

DETERMINATION OF THE EFFICACY OF CIVILSOFT QUICK SERIES IN THE DESIGN OF REINFORCED CEMENT CONCRETE. A CASE STUDY OF THE DESIGN OF A SEVEN PANEL SINGLE STOREY BUILDING.

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Abstract: The purpose of this research work is to design a seven panel single storey building using programme design software for civil engineering works for the modelling and designing of reinforced concrete structures ranging from bungalow (apartment) to high rise structures. This software automatically designs, loads, analysis and details all structural elements such as slabs (panels), beams, columns and foundations. This software was used for the design of a storey building consisting of seven panels. The loading, analysis and reinforcement design of slabs, beams, columns foundation and layout was done using the Civil soft Quickstruct Software for the modelling, and structural detailing was done by the software and then imported to AutoCAD for an easy and clear output. The design load, moment, shear force and shear stresses were automatically calculated and presented as required due to careful input of each parameter required which gave an appropriate reinforcement diameter and spacing to handle the action at its worst critical conditions. The study shows that the Quick civil soft is very effective software for civil engineering works and can be used for a speedy detail of reinforced concrete storey building.

KEY WORDS: Quick Series, CivilSoft, Reinforced Concrete Design, Storey Building.

1.0 INTRODUCTION

1.1 SOFTWARE

The use of software in modern science, art, technology and engineering has been a very helpful step in the development of human discipline in the modern society. The use of software is a welcome development that has come to stay considering the numerous advantages over manual design, analysis, detailing etc. Software gives a better edge over the manual method to enhance speed, accuracy, manipulation of bulk figures, the use of errors, etc.

In the field of Civil Engineering, software has been greatly appreciated since there has always been one from CAD application in its various branches like highway and traffic engineering, foundation and geotechnical engineering, water resources and hydraulic engineering, structural engineering etc.; with structural engineering which is the main area covered in this seminar.

This seminar focuses on reinforced concrete design of a storey building, this suite of program was written for the analysis and design of reinforced concrete elements such as slabs, beams, columns, footings. This program was written bearing in mind the design philosophy enunciated in BS 8110: Part 1 of 1997.

1.2 WHAT IS CIVILSOFT?

This Software is programmed specially for civil engineering works in the loading, analysis, detailing and modelling of various forms of reinforced concrete structures ranging from simple bungalow to high rising structures. It exposes the Civil Engineers to almost all the rudiments of reinforced concrete design including the design of all major elements such as slabs, beams, columns, staircases and foundation reinforced concrete structures such as retaining walls.

1.3 BACKGROUND HISTORY OF CIVILSOFT

Looking back at the last 25years of innovation in computer technology, it is tempting to think that we're close to the limits of what we can do with computers. This is because the progress has been so amazing. We have gone from standalone mainframes to hundreds of millions of incredibly powerful Personal computers (PCs) and smart devices. The spirit of Moore's law has taken processing power from KiloHertz to Gigahertz, storage from kilobytes to terabytes, and networking

speed from mere bits per second to gigabits per second. The American semiconductor pioneer, Gordon Moore in 1965, predicted that the number of transistors on a computer chip would double every year, a prediction that has come to be known as Moore's Law.

Computers have moved out of the information technology department into almost every part of our lives. More than 600 million PCs are in use today, a number that will rise to more than a billion in the next five years. Many devices use computers, with processing power, storage, and connectivity that meet or even beat the high - end PCs of just a few years ago. Yet we in Civilsoft are only beginning to realize computing potential. Civilsoft believes that we are entering an era when software will fundamentally transform almost everything we do. The continued growth of processing power, storage, networking, and graphics is making it possible to create almost any device imaginable. But it is the magic of software that will connect these devices into a seamless whole, making them an indispensable part of our everyday lives. With all these advances in computer, it became clear how valuable it can be used to aid structural analysis and design.

Civilsoft was born out of the need to bridge the digital divide in the field of civil engineering software development between advanced countries and Nigeria. It was out of the need to have the Nigeria own identity. It was also a need to develop software technologies that are most suitable for local situation and are of international standard.

In the year 2000, the first version was completed and used in student's project processing. It proved much cost and time effective, typographic error free. This was in sharp contrast to the old method where projects calculation formulae and terminologies were messed up by none engineers who type the project. The costs of production were costly and time consuming. This version of the software was DOS based.

In the year 2001, CivilSoft started developing software that were windows based and actually for work station (office use). In mid 2001, a bridge of the DOS and windows version was developed and demonstrated at the NSE Enugu branch seminar that year. Yet we saw so many endless possibilities out there. This version was later called Civilsoft Quickstruct for Structural analysis and design. By the end of 2001, the first ever windows version was completed. This version became the first indigenous commercial windows based civil engineering software in the country.

In the year 2002, there was the need to develop software that will combine both calculation power and graphics to give the engineer a new way of doing work. By mid 2002, Civilsoft came up with Quick Draughting Studio (QDS). QDS was developed to solve drafting problems associated with design. The following year 2003, at COREN and NSE conferences in Abuja and Ibadan, QDS caught the attention of so many engineers. They were thrilled especially at the speed at which QDS detailed beams and other structural elements. Again QDS became the first indigenous civil engineering drafting commercial software in the country.

With the success of QDS version one, it was suddenly discovered that in the future, a software that will combine analytical power with rich graphics was proposed. In 2004 Civilsoft set out to develop one of the most complicated software the industry has ever worked on. After developing QDS version, Civilsoft started considering the possibility of modelling the Beam General Arrangement as a whole graphically. One of the big questions was how to enable the computer to detect continuity and discontinuity of slab panels.

1.3.1 Inside Civilsoft Quickcivil Series

Civilsoft QuickCivil Series in made up of three softwares. These Softwares are:

- QuickStruct.
- Quick Draughting Studio.
- QuickSteel.

1.3.2 Civilsoft QuickStruct

Civilsoft QuickStruct is structural engineering computer aided design software that is specially designed for the structural design of buildings and other related structures. QuickStruct can be used to design slabs, beams, column, foundation and retaining wall. It takes care of the loading, analysis and reinforcement design of these elements.

The slab part of the software can handle two - way spanning slab, simple slab (one - way spanning slab), continuous slab (using moment coefficient and moment distribution) and cantilever slab. Of interest is the ease with which the data entered or generated by the program is circulated round the various stages of design. It can handle more than 1000 Slab panels at a time.

Beams are classified into simple beams, continuous beams and cantilever beams. The program also provides a beam wizard which makes it much easier for beam design. The loading types provided by the software can be entered directly and also have a way of transferring the slab loadings to the beams. It can take care of fixed end beams, simple ends, cantilever and continuous beams and also draw the bending moment and shear force diagrams.

Columns are classified into axial, uniaxial and biaxial. The program wizard was designed to calculate the axial forces, moments and column reinforcement design. It uses the simple sub frame principles for its column analysis. Loading from beams are automatically made available at column loading point. The program can also calculate column slenderness ratio. Quickstruct designs the following types of foundation: strip, pad, combined footing and raft foundations. It can design retaining walls that are with or without heels. Quickstruct has an inbuilt capacity to format the document after calculations are done.

1.3.3 Civilsoft QuickDraughting Studio (QDS)

QDS is specially designed for the structural detailing of buildings and other related structures. QDS can detail the following: beam general arrangement (G.A), drawing slab details, beam details, column details, foundation layout and details.

QDS has an object property orientation. The object is the element, and such elements are slab, beam, column and footing. The slab can be made of many panels. Each of those panels is a distinct object having its own individual properties. Each object can function alone or collectively as a unit. This looks more like the AutoCAD object properties. The object property orientation is one of the most important introductions to QDS. The property orientation enables the user to deal with each element, one at a time. Once an element is selected, all the properties associated with it are shown. Each object has geometry and reinforcement properties. The geometry properties are in most cases the depth, breadth, length etc. Once in the property page, each property can be set. The property page has object collection property that keeps track of all members belonging to a type of object. Once an object is created it can be copied, pasted and modified. Another important property of the object is that their properties can be matched, making it easier to edit object with common properties.

The first task in QDS is to model the general arrangement. Once this is done the programme automatically generates possible beams, columns and foundation positions. At the centre of the modelling is the slab - beam general arrangement modelling. This edition of QDS did an extensive work on how general arrangement is modelled.

Panel can be referenced "By Panel", "By Coordinate" and "By Distance". The default reference is "By Panel". At the base of reference is "By Distance" because the actual plotting is done with distances. References by "By Panel" and "By Point" are much easier. By point refers to a point on the grid which defines both the X and Y coordinates at the same time. Once the model is laid out and element properties set, the detailing can then be done. The beam, column and foundation positions are modelled in the same manner.

QDS has the capability to prepare bar bending schedules. This is one feature that is useful for estimations.

QDS can generate both 2D and 3D models of structures.

1.3.4 Quick Steel

Quick Steel is optimized for truss analysis. It is very similar to QDS, and also maintains the same principle of the QDS. The modelling is visual. As you add the nodes and elements you see an instant graphical representation of the truss formation. Once the truss is built up, it can then be easily analyzed.

1.4 Codes

QuickStruct and Quick Draughting Studio are based on design principles of BS 8110:1997. QuickSteel is based on BS 5950:2000.

1.5 Platform

Quickcivilseries is built for users of Microsoft Windows 7, Windows XP, Windows ME, Windows 2000 and Windows 98 operating system. This is because Windows is the dominant operating system in the world for now. It requires up to 64 Random Access Memory (RAM) of memory, 5 Gigabyte of Hard disk space and at least Intel Pentium II and above or its equivalent. The software is faster with higher system configuration. It enjoys all the user friendly interfaces and mode of operation associated with windows. A normal windows user won't find it difficult navigating the software.

1.6 Scope and Limitation

This project is limited only on the design of reinforced concrete design of slabs, beams, columns, foundation footings and layout arrangement.

2.0 LITERATURE REVIEW

2.1 Brief History of Computer Aided Design (CAD) Software Development

CAD software also refers to as **Computer Aided Design software** and in the past as computer aided drafting software, refers, to software programs that assist engineers and designers in a wide variety of industries to design and manufacture physical products ranging from buildings, bridges, roads, aircraft, ships and cars to digital cameras, mobile phones, TVs, clothes and of course computers. Current packages range from 2D vectors based drafting systems to 3D solid and surface modellers.

Designers have long used computers for their calculations. Initial developments were carried out in the 1960s within the aircraft and automotive industries in the area of 3D surface construction and Normal Certificate (NC) programming, most of it independent of one another and often not publicly published until much later. Somee Schoenberg, Apalatequi (Douglas Aircraft) and Roy Liming (North American Aircraft), however probably the most important work on polynomial curves and sculptured surface was done by Pierre Bezier (Renault), Paul de Casteljaou (Citroen), Steven Anson Coons (M, Ford), James Ferguson (Boeing), Carl de Boor, Guided Missile (GM), Birkhoff (GM) in the 1960s and W. Gordon (GM) and R. Riesenfeld in the 1970s.

The term "computer – aided design, (CAD)" was coined by Doug Ross at Massachusetts Institute Technology (MIT) in 1959. It is argued that a turning point was the development of SKETCHPAD system in MIT in 1963 by Ivan Sutherland (who later created a graphics technology company with Dr. David Evans). The distinctive feature of SKETCHPAD was that it allowed the designer to interact with his computer graphically: the design can be fed into the computer by drawing on a CRT monitor with a light pen. Effectively, it was a prototype of graphical user interface, an indispensable feature of modern CAD. First commercial applications of CAD were in large companies in the automotive and aerospace industries, as well as in electronics. Only large corporations could afford the computers capable of performing the calculations. Notable company projects were at GM (Dr. Patrick J. Hanratty) With DAC – 1 (Design Augmented by Computer) 1964; Lockheed projects; Bell GRAPHIC 1andat Renault (Rezier) – UNISURF 1971 car body design and tooling. One of the most influential events in the development of CAD was the founding of manufacturing and Consulting Services Incorporation in 1971 by Dr. P. J. Hanratty, who wrote the system ADAM (Automated Drafting And Machining) but more importantly supplied code to companies such as McDonnell Douglas (Unigraphics), Computervision (CADDs), calma, Gerba, Autorol and control Data. As computers became more affordable, the application areas have gradually expanded. The development of CAD software for personal desk – top computers was the impetus for almost universal application in all areas of construction. Other key points in the 1960s and 1970s would be the foundation of CAD system United Computer, Intergraph, IBM, Intergraph IGDS in 1974 (which led to Bentley MicroStation in 1984). CAD implementations have evolved dramatically since then. Initially, with 2D in the 1970s, it was typically limited to producing drawings similar to hand – drafted drawings. Advances in programming and computer hardware, notably solid modelling in the 1980s, have allowed more versatile application of computers in design activities. Key products for 1981 were the solid modelling packages – Romulus (Shape Data) and Unisolid (Unigraphics) based on PADL-2 and the release of the surface modeller CATIA (Dassault Systemes). Autodesk was founded 1982 by John Walker, which led to the 2D system AutoCAD. The next milestone was the release of Pro/ENGINEER in 1988, which heralded greater usage of feature – based modelling methods and parametric linking of the parameters of features. Also of importance to the development of CAD was the development of the B-representation solid modelling Kernels (engines for manipulating geometrically and topologically consistent 3D objects) Parasolid (Shape Data) and ACIS (Spatial Technology Inc.) at the end of the 1980s and beginning of the 1990s, both inspired by the work of Ian Braid. This led to the release of mid-range packages such as solidWorks in 1995, Solid Edge (Intergraph) in 1996, IronCAD in 1998, AutoCAD12, 14 and then AutoCAD 2000 in year 2000 up to AutoCAD 2009. Today, we also have CivilCAD and CivilSoft 2000 in year 2000 and so on till the latest version, CivilSoft 2009, which is used in this project. These are also main mid-range packages used in designing and drafting.

3.0 RESULTS ANALYSIS

3.1 SLAB LOADING.

Slab Thickness = 150mm

Characteristic imposed load = 1.5KN/m²

Finishes = 1.2KN/m²

Partition allowance = 1KN/m²

Density of concrete = 24KN/m³

Self weight of slab = 0.15 x 24 = 3.6KN/m²

Characteristic dead load , gk = 3.6 + 1.2 + 1 = 5.8KN/m²

Design ultimate load = 1.4gk + 1.6 qk

Design ultimate load , n = 1.4 x 5.8 + 1.6 x 1.5 = 10.52KN/m²

Design ultimate load , n = 10.52KN/m²

Bending moments and Design

Panel 1

Total design load ,n = 10.52KN/m²:

Length of short span ,lx = 4200mm: Length of long span ,ly = 4800mm ly / lx = 1.142857

Short span - mid span : Msx = Bsx x n x lx² = 8.19KNm/m

effective depth, d = 124 : As required = 197.62 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : Msy = Bsy x n x lx² = 6.31KNm/m

effective depth, d = 112 : As required = 197.62 : As provided = 377 : Use Y12 @ 300

Short span - edge : Mx = Bx x n x lx² = 10.95KNm/m

effective depth, d = 124 : As required = 264.22 : As provided = 377 : Use Y12 @ 300

Long span - edge : My = By x n x lx² = 8.35KNm/m

effective depth, d = 124 : As required = 201.48 : As provided = 377 : Use Y12 @ 300

Panel 2

Total design load ,n = 10.52KN/m²

Length of short span ,lx = 1200mm : Length of long span ,ly = 4200mm : ly / lx = 3.5

Short span - mid span : Msx = Bsx x n x lx² = 1.89KNm/m

effective depth, d = 124 : As required = 45.61 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : $M_{sy} = B_{sy} \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 112$: As required = 45.61 : As provided = 377 : Use Y12 @ 300

Short span - edge : $M_x = B_x \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 124$: As required = 0 : As provided = 377 : Use Y12 @ 300

Long span - edge : $M_y = B_y \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 124$: As required = 0 : As provided = 377 : Use Y12 @ 300

Panel 3

Total design load , $n = 10.52 \text{KN/m}^2$

Length of short span , $l_x = 1800 \text{mm}$: Length of long span , $l_y = 4200 \text{mm}$: $l_y / l_x = 2.333333$

Short span - mid span : $M_{sx} = B_{sx} \times n \times l_x^2 = 4.26 \text{KNm/m}$

effective depth, $d = 124$: As required = 102.79 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : $M_{sy} = B_{sy} \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 112$: As required = 102.79 : As provided = 377 : Use Y12 @ 300

Short span - edge : $M_x = B_x \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 124$: As required = 0 : As provided = 377 : Use Y12 @ 300

Long span - edge : $M_y = B_y \times n \times l_x^2 = 0 \text{KNm/m}$

effective depth, $d = 124$: As required = 0 : As provided = 377 : Use Y12 @ 300

Panel 4

Total design load , $n = 10.52 \text{KN/m}^2$

Length of short span , $l_x = 3600 \text{mm}$: Length of long span , $l_y = 4200 \text{mm}$: $l_y / l_x = 1.166667$

Short span - mid span : $M_{sx} = B_{sx} \times n \times l_x^2 = 6.18 \text{KNm/m}$

effective depth, $d = 124$: As required = 149.12 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : $M_{sy} = B_{sy} \times n \times l_x^2 = 4.64 \text{KNm/m}$

effective depth, $d = 112$: As required = 149.12 : As provided = 377 : Use Y12 @ 300

Short span - edge : $M_x = B_x \times n \times l_x^2 = 8.27 \text{KNm/m}$

effective depth, $d = 124$: As required = 199.55 : As provided = 377 : Use Y12 @ 300

Long span - edge : $M_y = B_y \times n \times l_x^2 = 6.14\text{KNm/m}$

effective depth, $d = 124$: As required = 148.16 : As provided = 377 : Use Y12 @ 300

Panel 5

Total design load , $n = 10.52\text{KN/m}^2$

Length of short span , $l_x = 2970\text{mm}$: Length of long span , $l_y = 3000\text{mm}$: $l_y / l_x = 1.010101$

Short span - mid span : $M_{sx} = B_{sx} \times n \times l_x^2 = 2.84\text{KNm/m}$

effective depth, $d = 124$: As required = 68.53 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : $M_{sy} = B_{sy} \times n \times l_x^2 = 2.6\text{KNm/m}$

effective depth, $d = 112$: As required = 68.53 : As provided = 377 : Use Y12 @ 300

Short span - edge : $M_x = B_x \times n \times l_x^2 = 3.71\text{KNm/m}$

effective depth, $d = 124$: As required = 89.52 : As provided = 377 : Use Y12 @ 300

Long span - edge : $M_y = B_y \times n \times l_x^2 = 3.43\text{KNm/m}$

effective depth, $d = 124$: As required = 82.76 : As provided = 377 : Use Y12 @ 300

Panel 6

Total design load , $n = 10.52\text{KN/m}^2$

Length of short span , $l_x = 3000\text{mm}$: Length of long span , $l_y = 4200\text{mm}$: $l_y / l_x = 1.4$

Short span - mid span : $M_{sx} = B_{sx} \times n \times l_x^2 = 5.21\text{KNm/m}$

effective depth, $d = 124$: As required = 125.72 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : $M_{sy} = B_{sy} \times n \times l_x^2 = 3.22\text{KNm/m}$

effective depth, $d = 112$: As required = 125.72 : As provided = 377 : Use Y12 @ 300

Short span - edge : $M_x = B_x \times n \times l_x^2 = 7.01\text{KNm/m}$

effective depth, $d = 124$: As required = 169.15 : As provided = 377 : Use Y12 @ 300

Long span - edge : $M_y = B_y \times n \times l_x^2 = 4.26\text{KNm/m}$

effective depth, $d = 124$: As required = 102.79 : As provided = 377 : Use Y12 @ 300

Panel 7

Total design load ,n = 10.52KN/m²

Length of short span ,lx = 4800mm : Length of long span ,ly = 5770mm : ly / lx = 1.202083

Short span - mid span : Msx = Bs_x x n x lx² = 11.41KNm/m

effective depth, d = 124 : As required = 275.32 : As provided = 377

Use Y12 @ 300 : Deflection Check Ok

Long span - mid span : Msy = Bs_y x n x lx² = 8.24KNm/m

effective depth, d = 112 : As required = 275.32 : As provided = 377 : Use Y12 @ 300

Short span - edge : Mx = Bx x n x lx² = 15.3KNm/m

effective depth, d = 124 : As required = 372.13 : As provided = 377 : Use Y12 @ 300

Long span - edge : My = By x n x lx² = 10.91KNm/m

effective depth, d = 124 : As required = 263.25 : As provided = 377 : Use Y12 @ 300

Code reference - BS 8110 : Part 1 : 1997 : Section 3.5.3.4

4.0 CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

With the development and improvement of technology in the field of engineering mostly in Civil engineering the use of computer in this era is becoming the order of the day where the use of computer software is transforming almost everything we do. With all these improvement in computer it has become clear how valuable it can be used to aid structural analysis design in Civil Engineering. This Project work makes it clear that CivilSoft has become an imperative response in the design of reinforced concrete design, modelling, loading, analysis, design, and detailing of structural members are given quick answers by CivilSoft . The software is very effective in the design and analysis of reinforced concrete. An important fact of this work is the culmination of theoretical knowledge learnt in class with the practical analysis on site.

4.2 RECOMMENDATION

It is recommended that practicing or non-practicing engineers, lecturers or students ensure that they know how to use this software in collaboration with Auto CAD it saves time and energy. It is important because all engineering institutions, whether of learning or construction in this era will not be effective without the use of appropriate software s. Further research should be made on the possibility of the software programming in other design such as piles, piers, e t c.

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