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Analysis of Seismic Load for Evaluation the Behavior of Frames System

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تبعا للكود المصرى لحساب للاحمال و القوى فى الاعمال الانشائية واعمال المبانى فانه يوصى باستخدام قيمة معامل تخفيض للقوى للاطارات الخرسانية المسلحة ذات الممطولية الكافية يساوى ٧ و للاطارات الخرسانية المسلحة ذات الممطولية المحدودة يساوى ٥، حيث يعتمد هذا المعامل على درجة الممطولية للنظام الانشائى والتى تعتمد على تفاصيل تسليح الوصلات و العناصر الانشائية المكونة للنظام الانشائى، و يلعب معامل تخفيض القوى دورا هاما فى التعبير عن درجة الممطولية للنظام الانشائى المستخدم حيث يمثل قدرة المنشأ على تبديد طاقة الزلزال فى صورة تشكلات لدنة وهو يعتمد بدوره على معامل الممطولية وهى النسبة بين التشكلات اللدنة و التشكلات المرنة، ويعتبر نظام الاطارات الخرسانية المسلحة من اكثر الانظمة استخداما فى مقاومة قوى الزلازل وذلك نظرا لسهولة تنفيذه و درجة ممطوليته العالية ولذلك وجب التركيز على دراسة مثل هذا النوع من الانظمة الانشائية فى مقاومة قوى الزلازل، فى هذا البحث تم دراسة نظام الاطارات الخرسانية المسلحة فى مقاومة قوى الزلالزل باستخدام التحليل الاستاتيكى الغير خطى لتعيين خواص النظام الانشائى وتعيين قيمة معامل تخفيض الاحمال وقد نتج عن هذا التحليل ان قيمة هذا المعامل اقل من القيمة الموصى بها فى الكود المصرى للاحمال والقوى بمقدار ٣٤ %، و لذلك يوصى بالاخذ فى الاعتبار مقدار هذا التخفيض عند التصميم باستخدام الكود المصرى للاحمال لعمل تصميم امن.

Abstract.

According to ECP-08, it is recommended to use a value for response modification factor (R factor) equal to 5 for limited ductility frames and equal to 7 for ductile frames, in this study a nonlinear pushover analysis will be used for evaluating these values.

Keywords. Seismic shear demand, Frames systems, nonlinear static analysis, pushover curve.

1. Introduction

Buildings should be designed to resist earthquake forces by a lateral load resisting system which have a considerable ductility to dissipate the energy into inelastic deformations, hence R factor plays an important rule for estimating this force. frames considered one of the most lateral resisting systems used to resist seismic force, analysis like this type of lateral system is one of important issue to represent the actual behavior during earthquake shaking, nonlinear pushover analysis conducted for estimating this behavior using Etabs program.

2. Structural system

The case-study is a five bay 3 story frame, the story height and bay length were 12' and 12'-9" respectively, steel yield strength is 60 ksi figure 1 shows the stress strain curve for steel material, while concrete compressive strength is 3.5 ksi figure 2 shows the stress strain curve for reinforced concrete material, the frame columns cross section of 12"x24" has been used throughout the entire column length with 2% reinforcement ratio. However, the beam elements had cross sections of 12"x14" with 1.75% reinforcement ratio, the density of concrete is150 pcf and the thickness of slab is 5 in, Self-weight of beam, columns, and slab was calculated based on size of the sections used, superimposed dead load of 10 psf, live load of 55 psf and cladding of 10 psf was considered. For evaluation of R factor Etabs push over analysis has been conducted for 5 bay 3 story frame by assuming plastic hinges at first and end for each frame object (figure 3 shows assigned frame element labels). Plastic hinge definition conducted according to Fema356. For beams (M3 Degree of freedom) and columns (P-M3 degree of freedom) plastic hinges defined according to table 10-7(concrete beam-flexure item i) &10-8 (concrete column-flexure item i) respectively, depend on previous cross section, reinforcement and length used in the previous study figure 4 shows plastic hinge property for beams and Figure 5 shows plastic hinge property for columns. For geometry nonlinearity P-Δ analysis has been conducted based on 1.2 Dead load. For Mass option lateral mass lumped at story level considering mass source from Dead load + 0.25 live load. Rigid diaphragm has been assigned for joints at each floor level.

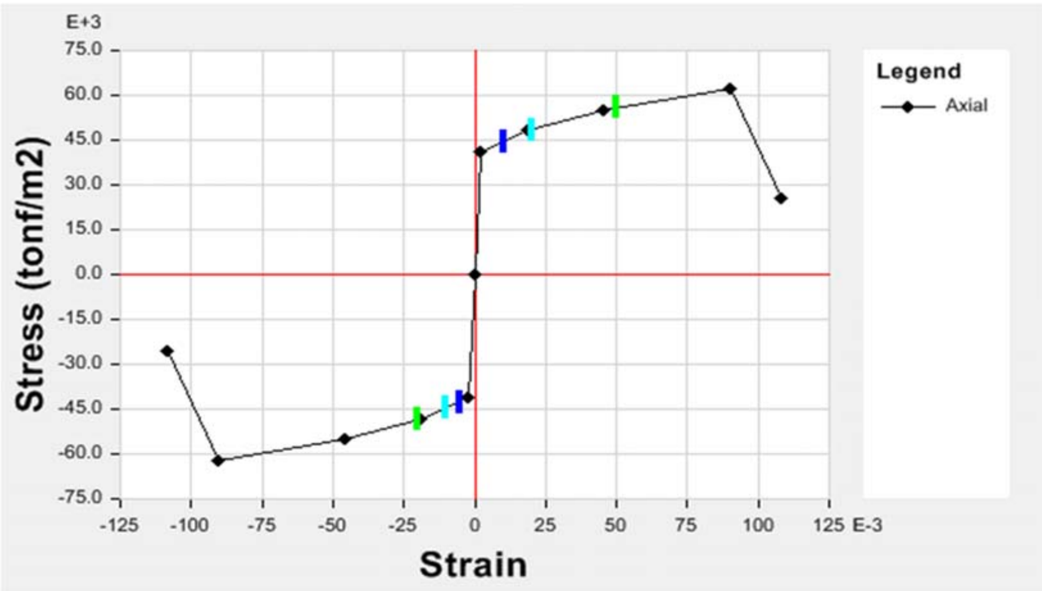


Figure 1. Stress-strain curve for steel material

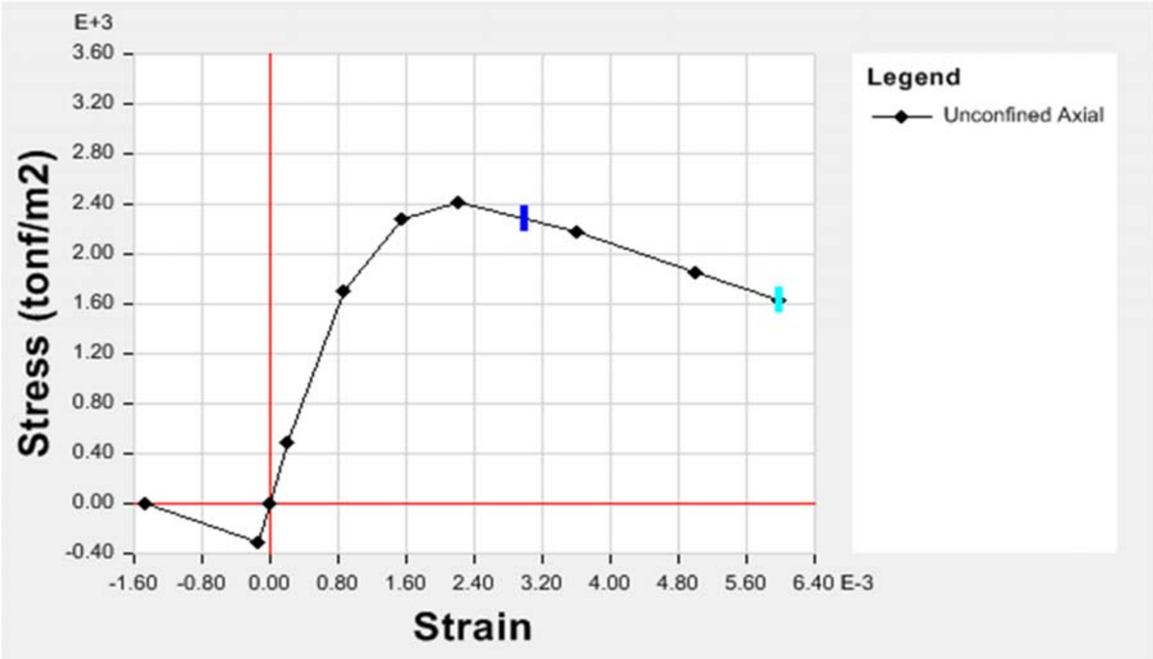


Figure 2. Stress-strain curve for reinforced concrete material

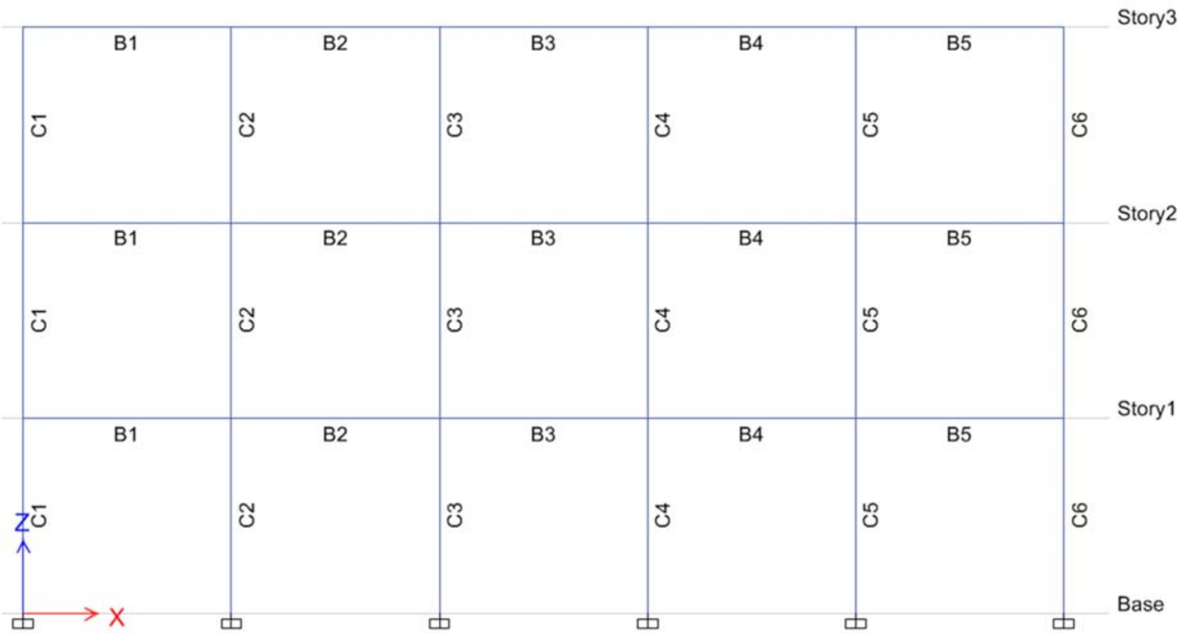


Figure 3. Shows frame element labels

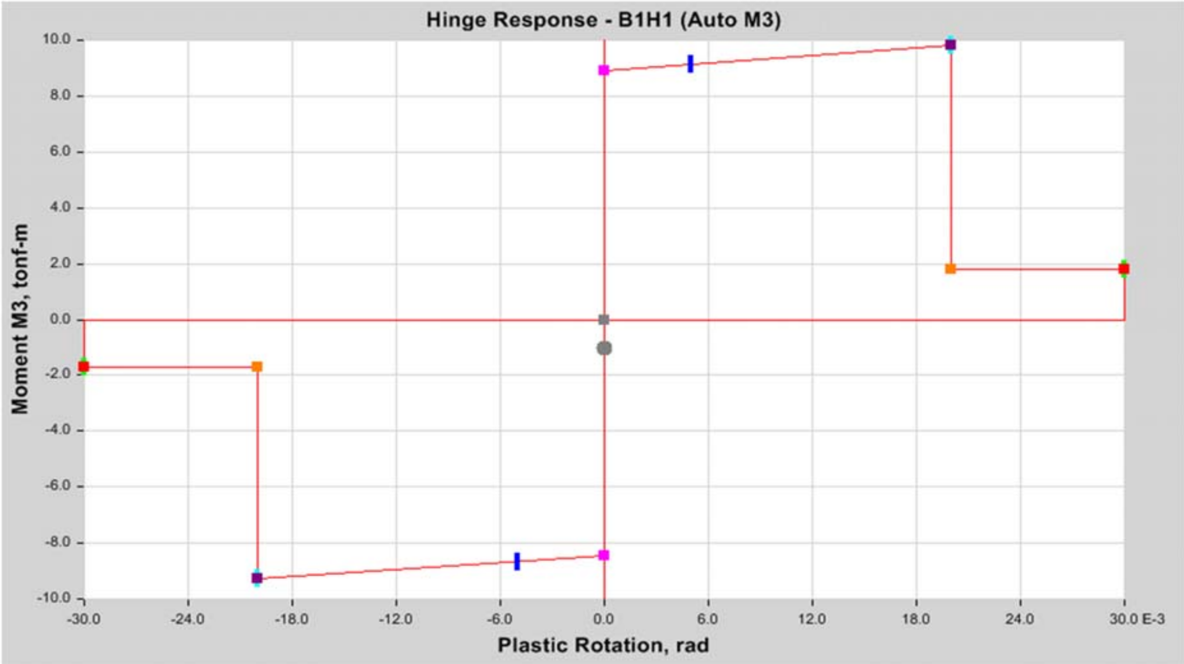


Figure 4. Plastic hinge prosperity for beams

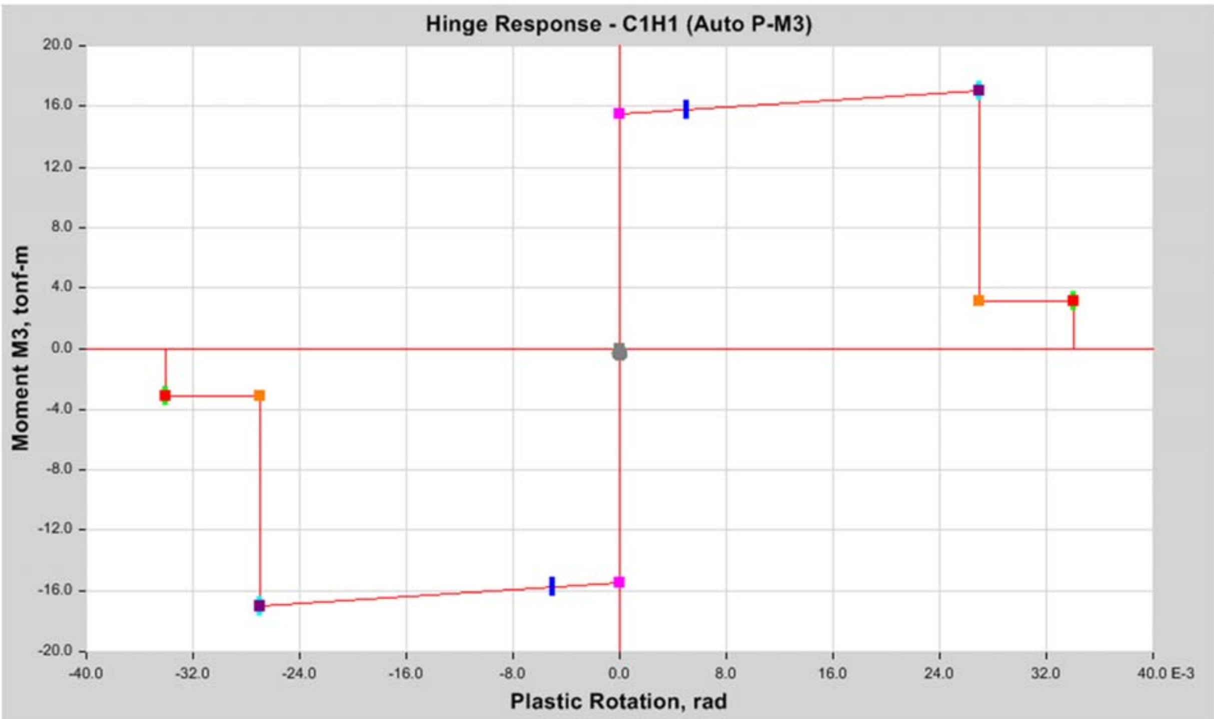
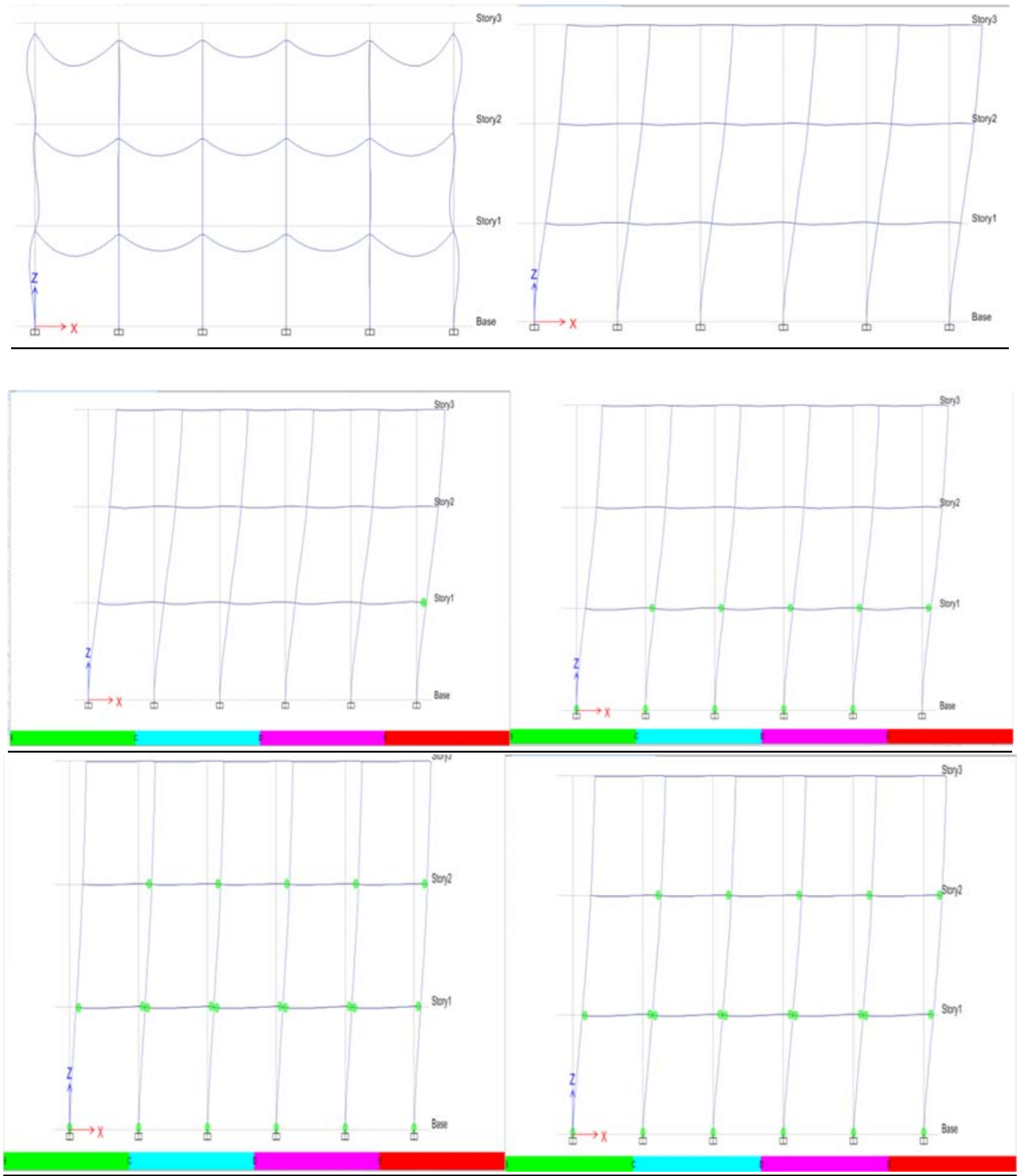
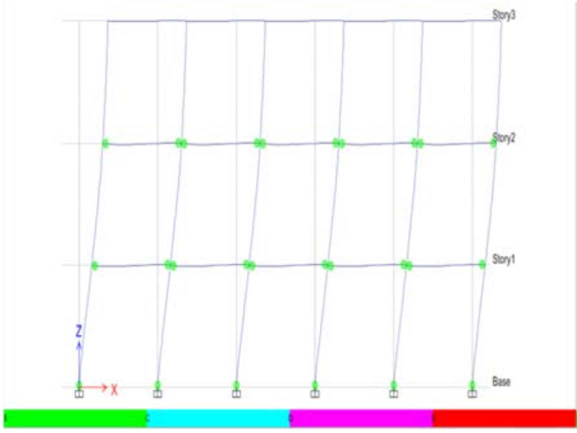


Figure 5. Plastic hinge prosperity for Columns

Push over analysis and formation of plastic hinges has been conducted during 17 steps from dead load to step 17 as below.


Story3
Story2
Story1
Base
Z
X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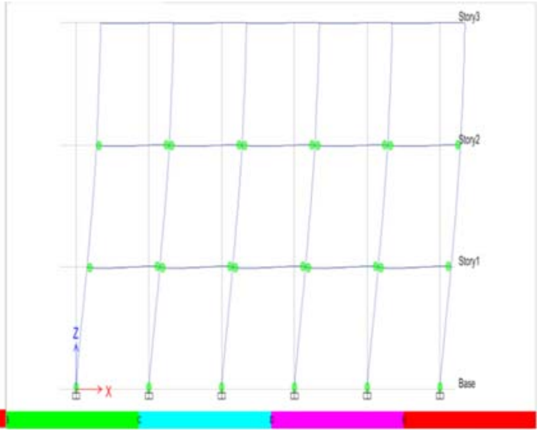
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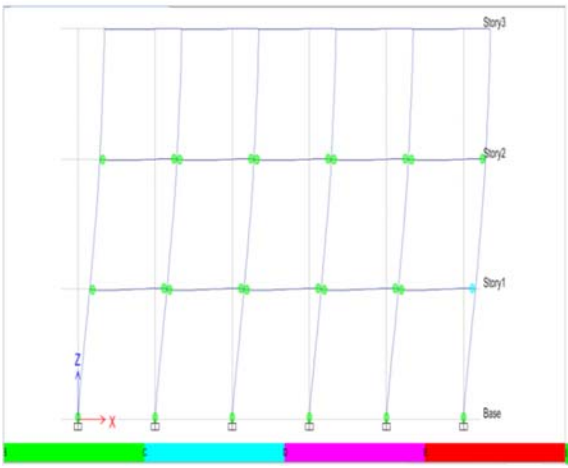
Story3
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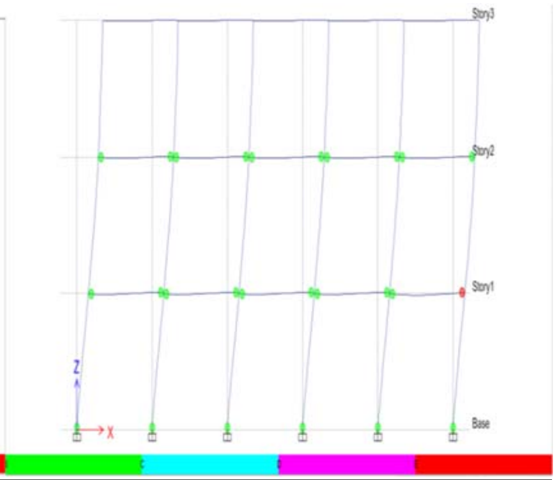
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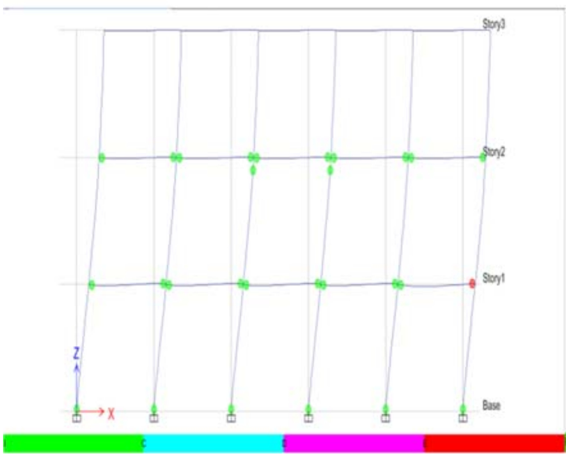
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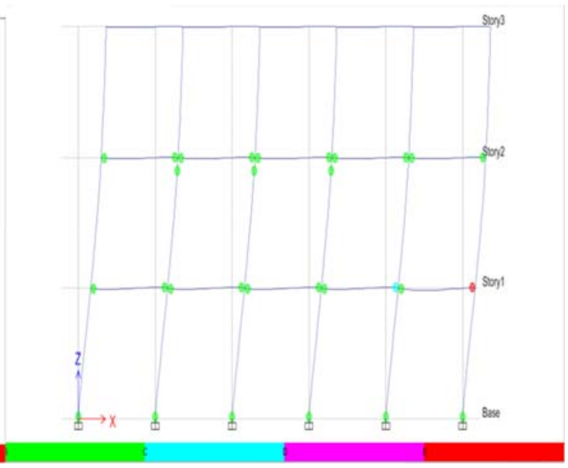
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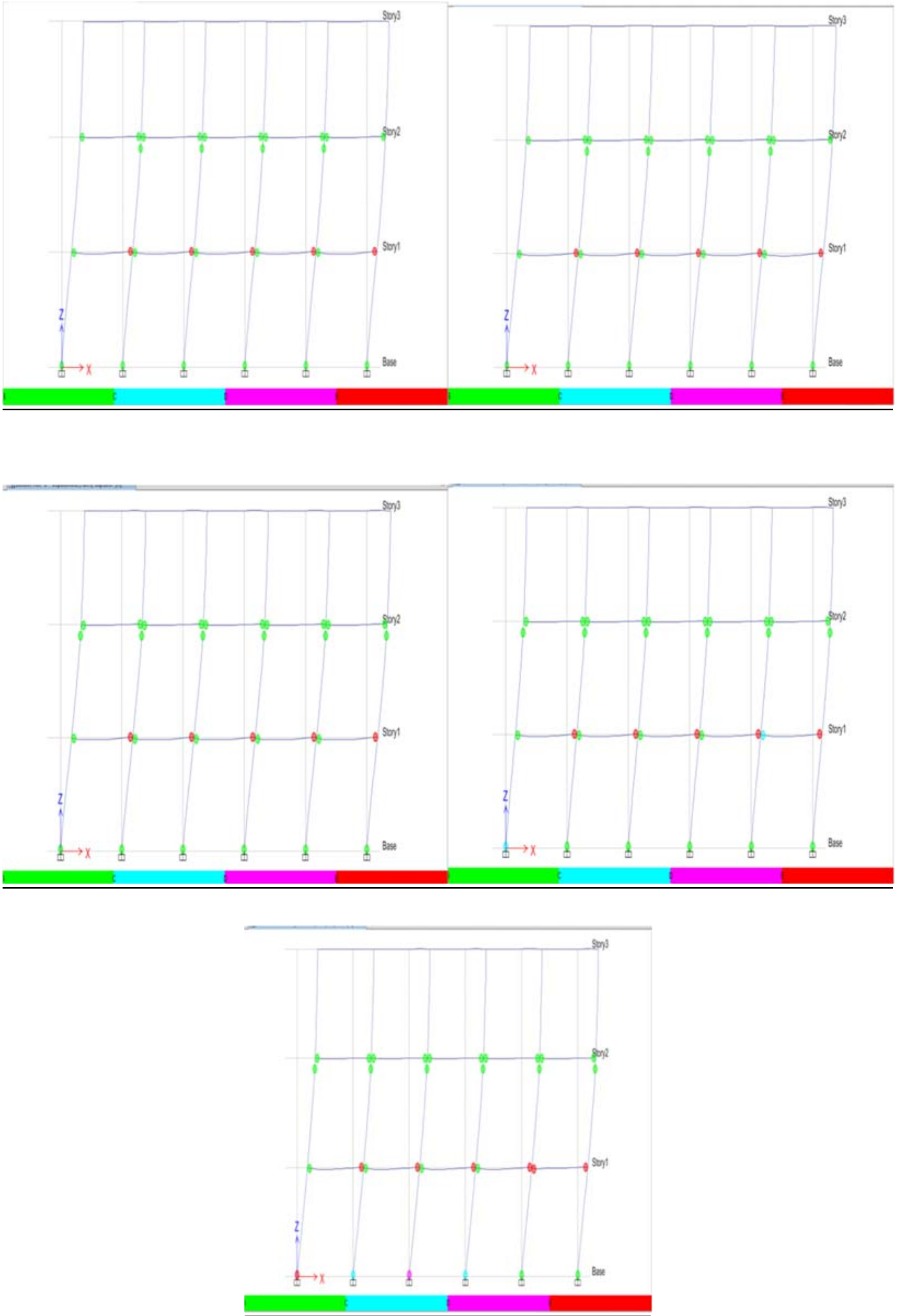

Figure 6. Stages of pushover analysis

3. Results

<u>Push over analysis curve</u>

Figure 7. Base shear-Dislacement curve for building response.

μ = Ultimate Deformation / yield deformation

μ= 0.192282 m / 0.067 m = 2.87

T = 0.775 Sec

From Miranda and Bertero equation

$$R_{\mu} = \frac{\mu - 1}{\Phi} + 1$$

where Φ is a factor type of soil as shown below.

$$\Phi = 1 + \frac{1}{12T - \mu T} - \frac{2}{5T} \exp[-2(\ln T - 0.2)^2] \quad \text{for alluvium site}$$

Ø = 0.8

Rμ = 3.3

4. Conclusions

This study has investigated Response modification factor mentioned in the Egyptian code 2008 to design a five bay 3 story frame by comparing the demands from ECP-08 with those from nonlinear pushover analysis procedures. The results shows that seismic response modification factor of the reinforced concrete frame from non-linear static analysis is different from the factor of the frame designed by nonlinear static analysis procedure. This could lead to shear failure in the shear walls designed by ECP-08. To avoid shear failure in the shear wall elements, the shear demands in the wall elements designed by ECP-08 procedure needs to be modified which is equivalent to modifying the response modification factor R in ECP-08.

5. References

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