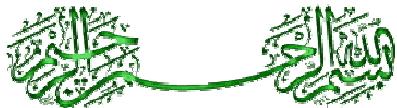


# الآية



قال الله تعالى :

إِنَّمَا يُنْهَا نَفَّاثَاتُهُ عَلَىٰ تَقْوَىٰ مِنَ الْمُلْكِ  
وَرَضِيَ اللَّهُ عَنْهُ أَمْ مَنْ أَسَسَ بُنْيَانَهُ عَلَىٰ  
شَفَّا جُرْفٍ هَارِ فَانْهَارَ بِهِ فِي نَارٍ  
نَّمَ وَاللَّهُ لَا يَهْدِي الْقَوْمَ الظَّالِمِينَ }

صدق الله العظيم

سورة التوبه الآية (

(109)

## **Dedication**

I dedicate this work to my respective parents who have been the constant source of inspiration .Without their love and support this research would not have been made possible .And also to my wife who supported me in each step of the way , and to my wonderful son.

And I dedicate this fruitful work to my honorable teachers and my colleagues.

## **Acknowledgement**

Great thanks to Allah the greatest. I would like to express my deepest appreciation to my supervisor, Dr. Nuha Meawia Akasha for her kind patience and invaluable guidance throughout this study, and I would like to extend my thanks for teacher Dr. Fath-Alrahaman Adam for his help and appreciative efforts. Thanks also to the teachers at university of Sudan Faculty of civil Engineering. Last but not least, my heartfelt gratitude to my family and friends who believed in me and stuck by me from day one.

## **Abstract**

This research concentrate on design a multi storey building consist of twenty storeys building by using manual calculations(BS81101997code) and computer programmes named Etabs and Safe according to different international codes such as: BS8110-1997, ACI-2005, Eurocode 2-1992. The building consist of flat slabs, columns, raft foundation, shear wall and staircases. Moreover, the comparison was made and it was found that: firstly, the area of steel for flat slab by using ACI-2005 is greater than the area of steel for flat slab by using manual calculations(BS81101997code) about 3% ,and greater than the area of steel by using both codes BSI8110-1997 and EC2-1992 codes about 1% . Secondly: the area of steel for columns by using ACI-2005 is greater than the area of steel for columns by using manual calculations(BS81101997code) about 0.2% ,and greater than the area of steel by using both codes BSI8110-1997 and EC2-1992 codes about 2%. Thirdly: the area of steel for raft foundation by using EC2-1992 code is greater than the area of steel in manual calculations(BS81101997code) about 29% ,and greater than the area of steel by using BSI8110-1997 code about 5% and greater than the area of steel by using ACI-2005 code about 3%.

## المستخلص

هذا البحث يختص بتصميم مبنى متعدد الطوابق مكون من عشرين طابق يدوياً وباستخدام برنامج الایتابس (Etabs) وبرنامج السيف (Safe) لمدونات مختلفة وهى: المدونة البريطانية Eurocode 2-1997، المدونة الأمريكية ACI-2005،المدونة الأوربية- BS8110-1992. المبنى مكون من بلاطات مسطحة واعمدة واساس حصيري وحوائط قص وسلام. قورنت نتائج التصميم اليدوى مع نتائج التصميم بواسطة البرامج المستخدمة . وعليه وجد أن : أولاً: حديد التسليح الناتج من المدونة الامريكية فى البلاطه المسطحة أكبر من حديد التسليح الناتج من التصميم اليدوى بنسبة 3% وايضاً أكبر من حديد التسليح الناتج من المدونتين البريطانية و الأوربيه بنسبة 1%. ثانياً: حديد التسليح الناتج من المدونة الامريكية فى الاعمدة أكبر من حديد التسليح الناتج من التصميم اليدوى بنسبة 2% وايضاً أكبر من حديد التسليح الناتج من المدونتين البريطانية و الأوربيه بنسبة 2%. ثالثاً: حديد التسليح الناتج من المدونة الأوربيه فى اللبسة أكبر من حديد التسليح الناتج من التصميم اليدوى بنسبة 29% وايضاً أكبر من حديد التسليح الناتج من المدونة البريطانية بنسبة 5% واكبر من المدونة الامريكية بنسبة 3%.

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## List of Abbreviations

### ACI 2005 Code:

$M_0$  = total factored static moment, N/mm<sup>2</sup>

$q_u$  = factored load per unit area

$l_2$  = length of span in direction perpendicular to  $l_1$

$l_n$  = length of clear span measured face-to-face of supports, mm

$M_2$  = factored moment at section, N/mm<sup>2</sup>

$d$  = distance from extreme compression fiber to centroid of longitudinal tension reinforcement

$f_c$  = specified compressive strength of concrete, MPa

$f_y$  = specified yield strength of reinforcement, MPa

$A_{s,min}$  = minimum area of flexural reinforcement, mm<sup>2</sup>

$b_w$  = web width, or diameter of circular section

$c_c$  = clear cover of reinforcement, mm

$d_b$  = nominal diameter of bar, wire, or pre-stressing strand, mm

$f_s$  = calculated tensile stress in reinforcement at service loads, MPa

$S$  = snow load, or related internal moments and forces

$V_u$  = factored shear force at section, N

$r$  = radius of gyration of cross section of a compression member, mm,

$f_{yt}$  = specified yield strength  $f_y$  of transverse reinforcement, MPa

$A_v$  = area of shear reinforcement spacing  $s$ , mm<sup>2</sup>

$\phi$  = strength reduction factor

$\beta$  = ratio of long to short dimensions: clear spans for two-way slabs

$\alpha_s$  = constant used to compute  $V_c$  in slabs and footings

$\psi$  = is the effective length factor at the restrained end

$b_0$  = perimeter of critical section for shear in slabs and footings, mm

$\beta_1$  = factor relating depth of equivalent rectangular compressive stress block to neutral axis depth

T = cumulative effect of temperature, creep, shrinkage, differential settlement, and shrinkage-compensating concrete

$P_u$  = factored axial force; to be taken as positive for compression and negative for tension, N

$\epsilon_t$  = net tensile strain in extreme layer of longitudinal tension steel at nominal strength, excluding strains due to effective pre stress, creep, shrinkage, and temperature.

$P_n$  = nominal axial strength of cross section, N

$l_u$  = unsupported length of compression member, mm

k = effective length factor for compression members

K = wobble friction coefficient per meter of tendon

$M_2$  = larger factored end moment on compression member, always positive, N.mm.

$M_1$  = smaller factored end moment on a compression member, to be taken as positive if member is bent in single curvature, and negative if bent in double curvature, N.mm.

$A_g$  = gross area of concrete section,  $mm^2$  For a hollow section,  $A_g$  is the area of the concrete only and does not include the area of the void(s)

$M_n$  = nominal flexural strength at section, N.mm

h = overall thickness or height of member, mm

E = load effects of earthquake, or related internal moments and forces

$M$  = maximum unfactored moment due to service loads, including  $P$  effects, N.mm

$E_s$  = modulus of elasticity of reinforcement and structural steel, MPa.

$A_{st}$  = total area of nonprestressed longitudinal reinforcement, (bars or steel shapes),

$mm^2$

$P_{n,max}$  = maximum allowable value of  $P_n$ , N,

$V_n$  = nominal shear strength, N,

$\rho$  = reinforcement ratio Eurocode 2

### ***Euro codes 2-1992:***

$M$  = moment or bending moment breadth or width  $b$

$f_{ck}$  = characteristic cylinder strength of concrete

$b_w$  = minimum width of section

$h$  = overall depth of section in plane of bending

$t$  = thickness

$i$  = radius of gyration

$A_s$  = cross-sectional area of tension reinforcement

$f_{ctm}$  = mean tensile strength of concrete

$x$  = neutral axis depth

$A_s$  = cross-sectional area of compression reinforcement

$d$  = depth to compression reinforcement

$f_{yk}$  = characteristic yield strength of reinforcement

$A_{s,prov}$  = cross-sectional area of tension reinforcement provided at the ultimate

limit state

$A_{s,req}$  = cross-sectional area of tension reinforcement required at the ultimate limit state

$\delta$  = moment redistribution factor

$L_0$  = effective height of column or wall

$L_a$  = lever-arm factor =  $z/d$

$s$  = spacing of shear reinforcement or depth of stress block

$A_{sw}$  = cross-sectional area of shear reinforcement in the form of links or bent-up bars

$\alpha$  = coefficient of thermal expansion

$I$  = second moment of area

$k_1$  = average compressive stress in the concrete for a rectangular parabolic stress

$k_2$  = a factor that relates the depth to the centroid of the rectangular parabolic stress

$L$  = Length or span

$E$  = modulus of elasticity

$n$  = ultimate load per unit area

$A_c$  = concrete cross-sectional area

$N_{Ed}$  = design value of axial force

$M_{Ed}$  = design value of moment

$s_r$  = is the radial spacing of perimeters of shear reinforcement

$f_{ywd,es}$  = is the effective design strength of shear reinforcement

$V$  = shear force

$N$  = axial load

$V_{Rd,es}$  = is the punching shear resistance of the reinforced slab

$s_t$  = is the spacing of links around the perimeter and.

$A_{sw,min}$  = is the area of an individual link leg

$V_{Ed,max}$  = maximum design shear force

$V_{Rd,max}$  = crushing strength of the concrete diagonal strut at the section of maximum shear

$\phi_{ef}$  = effective cr.]

## **British code B8110-1997:**

$d$ = Effective depth of tension reinforcement

$g_k$  = characteristic dead load

$q_k$ = characteristic live load

$L_x$  = the length of the shorter side

$z$ = lever arm

$l_e$  is the effective span in the shorter direction

$M$  = moment after redistribution

$M'$  = moment before redistribution

$\beta_{sy}$  = moment coefficient

$L_x$  = the length of the longer side

$f_y$ = Characteristic strength of reinforcement

$f_{yv}$  = Characteristic strength of link reinforcement

$f_{cu}$ = Characteristic concrete cube strength

$N$  = Ultimate load per unit area

$P$  = Final prestress force

$\rho$  = percentage of total reinforcement in a column=  $100A_s/bd$

$\rho$  = percentage of tensile reinforcement in a beam=  $100A_s/bd$

$h$  = Overall depth of section In plane of bending

$N$ =Axial load

$B$ =Width of section

$M$  = design ultimate moment.

$V$  = design ultimate shear force

$V_c$ =Ultimate shear stress in concrete

$C_x$  = horizontal dimension of a column, parallel to  $l_x$

$x$  = Neutral axis depth

$C_y$  = horizontal dimension of a column, parallel to  $l_y$

$s_v$  = Spacing of links along the member

$l_0$  = Effective height of a column or wall

$e_x$  = is the resultant eccentricity of load at right angles to the plane of the wall (with minimum value  $h/20$ )

$A_{sc}$  = Area of steel in column

$A_{sv}$  = Cross-sectional area of shear reinforcement in the form of links

$A_s$  = Cross-sectional area of compression reinforcement

$A_{sreqd}$  = area of steel required from calculations

$A_{sprov}$  = area of steel actually provided.

$A_c$  = net area of concrete

$f_s$  = Service stress or steel stress.

Z = Seismic zone factor

I = Importance factor

W = Total seismic dead load

C = Numerical coefficient

Rw = Numerical seismic coefficient

S = Site coefficient for soil characteristic

T = Fundamental period of vibration of structure

hn = Height in meter above the base to level N