ABSTRACT

Simplified and accurate methods of analysis are required for quick, repetitive and low cost analysis of tall buildings.

In this work a new simplified analysis method called the "Moment Transformation Method" is developed and used to analyze two and three dimensional tall buildings subjected to vertical and horizontal loads. A computer program "MTProg" is developed and implemented for the method. Several different two and three dimensional problems are analyzed by using the program and the results obtained are verified by comparison with the published results.

A case study of a fifteen floors multi-storey building subjected to non-symmetrical lateral loading is analyzed by using the three dimensional option of the program. The accuracy of the results is verified by using the structural analysis packages ETABS and STAADPro.

The results used for verification are:

(i) The lateral displacements and the twist rotations of the joints at each floor level. (ii) Bending moments, shear forces, torsion moments and axial loads induced in the vertical members. (iii) The contour of the moments and shear stresses induced in the floor slabs.

The comparison shows, clearly, that the results are in good agreement, thus verifying the accuracy of the proposed method.

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مستخلص:

هنالك حاجة لطرائق مُبَسَّطة و دقيقة لِلتحليل السريع والمتكرر وقليل التكلفة للمباني العالية .

في هذا البحث تم تطوير طريقـــة تحليـــل مُبَـــسَّطة وجديـــدة هـــي طريقـــة نقـــل العـــزوم , "Moment Transformation Method " وإستخدام هذه الطريقة للتَحليل الثنائي الأبعاد والثلاثي الأبعاد للمباني العالية المعرضة لأحمال أفقية ورأسية في وقت واحد.

تم تطوير برنامج الحاسوب "MTProg" للطريقة المقترحة وتطبيقه.

حللت عدة مسائل ثنائية وثلاثية الأبعاد بإستعمال البرنامج وتم التحقق من النتـــائج بمقارنتهـــا مَـــع النَتـــائِج المَنْشُورة.

وفي دراسة حالة تم تحليل بناية متعددة الطوابق مكونة من خمسة عشر طابقاً أخضعتْ لتحميل جانبيٍ غيـــر متماثل وذلك بإستخدام الخيار الثلاثي الأبعاد للبرنامج . تم التحقق من دقةَ النَتـــائِج بالمقارنـــة مـــع النتـــائج المتحصل عليها بإستخدام برنامجي التحليل الإنشائي ETABS و STAADPro .

النَتائِجَ المستخدمة للتحقق شملت :

(i) الإزاحات الجانبية والدورانات في المفاصلِ في كُل المستويات. (ii) عزوم الثني و قوى القص و عـــزوم الإلتواء والقوى المحورية في الأعضاء الرأسية. (iii) خطوط الكنتور للعزوم وإجهادات القص في البلاطات. المقارنات تؤكد و بشكل واضح أن هنالك توافقاً جيداً بين النتائج ، مما يؤكد دقة الطريقة المقترحة.

DEDICATION

To the cherished memory of my father.

To my mother, whose prayers supplication gave me support and confidence.

To my patient family, whose forbearance has been incentive to work hard on this research.

To the new generation my kids, Rayyan, Mahmood, Baddory, Riham, I hope for them good future.

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LIST OF SYMBOLS

D_j	The displacements corresponding to the stiffness configuration #*j*.
E	Modulus of elasticity.
FE	The moment transformation factor.
G	Modulus of torsional rigidity.
h	Height of a rigid frame.
I	Moment of inertia.
L	Length of member.
M	Bending Moment.
SE and KE	The equivalent stiffness.
*S*ij*	The elements of the condensed rotational stiffness (the modified rotation stiffness).
S^*	The modified or the condensed stiffness of the member.
S_i	The ordinary rotation stiffness of member # *i* ($S_i = 4EI/L$, considering bending deformation only).
$(SR1)_i$	The rotational stiffness of shear wall #*i* in the *u*-direction, due to rotation of 1 radian and translation not permitted.
$(SR_2)_i$	The rotational stiffness of shear wall #*i* in the *v*-direction , due to rotation of 1 radian and translation not permitted.
$(SRT_1)_i$	The rotation stiffness of shear wall # *i* in the *u*-direction, due to translation of 1 unit length and rotation not permitted.
$(SRT_2)_i$	The rotation stiffness of shear wall # *i* in the *v*-direction, due to translation of 1 unit length and rotation not permitted.
$(ST_{ij})_k$	The translation stiffness of shear wall #*k* transformed to the building global coordinates, the transformation matrix used in the transformation of the wall stiffness is due to a unit translation in *x* & *y* directions and unit rotation about the *z* coordinate.
t^*	The modified carry-over moment.
t_i	The ordinary carry-over moment of member # *i* ($t_i = 2EI/L$, Considering bending deformation only).
V	Shear Force.
v	Poisson's Ratio.
θ	The rotation angle in radians.
$[A]_i$	The Condensed Rotation Stiffness Matrix of The Floor # *i*.
$[BC]_i$	The Carry-over Moments Matrix of The Floor # *i*.
$[FF]_i$	The Transformation Factors Matrix of The Floor # *i*.
$[FF]K+1 \rightarrow K+2$	The Transformation Factors Matrix of Floor between. level #*K+1* and level *K+2*.
$[FT]K \rightarrow K+i$	The total transformation factors matrix used to transform. the moments at level # *K* toward the level # *K+i* , ($i \geq 1$).
$[GG]_i$	The Equivalent Rotation Stiffness Matrix of The Floor # *i*.

$[\,KT\,]\,i$	The total stiffness matrix at the level # i.
$[\,NN\,]_i$	The Over All Rotation Stiffness Matrix of the Level # i.
$\{\,MTOT\,\}_i$	The total moments at level # i.
$\{\,MB\,\}_i$	The original and the transformed moments just below the level # i.
$\{\,MT\,\}_i$	The original and the transformed moments just above the level # i.
$\{\,MS\,\}_i$	The original moments at the beams ends of the level # i.
$\{\,ROT\,\}_i$	The rotations of the joints at the level # i.
$\{\,MBf\,\}_i$	The final moments just below the level # i.
$\{\,MTf\,\}_i$	The final moments just above the level # i.
$\{\,MSf\,\}_i$	The final moments at the beams ends of the level # i.
$[B]_\mathrm{i}$	The transformation matrix of shear wall #i.
$[\,D\,]$	Displacement matrix corresponding to the condensed stiffness matrix
$[F_i]_\mathrm{j}$	The internal force at wall# i in the j displacement configuration.
$[\,S^*]$	The condensed rotation stiffness matrix.
$[S_{ij}]$	Sub-Matrices of the main matrix.
$[t^*]$	The carry-over moments matrix.
$[\,u\ \ v\ \ \ rw\,]^T_i$	The local displacements vector, corresponding to the condensed or the adjusted rotation stiffness S^*_{ji}.
$[\,x\ \ y\ \ \ rz\ \,]^T_i$	The global displacements vector, corresponding to the condensed or the adjusted rotation stiffness S^*_{ji}.
[I]	Identity matrix.
[0]	Null matrix.