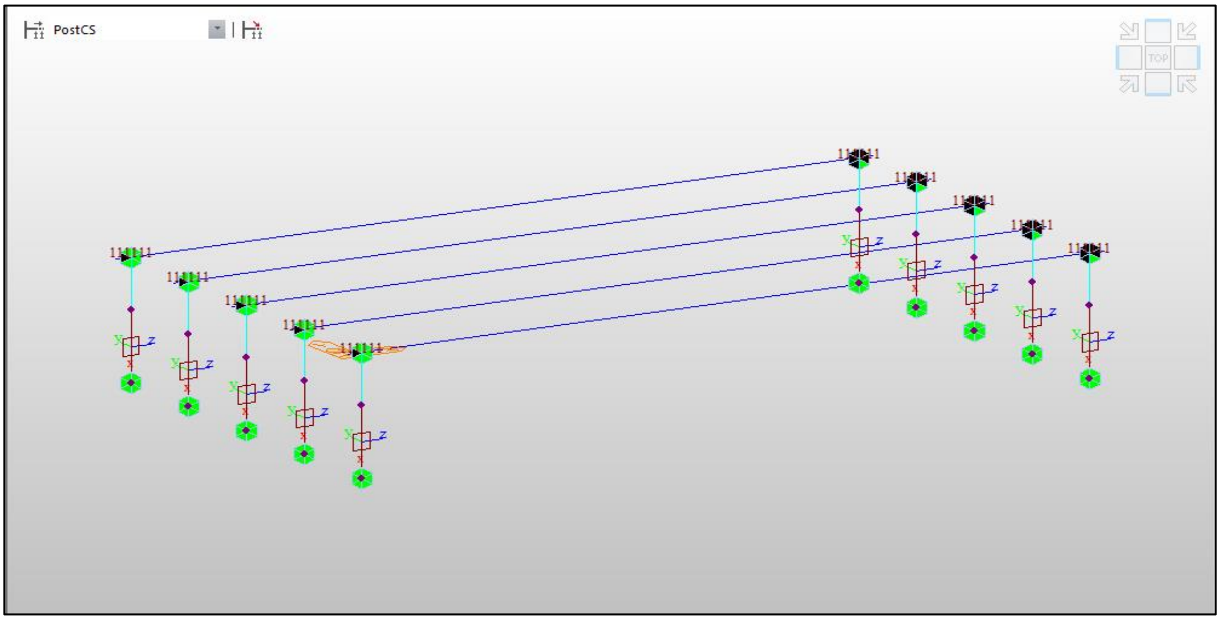


Figure 4: Boundary Condition of Span

The seismic record and the medium/hard site soil characteristics that are frequently used in the lit-erature for time history analysis are also applicable to the seismic record.

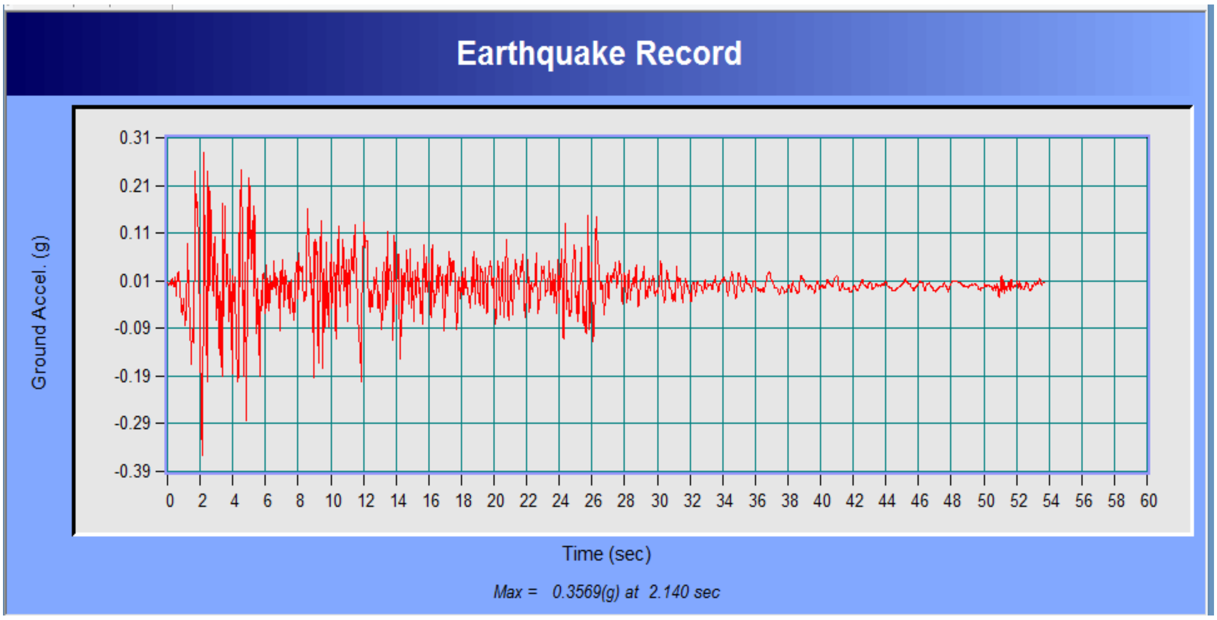


Figure 5: Earthquake Record close to the site

Beam cracking effect

It should be noted that in scenarios with different input excitations, the cracking damage regions agree with the larger tension and compression stress zones. The initial force of the dead load under the ground movements is taken while doing time-history analysis for the bridge. Because of short period of study, just the beam's stress responses under scaled-amplitude ground motions are de-scribed. The major compressive stress of M45 concrete's axial compressive strength (40.5 MPa). The major tensile and compressive stress values of the webs are quite low for side-spans. The principal stresses' maximum values are 43 MPa for tensile stress and 131 MPa for compressive stress.

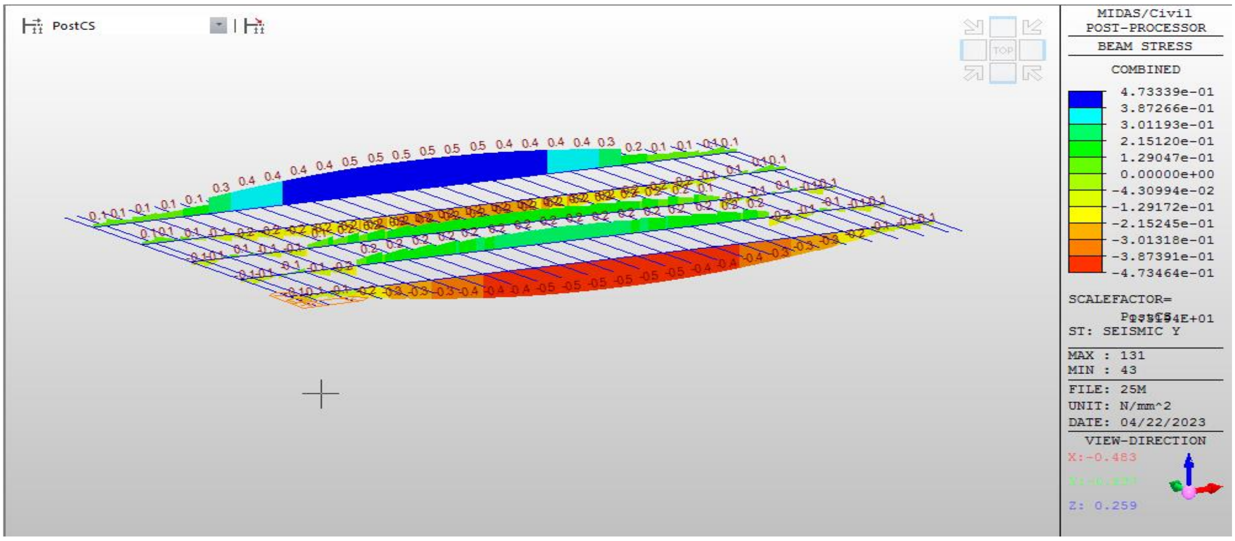


Figure 6: Beam Stress due to earthquake

The high tensile and high compressive stress distribution regions that are determined from numeri-cal computation are closer to the real fracture zones. The results are in line with the Bridge's seismic damage. The major determinant of the stress on the bridge's main beams is the height of the piers, with the span perhaps having a secondary effect. The bridge's spans are longer, and its princi-pal tensile and compressive stresses are higher. It demonstrates how broadly applicable the analytical findings of this paper are.

Shearkey damage effect

The seismic cracks at the ends of the beams for the bridge's two side spans is depicted in The evolution of seismic cracks can be inferred from the look. The end of span is vulnerable to significant movement caused by opposite ground movement when the side span's span is considerable. Damage to the bearings and contact of the beam end with the shear keys will result. Because there is no lateral constraint at the end of the beam once the shear keys fail, the displacement reaction will be larger.

The bearings will rapidly wear out their vertical tensile limit and convert to compression-only bearings if the end span mass to middle span mass ratio is low or there is significant vertical earthquake activity. In meantime, it is simple to slap the top of the pier vertically with beam beam.

Figure 7: Damaged Bearing

This section examines how Various boundary conditions have an impact on outcomes and understanding of final earthquake crackes. The effect of earthquake on the bridge are investigated using boundary conditions, each based on earthquake damage to transition pier bearings and shear keys:

a) Bearings don't get damaged while using shear keys, and lateral motions at the beam's end are elastically restrained.

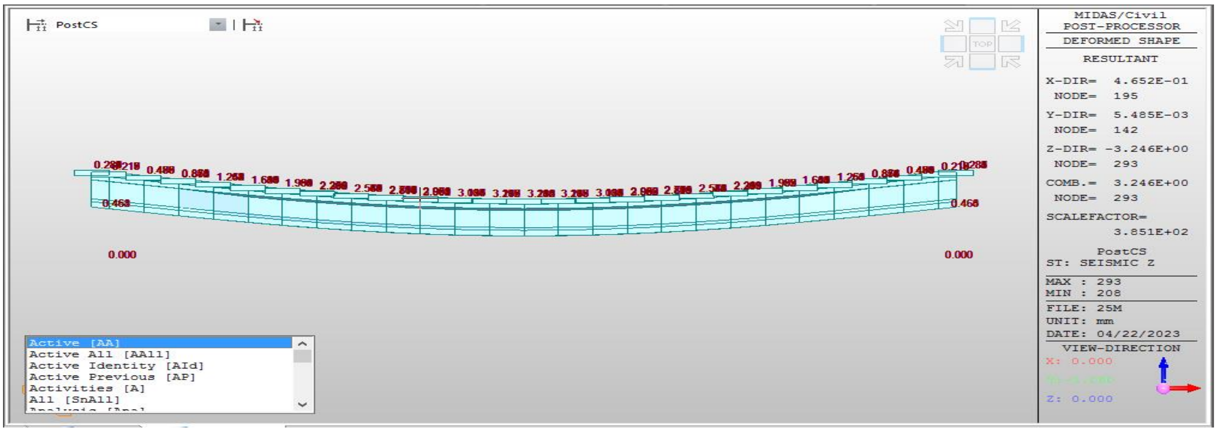
b) shear keys has broken, and the horizontal reactions of the bridge at the beam’s end are un-restrained; bearings are also unharmed.

c) Shear keys are undamaged and may regulate the lateral displacement reaction due to the up-lift of the beam ends. Uplift behaviours of the beam ends in the vertical direction when the bearings fail.

There are no restrictions on the bridge's longitudinal bearings at all. If the records are used as the seismic inputs, then the computation results are quite accurate in predicting the seismic dam-age.The impacts of shear key damage and compression-only behaviour (uplift) of beam ends are investigated using section stress, torque force, collision, and displacement of beam ends.

Beam displacement

The lateral displacements of the Bridge's spans that were still there after the earthquake were clearly visible. The beam's lateral displacement was 29 cm.



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MIDAS/Civil
POST-PROCESSOR
DEFORMED SHAPE
RESULTANT
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 NODE=  195
Y-DIR=  5.485E-03
 NODE=  142
Z-DIR= -3.246E+00
 NODE=  293
COMB.=  3.246E+00
 NODE=  293
SCALEFACTOR=
        3.851E+02
PostCS
ST: SEISMIC Z
MAX : 293
MIN : 208
FILE: 25M
UNIT: mm
DATE: 04/22/2023
VIEW-DIRECTION
X: 0.000
Z: 0.000
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Figure 8: Beam Deformation due to shear

The beam transverse drift reactions computation model. side span of the beam ends exhibit signifi-cant lateral displacements following damage to the shear keys. the beam ground movements' maxi-mum transverse displacement response. The beam ends' transverse displacement reactions to ground movement are somewhat bigger (29 cm) than the remaining displacement after the earthquake.

III. CONCLUSION

The most important findings are given here:

- Cracking occurs when the largest (principal) tensile stress exceeds the tensile strength of the concrete.
- The estimated highly stress zones of the section correlate well with the bridge beam's actual earthquake damage.
- The Bridge's numerical modelling findings show that high (primary) tensile stress causes beam fracture.
- Particular consideration shall be given to the influence of parallel ground movement on web cracking in the end span and middle span.
- Consider the influence of directional ground movement on the span of the end, as well as the effects of transverse and vertical ground movement on the middle span, to restrict bot-tom fracturing and crushing.
- Given the failure of lateral shear keys at the main bridge's transition pier, the stress in the beam decreases at the mid-span. However, the beam ends exhibit significant lateral dis-placement reactions.
- When the beam ends are uplifted, the (primary) compressive stress and torque of the beam's side span are greatly decreased.
- The vertical bearing capacity was surpassed by the beam's and bearings' maximum vertical collision force.

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