ТЕХНИЧЕСКИЕ АСПЕКТЫ СТРОИТЕЛЬСТВА / CONSTRUCTION ENGINEERING

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EFFICIENCY OF MOMENT AMPLIFICATION PROCEDURES FOR THE SECOND-ORDER ANALYSIS OF STEEL FRAMES

Abstract

Beam-column is the member subjected to axial compression and bending. Secondary Moment was accounted for in the design and was additional moment induced by axial load.

Comparing the results analysis from two computer aided software (SAP2000 and Java). The moment amplification factor A_f was inputted in the Java code. A_f did not create any change in the result outputs in the Java Code results.

There are many different ways to apply amplification factors to first-order analysis results, each with various ranges of applicability. The results shown in this paper are the comparative results of the moment diagrams, axial forces, and shear forces. The type of steel used in the design and analysis is ASTM A992.

Keywords: efficiency**,** moment**,** amplification**,** second-order, steel.

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ЭФФЕКТИВНОСТЬ ПРОЦЕДУР УСИЛЕНИЯ МОМЕНТА ДЛЯ АНАЛИЗА СТАЛЬНЫХ РАМОК ВТОРОГО ПОРЯДКА

Аннотация

Сжатоизогнутый элемент представляет собой элемент, подвергнутый осевому сжатию и изгибу. Вторичный момент учтен в конструкции и был дополнительным моментом, вызванным осевой нагрузкой.

Сравнивались результаты анализа из двух программных сред (SAP2000 и Java). В код Java введен коэффициент усиления момента A_f. A_f не дал видимых изменений в результатах, полученных с применением Java Code.

Существует множество способов применения коэффициентов усиления к результатам анализа первого порядка, каждый из которых имеет различные диапазоны применимости. Результаты, представленные в этой статье – это сравнительные результаты диаграмм момента, осевых сил и поперечных сил. Тип стали, используемой при проектировании и анализе – ASTM A992.

Ключевые слова: эффективность, момент, усиление, второй порядок, сталь.
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Introduction

This paper is a continuation (part 2) of [1]. Deriving the value of moment amplification factor from [1], which says A_f = 1.0, this value will be inputted in the Java software with the figures from the column and beam designs derived in [1].

Figure 1 shows the 3D steel frame designed achieved from in computer aided software (SAP2000). After the design, a full analysis is done still on same software. A full illustration of the design procedures are seen in [1], with the calculations of the primary steel structural members (columns and beams), the loads needed in the design analysis of this steel frame is also illustrated in [1]. This paper is the practical and result explanation of reference [1] in which the efficiency of the moment amplification procedures is illustrated.

Moment amplification

Beam-column is the member subjected to axial compression and bending. Secondary moment must be accounted for in the design and are additional moment induced by axial load. AISC permits use of moment amplification method or second order analysis.

Comparing the results analysis from two computer aided software (SAP2000 and Java). The moment amplification factor A_f is inputted in the Java code.

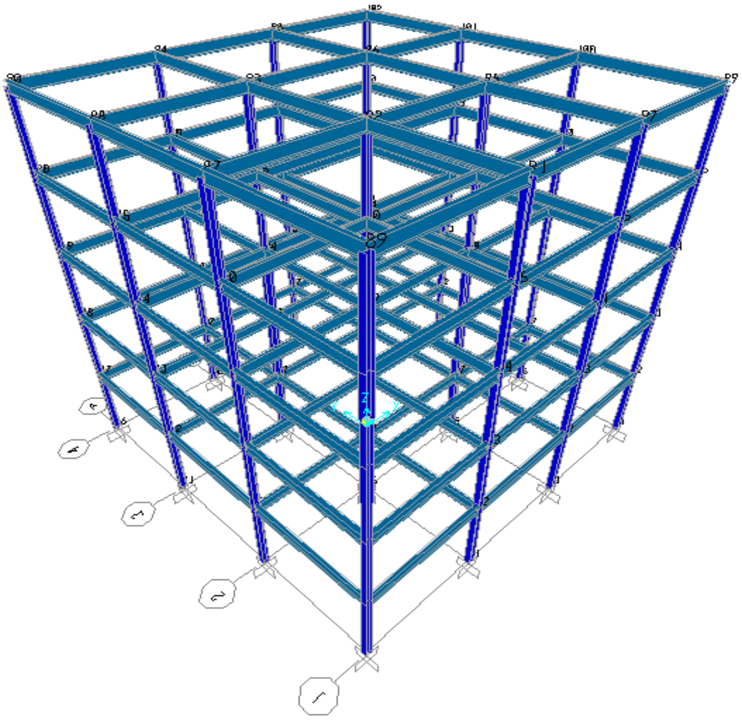


Fig. 1 – A four (4) Storey steel frame

The overall calculation of second-order effects applies to all types of frames: braced frames, moment frames and combined systems. In addition, a second-order analysis must include all gravity load stabilized by the corresponding frame or frames, including loads on the elements.

The destabilizing effects from gravity columns have often been overlooked entirely, or only a part of the gravity load has been included; this can result in significant underestimation of the actual forces and displacements associated with the side-sway of the structure [2].

One of the common way (Amplifier-Based Procedures) in which second-order analysis may be implemented in the design process is implemented in the process of this paper.

Amplifier-based procedures are methods of second-order analysis in which;

- the calculated internal forces caused by design loadings are first-order, and therefore, linear elastic,
- amplification factors are determined based on the ratio of the strength load levels to certain idealized elastic buckling load levels, and
- these amplification factors are applied to the calculated internal forces to account for second-order effects.

There are many different ways to apply amplification factors to first-order analysis results, each with various ranges of applicability. One common method provided in AISC Specification Section C2.1b [3]is known as the B_1-B_2 method.

A key attribute of amplifier-based procedures is the ability to analyze the structure separately for the various types of loading, using simple and efficient linear elastic analysis procedures. Subsequently, the results from these analyses can be combined using superposition.

These procedures allow the gravity and lateral load analyses to be handled separately, which provides for simplicity in the design process. The gravity load analysis may be conducted by hand using simple moment coefficients or by computer software that analyzes all or a portion of the floor framing. The lateral load analysis is done using only lateral loads without any gravity loads.

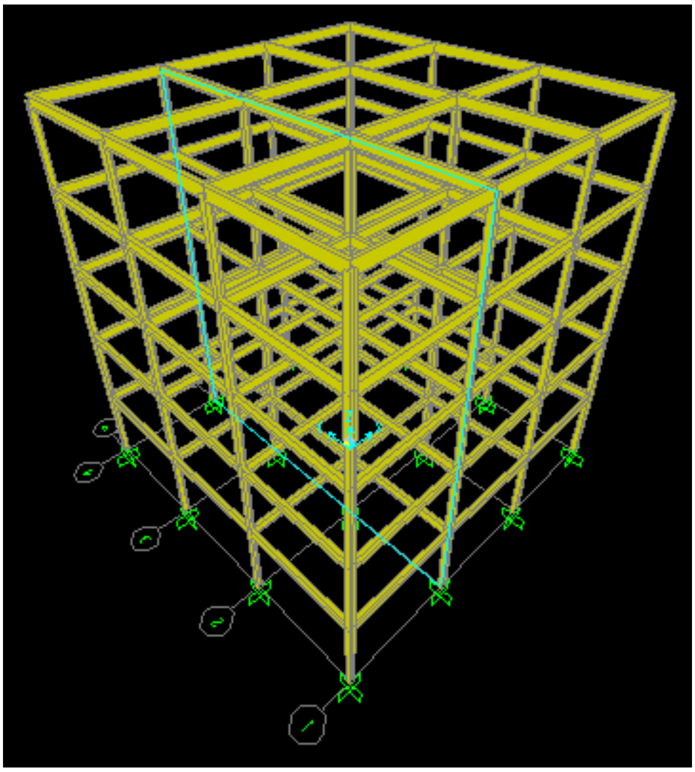


Fig. 2 – A steel frame structure with indicator

Amplifier-based methods lend themselves to regular, orthogonal framing with defined levels and predictable load paths [2]. The second-order effects can be significantly different for each code-prescribed load combination because of the different vertical loads for each combination. One typical illustration is the use of a single conservative amplifier that is applied to all the various load combinations.

Results of Analysis based on the first part of this paper [1].

The type of steel used in the design and analysis is ASTM A992.

ASTM A992 is considered the most suitable for this construction. Full and more detail about STEEL A992 is illustrated in [2].

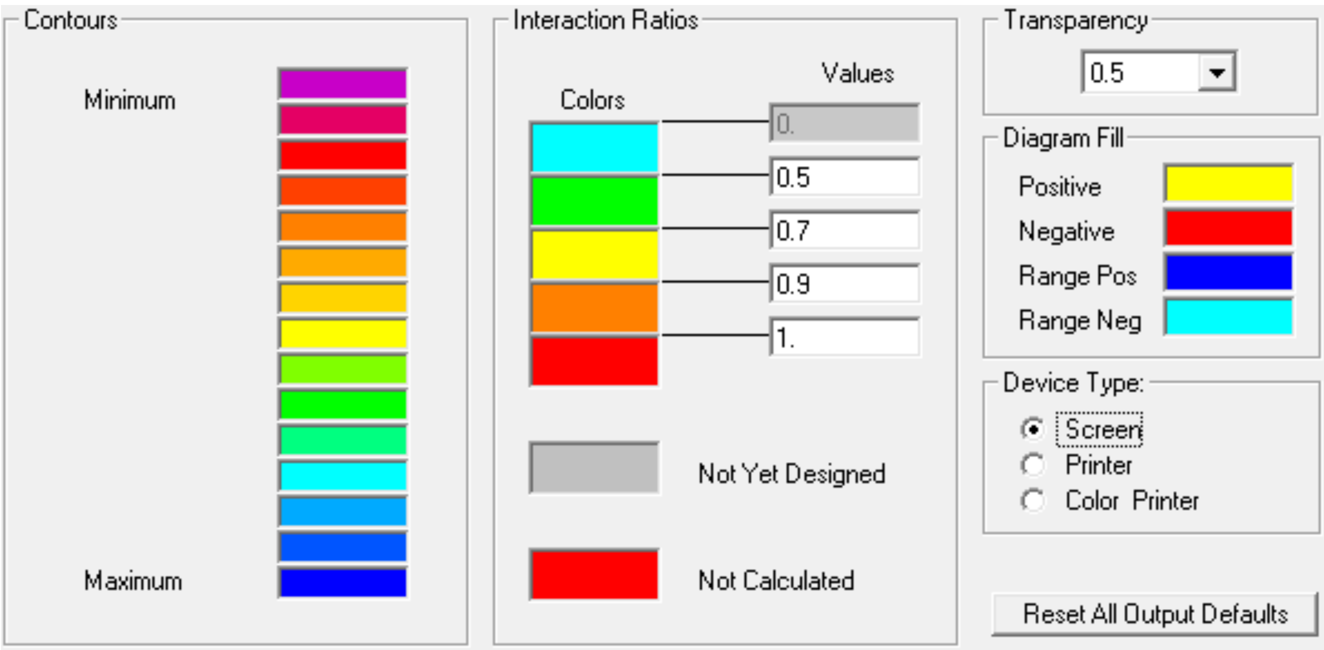


Fig. 3 – Contours color boxes on SAP 2000

The frame section in figure 2, with blue line indicator is the frame section which its analysis and results will be shown and compared in the two computer aided software (SAP2000 and Java IntelliJ IDEA). In figure 4, the steel design section shows the beams and columns sections. With close look, it is discovered that the load bearing systems (beams and columns) are having non- RED color. This means that the systems are able to contain the maximum loads[1] applied on them. Contours color boxes figure 3: Specify the display of maximum to minimum shell stress contours using a range of colors from blue (maximum) to magenta (minimum).

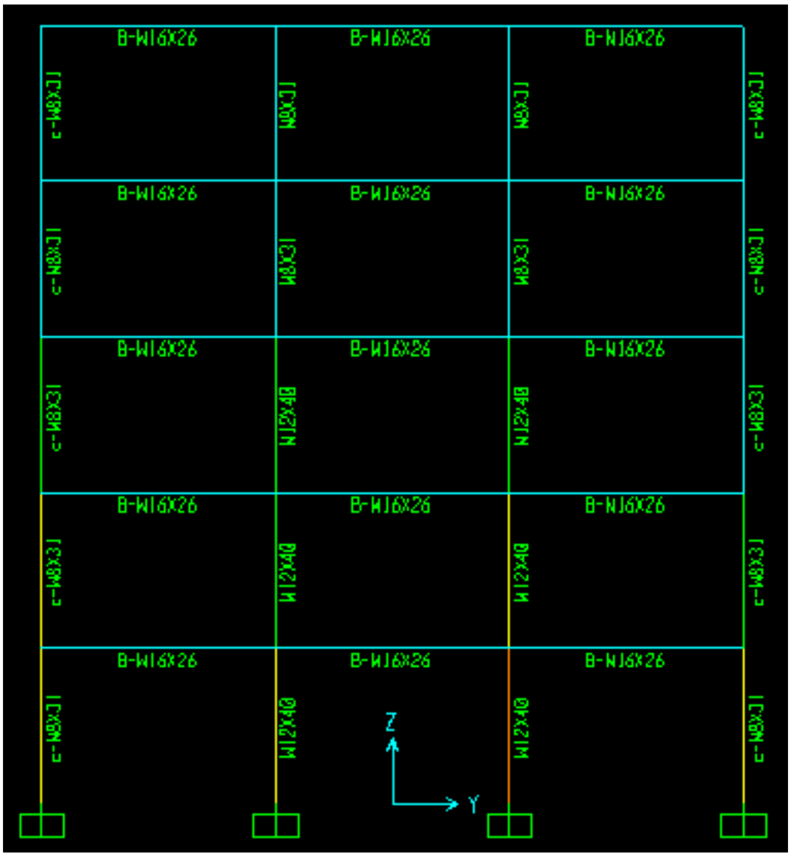


Fig. 4 – Steel design section (AISC-LRFD93) on SAP2000

Working on load combination that is captioned COMB3
constitutes of L+D+W+R, where;

L = Live load
D = Dead load
W = Wind load
R = Rain load

Earthquake is not considered because the assumed location of construction is not prone to earthquake.

After implementing the moment amplification factor in the Java code, the results diagrams in figure 8, 9 and 10 were derived.

This Java code is a developing code on Java that I am still in the process of perfecting the code for public use, for the analysis of structural frames and members.

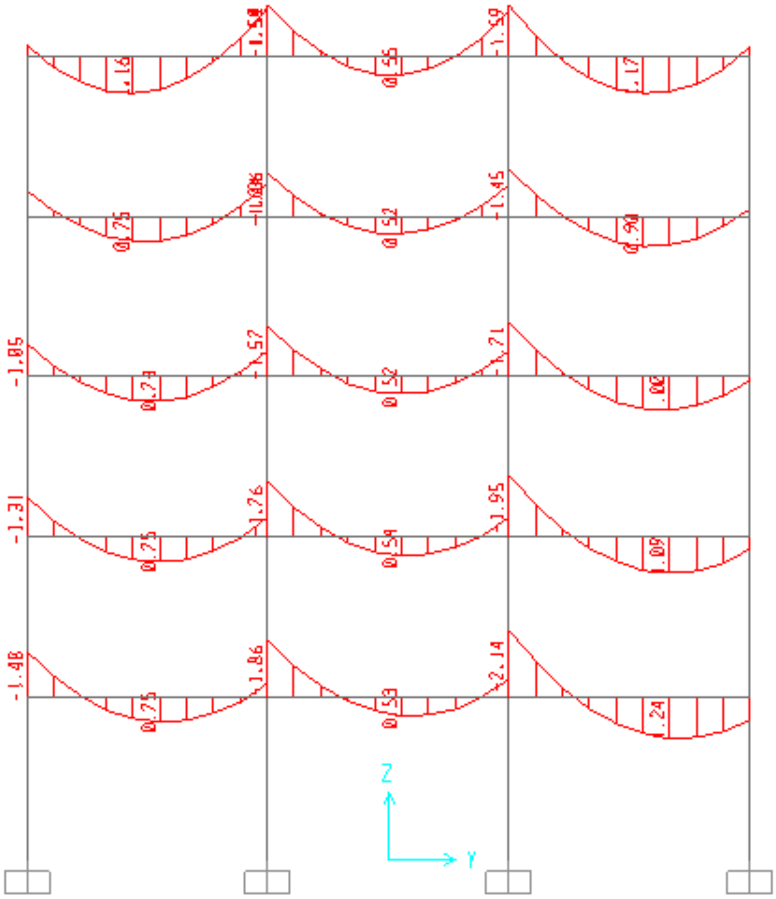


Fig. 5 – Moment 3-3 diagram on SAP2000

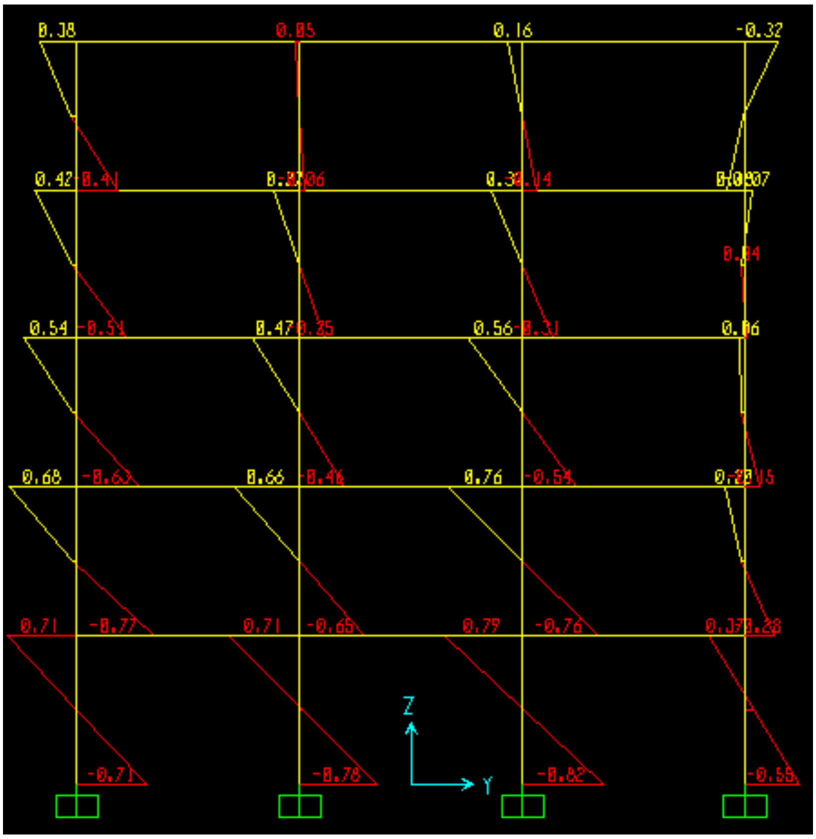


Fig. 6 – Shear Force diagram on SAP2000

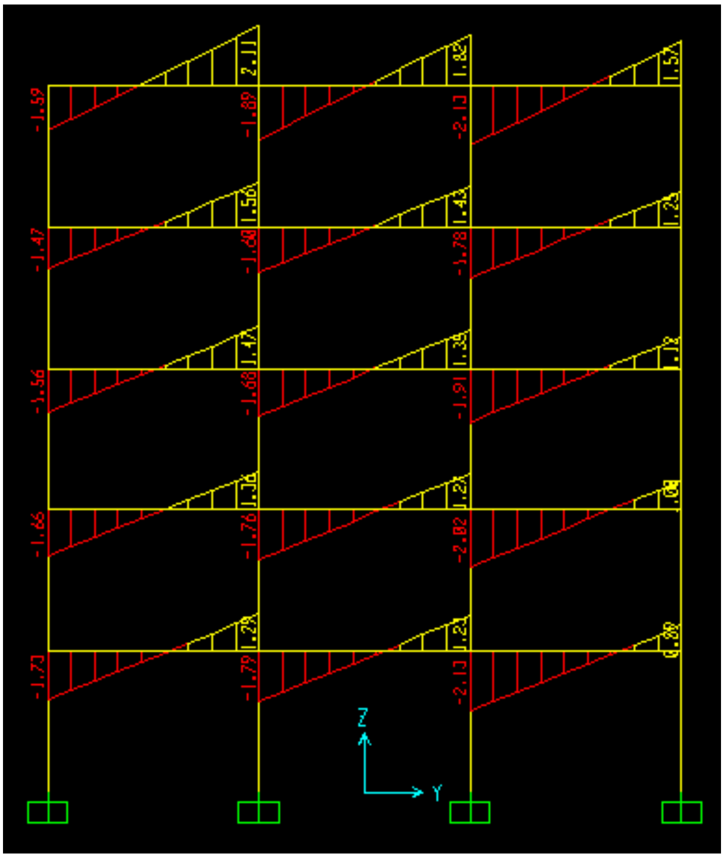


Fig. 7 – Moment 2-2 diagram on SAP2000

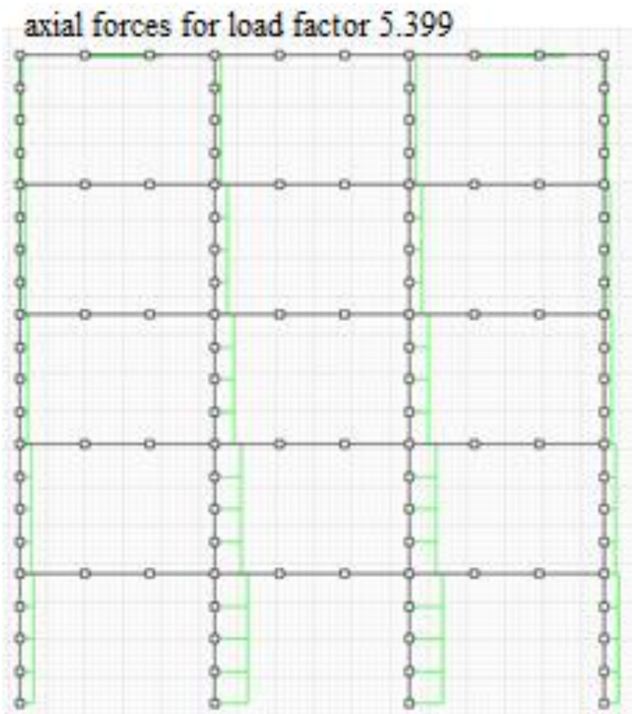
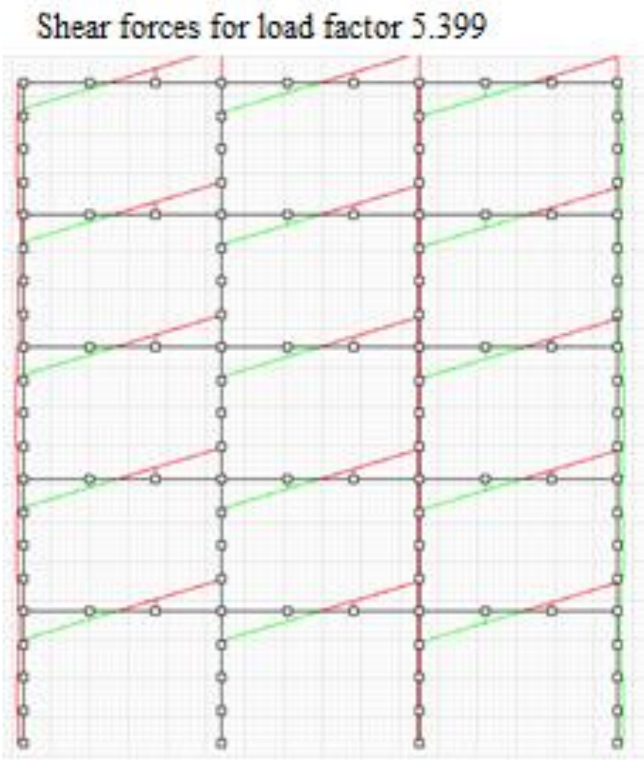


Fig. 8 – Axial Force diagram on Java Code

Figures 5, 6 and 7 show the output result from Computer aided software SAP2000 while figures 8, 9 and 10 show the output result from a Java Code software on IntelliJ IDEA.

After implementing the moment amplification factor $A_f = 1.0$ in the Java code, the results diagrams in figure 8, 9 and 10 were derived.

This Java code is a developing code on Java that I am still in the process of perfecting the code for public use, for the analysis of structural frames and members.



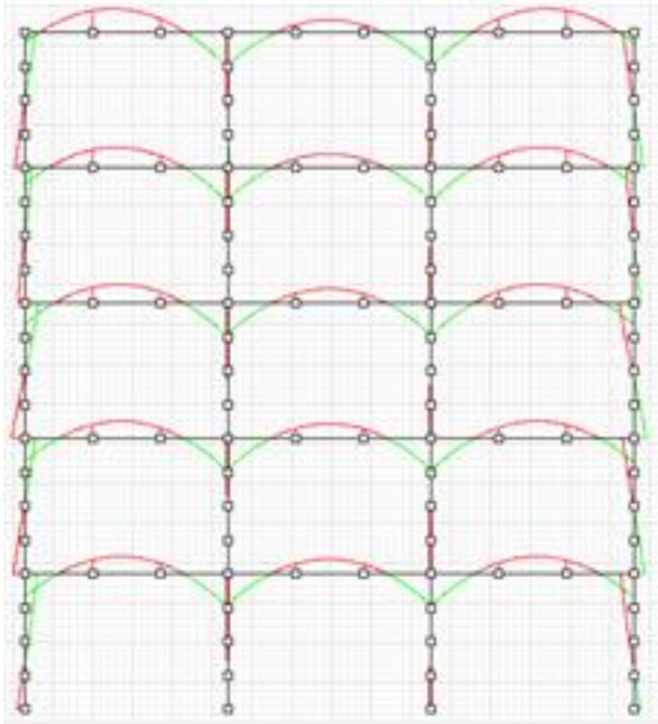


Fig. 9 – Shear Force diagram on Java Code

Fig. 10 – Moment diagram on SAP2000

Conclusion

The moment amplification factor $A_f = 1$, has no effect on the moment diagram neither on the shear force diagram nor on the axial force diagram.

Comparing the moment diagrams of figure 5, 7 and 10, it is recorded that the moment diagram in figure 9 seems to be in negative but, according to my Java code, it is taken as correct. The change in direction on the moment diagram of figure 9 is as a result of the graphics of the java.

In Java code results, the nodes of the frames appears on the frames making a difference between the two software.

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