



**DISCUSSION OF “An approximate method for free vibration analysis of multi-bay coupled shear walls” K. B. Bozdoğan and D. Öztürk, Mathematical and Computational Applications 12, 41-50 , 2007”**

Hikmet Hüseyin Çatal  
Dokuz Eylül University, Civil Engineering Department, Engineering  
Faculty, 35160, Buca, İzmir, Turkey  
huseyin.catal@deu.edu.tr

## **1. INTRODUCTION**

The behavior of coupled shear walls under horizontal loads was idealized as a sandwich beam by the authors. However, it is necessary for this analysis to make assumptions. The authors unfortunately did not present assumptions in the paper and confused the Poisson's ratio with a constant. Furthermore, in Eqs. (1),(5),(6) and (7) of the author's paper are not correct. I wish to make the following comments on the author's paper.

## **2. COMMENTS**

1.) The authors must be present assumptions for this analysis below as in the following:

1. The behavior of the material is linear-elastic and small displacement theory is valid.
2. P-Δ effects are negligible.
3. The cross-sections of the members are constant.
4. The axes of the members are linear.
5. The heights of storey are regular.

2.) The authors mentioned in the section 2 that under the horizontal loads the equations for a coupled shear wall of the  $i$  th storey can be written as

$$EI_i \frac{d^4 y_i}{dz_i^4} - GA_i \frac{d^2 y_i}{dz_i^2} + GA \frac{d\psi_i}{dz_i} = 0$$

The above equation is derived incorrectly in the paper because external horizontal loads are omitted by the authors. The mathematical model of equivalent sandwich beam should be as (figure-1)

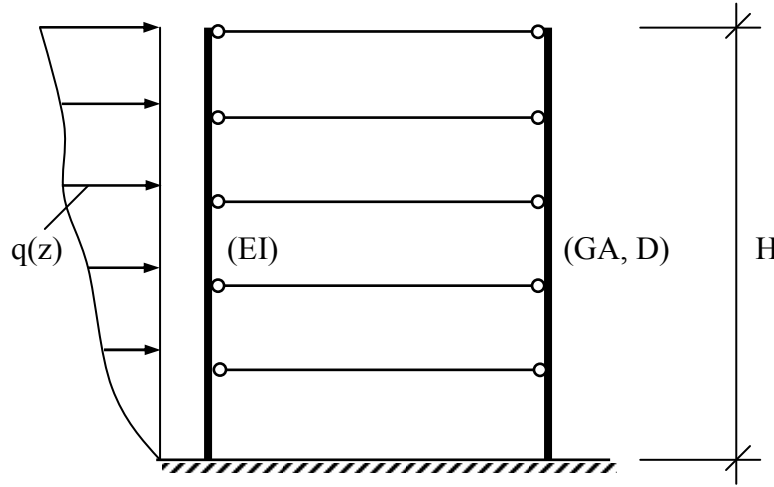


Figure-1: Mathematical model of equivalent sandwich beam.

Equation (1) of the paper should be rewritten as

$$EI_i \frac{d^4 y_i}{dz_i^4} - GA_i \frac{d^2 y_i}{dz_i^2} + GA_i \frac{d\psi_i}{dz_i} = q(z) \quad (1)$$

Where,  $q(z)$  is external horizontal load function. Thus, Eqs.(5),(6) and (7) of the paper which are derived by using equation (1) of the paper are not correct.

3.) In the fifth paragraph of section 2, the authors mentioned that  $\rho$  in eq.(4) is the poisson ratio. The definition of  $\rho$  is not true. Poisson's ratio is the ratio of transverse contraction strain to longitudinal extension strain in the direction of stretching force [1]. In equation (4) of the paper,  $\rho$  must be a constant whose value depends on the shape of the cross-section of the beams [2],[3],[4].  $\rho$  can be calculated as below [5].

$$\rho = \frac{A}{I_x^2} \int \frac{S_x^2}{A b^2} dA \quad (3)$$

Where,  $A$ ,  $I_x$ ,  $b$ ,  $S_x$  are cross-section area, moment of inertia, the width of beam and first moment of the total cross-section area about neutral axis  $x$ , respectively.

The value of  $\rho$  is calculated for a beam with a rectangular cross-section of width ( $b$ ) and depth ( $h$ ) as shown in fig-2 below:

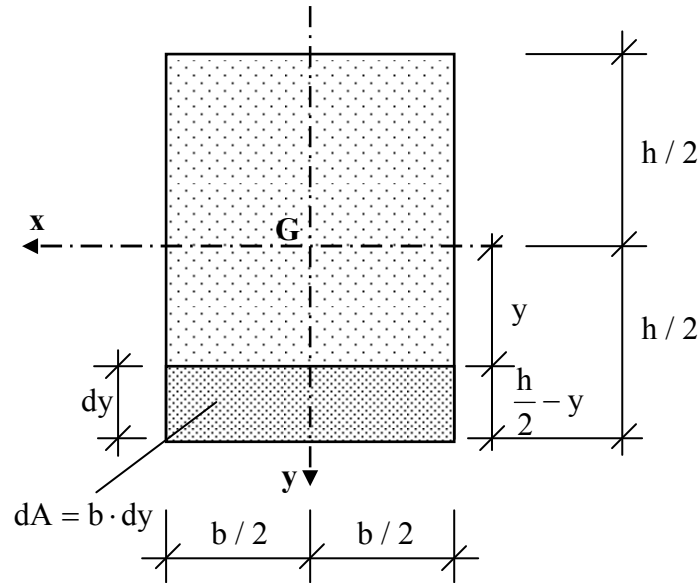


Figure-2: The beam with a rectangular cross-section.

$$S_x = \frac{b}{2} \left( \frac{h^2}{4} - y^2 \right); A = bh; dA = bdy \quad (4)$$

$$\rho = \frac{72}{h^5} \int_0^{h/2} \left( \frac{h^4}{16} - \frac{h^2}{2} y^2 + y^4 \right) dy = 1.2 \quad (5)$$

Thus, the value of  $\rho$  must be 1.2 for rectangular cross-section beams.

4.) The values of the equivalent shear rigidities of connecting beams ( $GA_i$ ) which were calculated by poisson's ratio are not correct in the numerical examples. These equivalent shear rigidities must be calculated by a constant whose value depends on shape of the cross-section of the beams ( $\rho=1.2$ ).

### 3. REFERENCES

1. Timoshenko S.P., Goodier J.N. ,Theory of Elasticity. McGraw-Hill Book Co.,Singapore,1970.
2. Zalka K.A., A simple method for the deflection analysis of tall wall-frame building structures under horizontal load, The Structural Design of Tall and Special Buildings. DOI:10.1002/tal.410,2007.
3. Zalka K.A, Buckling analysis of buildings barced by frame works, shear walls and cores, The Structural Design of Tall and Special Buildings. 11(2002):197-291.
4. Zalka K.A., A simplified method for calculation of the natural frequencies of wall-frame buildings, Engineering Structures. 23 (2001) 1544-1555.
5. Pöschl Th. ,Lehrbuch der Technischen Mechanik. Springer: Berlin,1930.