Quality of Reinforced Concrete used on Selected Building in Nairobi, Kenya

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The long term strategic plan for Kenya, under vision 2030, includes a big component of infrastructure development which will require a high level of structural safety, durability and performance.

Reinforced concrete is an integral material used for the construction of the required structures.

Quality assurance of these structures, especially for safety, is therefore important during and after the construction.
Over the last few years, a number of buildings some under construction and others completed have collapsed in Nairobi and other major towns in Kenya.

The reported causes of failure are poor design and supervision, poor materials and workmanship, concrete not meeting minimum strength for structural elements and corroded supporting RHS which lowered its strength.
Collapsed buildings
For the country to achieve vision 2030, dependable and reliable techniques are required to provide assessments in these structures during and after construction.

A pilot measurements study using Schmidt Rebound Hammer and Profometer 5+ Covermeter was conducted to investigate their accuracy and reliability and the role they can play in assessing the safety of new and existing structures.
Methodology

Sample Preparation

Samples were made from local materials which consisted of the commonly used cement in the construction industry, fine aggregates obtained from natural river sand and crushed course aggregate of diameters ranging from 10 mm to 20 mm.

36 cubes samples measuring 150 mm of various grades and five concrete blocks (500 mm × 300 mm × 150 mm) with rebars were prepared for the Schmidt hammer and Profometer 5+ measurements respectively.
For the Profometer measurements, rebars were placed at 40 mm, 60 mm, 80 mm and 100 mm from the measuring surface. Each of the five blocks was cast with one of the commonly used reinforcement bars i.e. 12 mm, 16 mm, 20 mm, 25 mm or 32 mm.
Schmidt hammer Measurements

- After 28 days the cubes were removed from water, held under a load of 7 N mm\(^{-2}\) on the compressive machine and horizontal rebound numbers obtained from two surfaces.
- Twenty-four (24) readings, 12 on each side, were obtained and an average value calculated.
- The cubes were then loaded to failure on a Denison Compressive testing machine failure loading recorded.
A regression curve of the average rebound number versus the maximum compressive strength to failure was then drawn from which a regression equation was generated for use in estimating the compressive strength for rebound numbers obtained in the field measurements of the building columns.
Profometer 5+ Measurements

- The Profometer’s search head was placed on the surface of prepared concrete blocks, moved from one end to other in a direction perpendicular to the rebar and the measured covers and rebar diameter values recorded.
- Four measurements were obtained at the location of the rebar, the average obtained and compared to the actual values.
Results and Discussions

Schmidt hammer

- The graph below shows the regression curve obtained from the hammer measurements against the compression strength to concrete failure.
- The equation $y = 0.9x$ at a coefficient of correlation, $R^2 = 0.8$ was the best fit equation through the origin.
- This equation was used to estimate the compressive strength of a 5 storey building from the Schmidt rebound values obtained from the building columns.
- Table 2 shows the rebound values and the estimated compressive strength of individual columns.
A Graph of Schmidt hammer average rebound number against compressive strength to failure of the measured cube specimen.
For the 12 mm diameter reinforcement bar, it was not possible to measure the size of the rebar at \( \geq 60 \) mm cover depth.

The accuracy of the Profometer was found to vary with the cover depth and rebar diameter with higher accuracy being achieved for rebars casted at \( \leq 60 \) mm cover depth and of diameters \( >12 \) mm.

For depths less than 60 mm, the covermeter was observed to be efficient in locating the rebars, and measuring their cover and diameters within an error of \(<10\%\) in both cases.

The accuracy decreased as the depth of the cover increased and it was not possible to measure the rebar diameter at 80 and 100 mm.
The rebound hammer and covermeter proved to be versatile instruments for assessment of concrete strength in structural development and would really assist the Kenyan contractors, planners and safety enforcement institutions, and help the investors in ascertaining the structures were built according to specifications.

It can also help in monitoring quality deterioration of concrete under environmental stress.

Thus non-destructive testing using a Schmidt rebound hammer and the Profometer can be used to provide quick and inexpensive means of assessing the safety of new and existing structures as well as the quality of the workmanship and materials used during the construction.

The field NDT can play an outstanding role in quality assurance.
Thank You!