INTRODUCTION

OBJECTIVE

Investigate the feasibility of using Incremental Dynamic Analysis curves to estimate seismic energy demand in comparison to traditional displacement demand.

Method

- Create Single Degree of Freedom Model
- Run Model with Scaled Earthquake Values
- Export Plastic and Elastic Force and Displacement Demands
- Determine Energy Demand Values
- Compare Plastic and Elastic Demands

Commonly Used Methods

- Force Based Design (FBD)
- Displacement Based Design (DBD)

Current Limitations

- FBD is inherently inaccurate due to the adjustment factors used to estimate inelastic behavior
- DBD assumes an elastic-perfectly plastic behavior

Proposed Alternative

- Energy Based Design (EBD)
- Accounts for both the force and displacement demand values
- No assumptions are made about the inelastic behavior of the structure
- Incremental Dynamic Analysis to determine the energy demand

The IDA curves above are used to directly compare the elastic to plastic demands. A linear correlation would indicate that the plastic demand can be predicted using the elastic demand.

Results

- Stronger Linear Correlation
- Weaker Linear Correlation

Strong Correlation

Energy vs. Displacement Elastic and Plastic Demand Correlation Comparison

Energy and Displacement Coefficient

Energy Coefficient: 84% Average

Coefficient of Variation = 0.182

Larger Variation

CONCLUSION

Final Thoughts:

From this study, it can be seen that EBD is a viable alternative to traditional design procedures. The elastic and plastic energy demands have a stronger linear correlation in comparison to elastic and plastic displacement demands. In using a coefficient to convert elastic demand into plastic demand, displacement based methods were shown to have larger variation. Both these results indicate that the plastic demand can more easily be estimated using EBD methods.

Further investigations should be conducted on different highway bents. This would serve as a means to verify conclusions drawn from this study. EBD should also be investigated in different materials. It would be beneficial to study the practicality of EBD based on different material properties.

References


Mentor: Dr. Giuseppe Lomiento

Kellogg Honors College Capstone Project