THE 22ND ENGINEER'S INTERNATIONAL CONFERENCE

The Intercontinental Hotel, Nairobi, Kenya

13th – 15th May, 2015

MULTI STOREY STEEL BUILDINGS (MSSB)

By

Geoffrey K. Gikandi &Lekina K. Tutui

Zenith Steel Fabricators Ltd, Nairobi, Kenya.

Contents

1.0 ABSTRACT

Multi storey steel buildings, a not so common building technology in Kenya, has its roots in the West since the 1940s. With today's technology and latest innovations the use of structural steel and concrete composite design is being applied in the construction of multi storey steel buildings. In addition to faster construction speed, increased economy is achieved to over 20% saving.

Design involves the design of structural members from composite slab out of decking sheets and lightly reinforced concrete to secondary beams, primary beams to columns and RC foundations.

2.0 INTRODUCTION

Steels are alloys of iron and carbon, widely used in construction and other applications because of their high tensile strengths and low costs. Carbon, other elements, and inclusions within iron act as hardening agents that prevent the movement of dislocations that otherwise occur in the crystal lattices of iron atoms. The carbon in typical steel alloys may contribute up to 2.1% of its weight. Varying the amount of alloying elements, their formation in the steel either as solute elements, or as precipitated phases, retards the movement of those dislocations that make iron so ductile and weak, and thus controls qualities such as the hardness, ductility, and tensile strength of the resulting steel. Steel's strength compared to pure iron is only possible at the expense of ductility, of which iron has an excess.

Over the years in Europe the development of steel-framed buildings with composite metal deck floors has transformed the construction of multi-storey buildings in the UK. During this time, with growth of increasingly sophisticated requirements for building services, the very efficiency of the design has led to the steady decline of the cost of the structure as a proportion of the overall cost of the building, yet the choice of structural system remains a key factor in the design of successful buildings.

Steel is not just a material aimed at technical prowess! It has many qualities that make it the preferred material for architects. It is economical and provides great mechanical functionality; it permits the design of structures which are graceful, light and airy; it streamlines construction site processes; and offers rapid execution. A major advantage, however, is the infinite freedom for creation which it affords the architect. The combinations of different products lend themselves to rich and varied types of construction. When combined with glass, steel makes fabulous use of light and space

Recently, Kenya has witnessed the up rise of multi-storey steel framed buildings primarily which are a product of Zenith Steel Fabricators Ltd.Zenith Steel Fabricators is an indigenous Kenyan ISO 9001:2008 certified company with over 34 years' experience of Design, Fabricate and Erect structural steelwork. The works that Zenith undertakes ranges in types as size including industrial, commercial, religious, institutional, governmental and private clients and more recently a trailer brand to carter for the growing demand for competitively priced and high quality trailers within the region.Zenith's high commitment to quality through its ISO 9001:2000 certification has enabled it to capture a large market both with in Kenya and the surrounding countries. Zenith currently operates in Kenya, Uganda, Tanzania, Zambia, Malawi, Rwanda, Southern Sudan and Ethiopia

For the full potential of the advantages of steel-frame construction to be realized, the design of multi-storey buildings require a considered and disciplined approach by the architects, engineers and contractors involved in the project. They must be aware of the constraints imposed on the design programme by the lead time between placing a contract for the supply of a steel framed building to and the erection of the first pieces of steel at site. The designer must realize that the steelwork is the skeleton around which every other element of the building will be constructed.

3.0 CONSTRUCTION PRACTICE OF MULTI STOREY BUILDINGS IN KENYA

Traditionally, structures in Kenya are constructed out of concrete which is a composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate, usually a combination of cement, fine aggregate and coarse aggregate. Materials for concrete productionare natural gravels or crushed rocks, natural sand or stone dusts, cement and water. Concrete has in the past enjoyed varied applications ranging from buildings, dams, bridges among many other application areas. Specifically to multi-storybuildings concrete have the following disadvantages;

1. Results in heavier structures.
2. Heavier structures result in increased foundation costs
3. Long spans can only be achieved by having numerous columns
4. Longer construction time as delay in concrete curing process
5. Works dependent on fair weather in many instances
6. Internal props and shuttering is required increasing overall project costs
7. Delayed revenue generation on account of longer construction cost
8. Deeper beams & thicker slabs limit the nominal floor to floor height

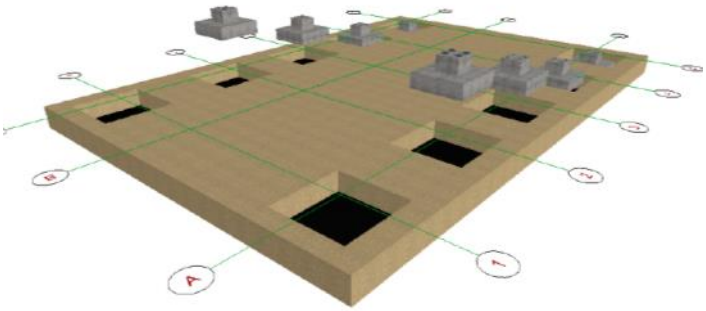
4.0 MULTI STOREY STEEL FRAMED BUILDINGS

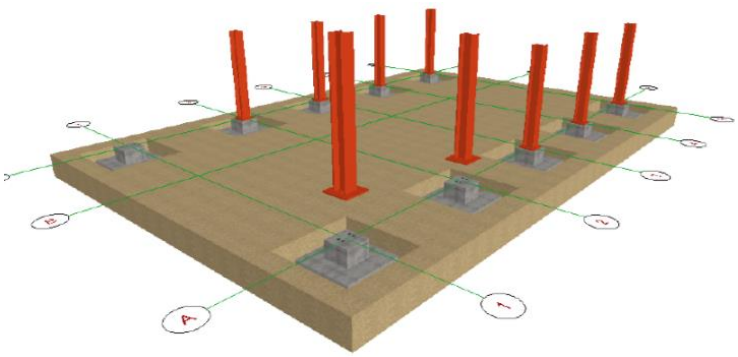
4.1 INTRODUCTION

These refer to buildings whose structural frame is made out structural universal beams and column sections from columns to floor beams. Advantages of using structural steel framing as compared to concrete framing in multi-storey buildings include but not limited to;

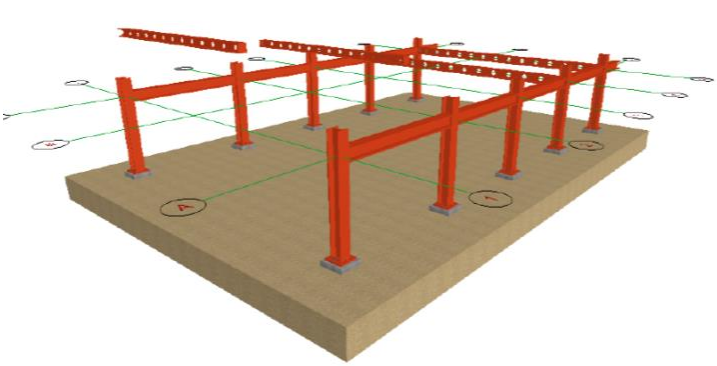
1. Steel frames are fast to erect upto 2times that of concrete
2. Cheaper cost of the structural frame up to 20%
3. The construction is lightweight, particularly in comparison with traditional concrete construction
4. The elements of the framework are pre-fabricated and manufactured under controlled factory conditions to establish quality procedures
5. The accuracy implicit in the manufacturing process by which the elements are produced enables the designer to take a confident view of the geometric properties of the erected framework
6. No formwork is required as the composite floor acts as the formwork further lowering the project cost
7. All weather construction is possible
8. Reduced concrete use is more environmentally friendly and steel is more easily recyclable
9. The framework is not susceptible to drying-out movement or delays due to slow strength gain
10. Steel frames have potential for adaptability inherent in their construction. Later modification to a building can be achieved relatively easily by unbolting a connection. With traditional concrete such modification would be expensive, and more extensive and disruptive
11. The use of steel makes possible the creation of large spans (column free internal spaces)making the building constraint free

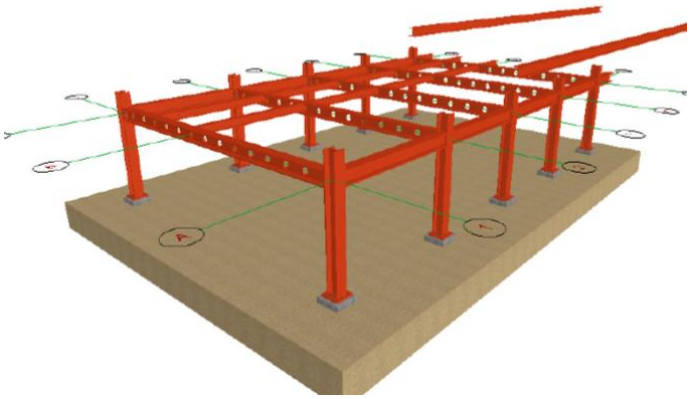
4.2CONSTRUCTION PROCEDURE



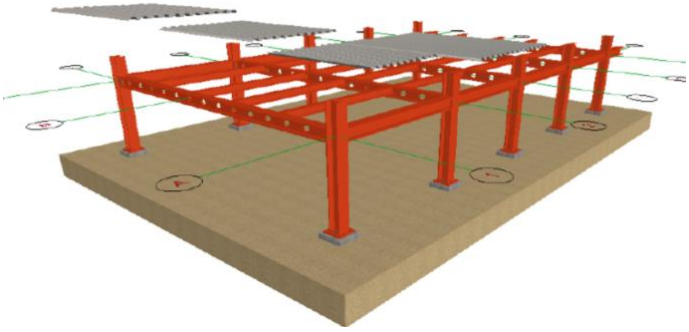


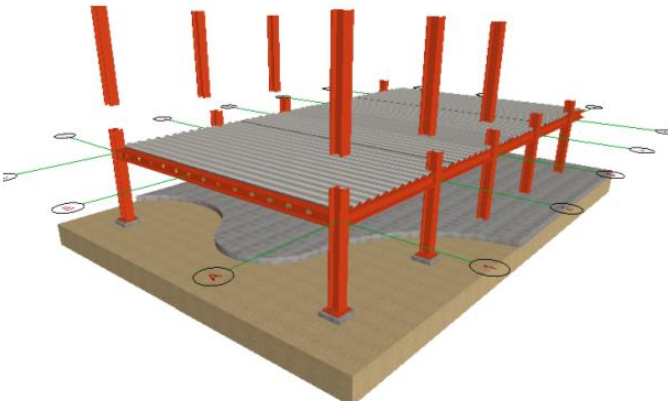
mns



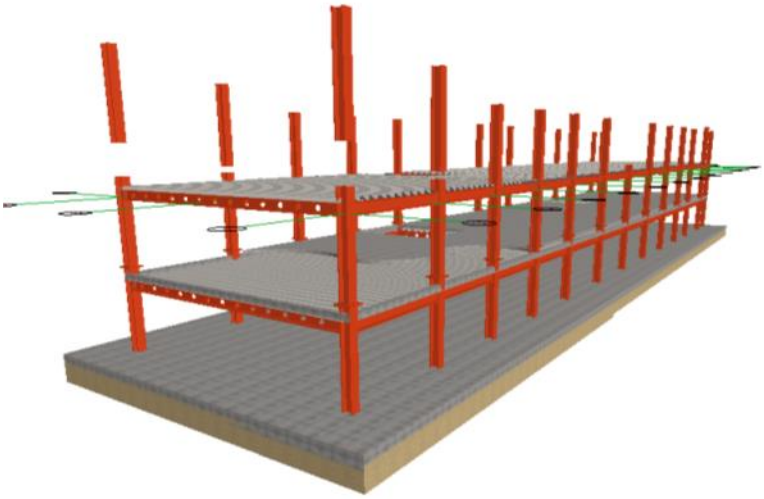


Step 3: Erection of primary beams *Step 4: Erection of secondary beams*



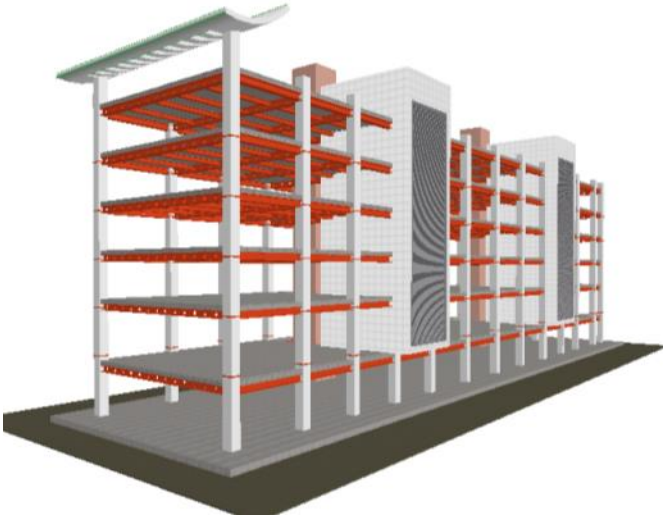


Step 5: Fixing of decking sheets *Step 6: Fixing of upper floor columns and pouring of concrete on ground floor*



Step 7: Repeat steps 3 to 5 for the upper floors and laying concrete on floors below

Step 8: Lay concrete on top most floor



Step 9: Do all the finishing works

Step 10: Finished building

4.3CASTELATED BEAMS

Castellated beams have been used for many years to increase the bending capacity of a beam section and to provide limited openings for services. These are rolled universal beams of which is first divided by a lengthwise zigzag cut, then welded together so as to join the peaks of both halves, thus increasing its depth, bending strength and design parameters.

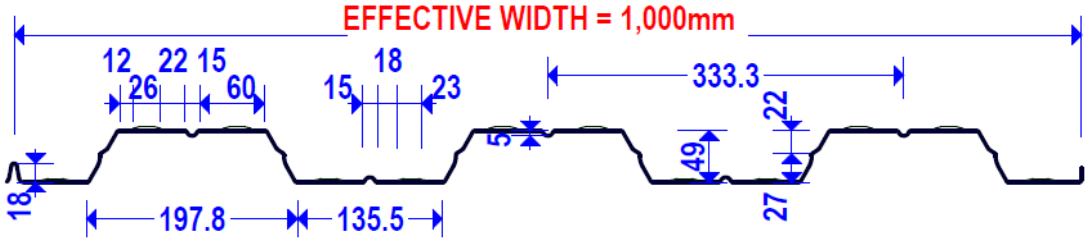
Floor beams in multistorey steel buildings are made out of castellated main beams which have the following advantages;

1. Increased section modulus compared to the parent beam
2. Allow easy passage of services
3. Reduced weight of beam compared to its equivalent capacity beam. Thus the overall weight of building is lighter.
4. Reduces cost of the project
5. Ease of material handling on site thus enhancing the speed of erection

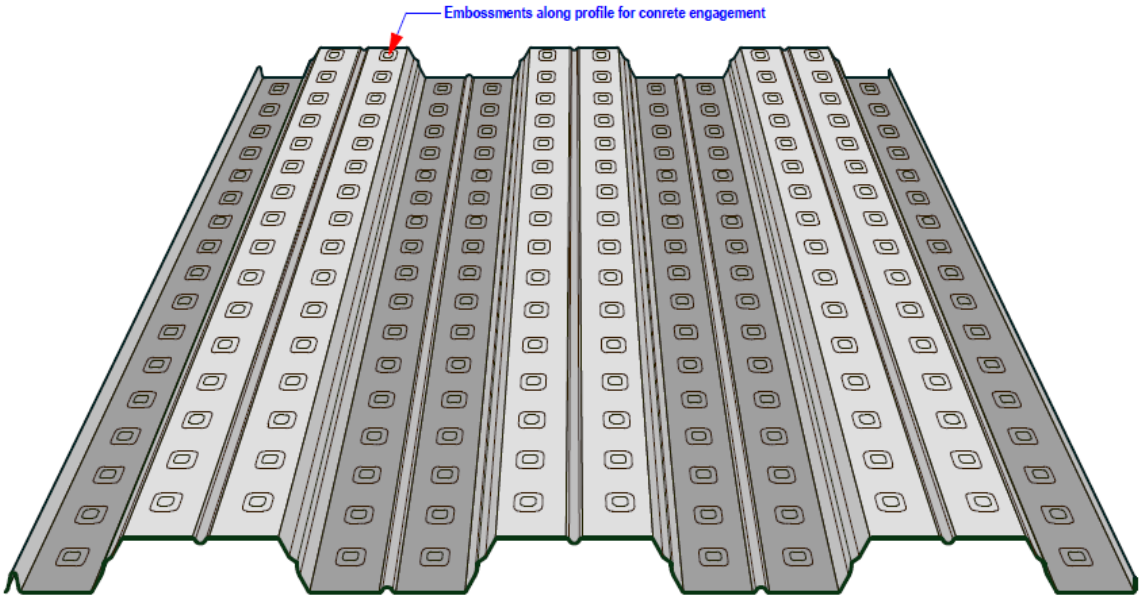
4.4 DECKING SHEETS

Decking sheets are fixed to the top flange of I-beams with self drilling screws. The decking sheets are designed to free span between beams, therefore eliminating the need for props and shuttering during casting on the concrete slab. This makes the construction method very quick

and efficient since the contractor does not need to wait for the curing time of the concrete slab before moving to upper subsequent floor levels



DECKING PROFILE - SECTIONAL PROFILE



DECKING PROFILE - ISOMETRIC VIEW

The composite steel and decking sheets can act as horizontal diaphragm providing further horizontal stiffness.

6.0 CONCLUSION &LANDMARK PROJECTS

Using structural steel framing as compared to concrete framing in multi-storey buildings is quite advantageous as described above. Moreover concrete manufacturing from its constituent materials such as cement etc to actual mixing at site or in a controlled environment delivered to site causes degradation of the environment such as the production of green house gases. Steel is by far more environmentally friendly and can be easily modified. Adoption of steel framed buildings can help to realize a steady and sustainable

Economic development. The changeover from traditional methods such as use of concrete will require retraining of operators in the construction industry, improving research and teaching institutions. Early high investment costs will be recovered through great savings in maintenance and early replacement costs.

Landmark projects done by Zenith steel fabricators include the following

Figure 1: Quality Centre in Dar es Salaam, Tanzania

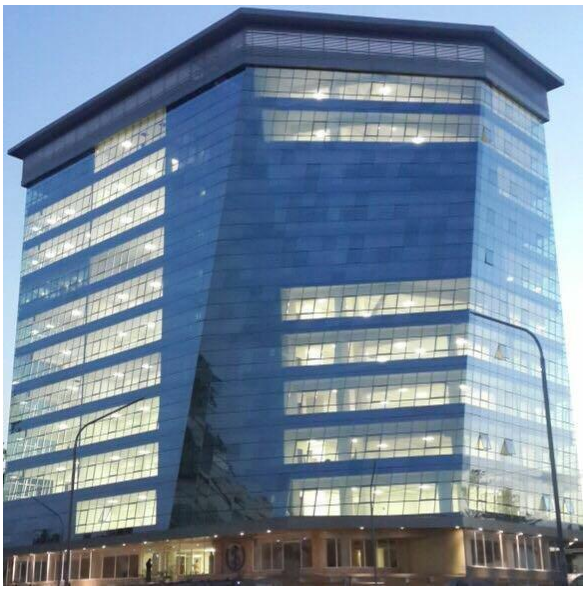


Figure 2: SIFA TOWERS, Kilimani, NAIROBI, KENYA

Figure 3: AFRICAB, Dar es Salaam, Tanzania

Figure 4: KITHIKI Towers, Nyali, Mombasa, Kenya

Figure 5: AFRICAB, Dar es Salaam, Tanzania

Figure 6: Tea Factory, Rwanda

Figure 7: Office Block, Tanzania

7.0 ACKNOWLEDGEMENT

During the writing of this paper the author consulted Mr. Raheem Abbas Biviji and Eng. J.M Kakundi both of Zenith steel fabricators Ltd, Nairobi Kenya. Their contribution is acknowledged with gratitude.

8.0 REFERENCES

1. The Steel Construction Institute, Steel Designers' Manual. Blackwell Scientific Publications, 5th Edition pp 36-68
2. The Architects Guide, Multi-Storey Steel Buildings, Part1:Architect's Guide
3. http://en.wikipedia.org/wiki/Steel
4. The Steel Construction Institute, Steelwork Design Guide to BS 5950: Part 1:1990. The SCI, Vol 2, pp 91-220