

ULTRA THIN REINFORCED CONCRETE PAVEMENT: BENEFITTING SOUTH AFRICA

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ABSTRACT

Ultra Thin Reinforced Concrete Pavement (UTRCP) has been applied as the final surfacing for several projects over the last few years. The objective of this paper is to discuss how UTRCP can benefit the road construction industry and at the same time create job opportunities.

This paper discuss by way of demonstration, the construction of UTRCP at the Ga-Rankuwa X10 residential development, in the Northern area of Tshwane. The project includes the installation of all services, water, sewer as well as roads and storm water for the 3 200 stands, built on 77 Hectares, of Ga-Rankuwa X10. The project is still under construction with the second phase in progress. Approximately 18 800 m² of the total of 62 000 m² street network has been completed to date.

Some site problems encountered with construction of the UTRCP are discussed. In conclusion, it is emphasized that UTRCP is a sustainable technique for road construction, which is not only economical, but will create work opportunities.

1. INTRODUCTION

Road construction in South Africa currently experiences restraints as a result of the bitumen shortage. As a result many road construction projects have fallen behind schedule, causing added cost to the projects (Cokayne, 2013).

The bitumen shortage was confirmed at the end of 2012 by the Minister of Transport, Ben Martins, stating that the shortage of bitumen supply in South Africa is straining road projects and sustainable solutions of preventing bitumen shortages are yet to be found (Engineering News, 10 August 2012). Unemployment is also a major concern in South Africa. The President of South Africa, Jacob Zuma, indicated that creating job opportunities will be a key focus for the 2013 period and onwards.

UTRCP is a labour intensive construction method with the ability to create employment in the local community where the construction is taking place. Figures 1 and 2 indicate general construction of UTRCP.



Figure 1: UTRCP Construction Team.



Figure 2: UTRCP Construction Team.

2. UTRCP OVERVIEW AND BENEFITS

Over the last decade considerable research effort has been put into the development of UTRCP, mainly by Mr Adrian Bergh of the CSIR. The techniques prescribed by the CSIR were further refined, resulting in the latest construction methods being relatively easy to execute and relatively high production output being achieved, (up to 600 m² per day with one team).

Note that UTRCP refers to a 50 mm thick, 30 MPa concrete and not conventional thicker concrete roads or the 50 mm Ultra Thin Continuously Reinforced Concrete Pavement (UTRCP) as applied by SANRAL on some freeways.

Materials used for the UTRCP consist of:

- 13 mm aggregate;
- Graded river sand;
- CEM I – 42.5N;
- Reference 200 steel mesh;
- Plasticizer;
- Polypropylene fibres, and

- 30 MPa concrete with a 150 mm slump.

UTRCP has many benefits, with this paper focussing on its economy and opportunities for job creation. Other benefits that UTRCP has are:

- Environmentally friendly with a reduced carbon footprint;
- Requires less maintenance than conventional asphalt and double seal surfacing;
- Skills development with easy skill transfer;
- Suitable for upcoming and SMME Contractors, and
- Reduced layer work as UTRCP functions as the base layer.

The UTRCP implements and creates one man-day job for every 15 m² of road area. The experience gained in the construction of the UTRCP has been incorporated into the Labour Intensive Construction manual published by Gautrans (2008).

The function of the UTRCP, having no joints, is to stretch over the lower layers, with the reinforcing providing the tensile strength. The effect of a point load is thus spread out over more than a meter diameter, thus reducing the effect on the sub grade substantially. The 30 MPa concrete is more than adequate to carry the wheel loads of heavy truck traffic and is not affected by the shoving action of tandem axles at intersections or softened by oil or diesel spills.

Compared to block paving it is several times stronger as a base, due to the reinforcing holding it together, (apart from being relatively waterproof), compared to the joints between the blocks, which tend to move downhill, opening up considerably.

The ability to support heavy loads was demonstrated at the Ga-Rankuwa site when a water pipe crossing sprung a leak under the UTRCP, causing the layers to sag and leave a void under the 50 mm concrete (Figure 3). The heavy hauling trucks were driving over the 'hammock' section, for several months, without much more effect than a hairline crack on either side of the trench. Apart from the incredible holding together ability of the UTRC, this also illustrates the advantages of using UTRCP in dolomitic areas.



Figure 3: Sagging UTRCP due to sagged layerworks.

3 UTRCP AT GA-RANKUWA X 10

3.1 Site layout and location

Ga-Rankuwa X10 is situated in the northern parts of Tshwane, north of the N4 and West of the N1 (Figures 4 and 5)



Figure 4: Ga-Rankuwa X10 Locality Map.

3.2 Project Background

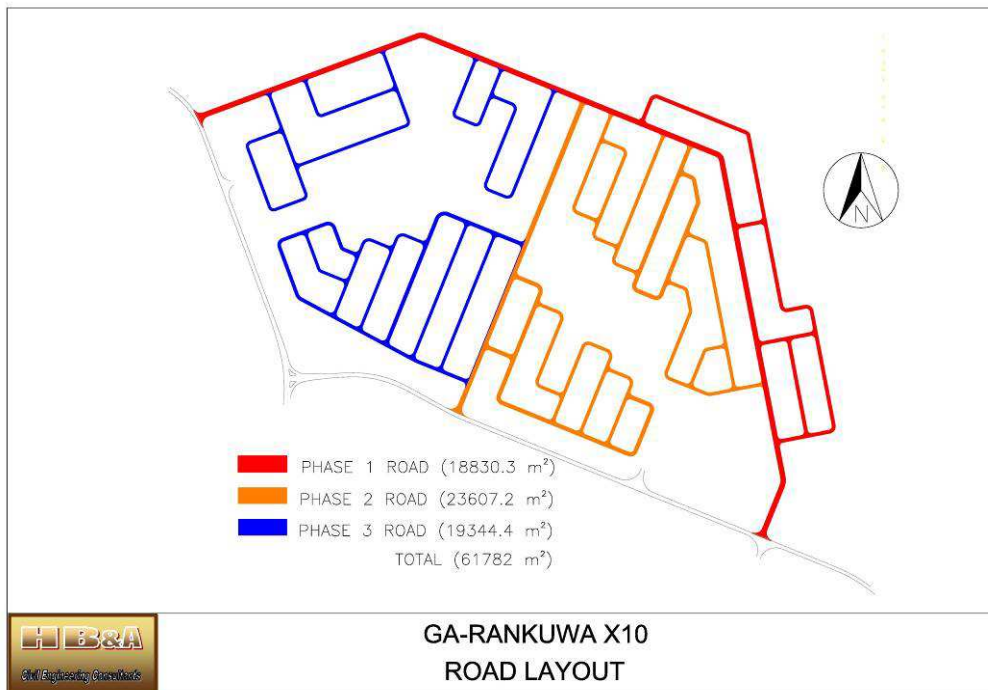


Figure 5: Ga-Rankuwa X10 Road Layout.

The project consists of constructing 3 200 stand-alone units with 1 200 of them being low cost housing. The total area of roads to be constructed is 62 000 m². The road construction was separated into three phases. Phase 1 is 18 000 m², phase 2 is 22 000 m² and phase three is also about 22 000 m². Phase 1 is almost complete and phase 2 is to start soon. The total man-day jobs that the UTRCP created here is 4 200.

3.3 Detail of the UTRCP

The following construction problems had to be overcome:

- Levels were incorrectly set out which created ponding at some sections (Figure

6);



Figure 6: Ponding on UTRCP.

- The final finishing of UTRCP is done by hand and if not closely monitored a discrepancy and inconsistency in the surface could result (Figure 7);



Figure 7: Inconsistent final finish.

- Adjacent anchor beams constructed with incorrect joining levels (Figure 8);



Figure 8: UTRCP Step at joint.

- The kerbs were constructed on top of the UTRCP at Ga-Rankuwa X10, and were cemented to the UTRCP with an epoxy. In some cases the UTRCP surface was not adequately cleaned and the kerbs became loose under heavy construction traffic (Figure 9);



Figure 9: Kerb constructed on UTRCP.

Apart from the usual site problems mentioned, the UTRCP is performing well, even under heavy construction traffic loads. The UTRCP is well suited for the clay conditions and using selected material from the site for the layer works. The design has resulted in major cost saving due to no importing of new material and less spoiling. On the long term however, the major cost saving will be in the limited maintenance required (Figure 10);



Figure 10: Completed UTRCP with Kerb and Sidewalk.

4 BRIEF COST COMPARISON FOR COMPARABLE SURFACING OPTIONS

UTRCP can provide a more economical option, than asphalt or block paving. The average cost of construction for UTRCP is approximately R 170.00 / m². Note that the base as needed for the other surfacing is replaced in this case by the UTRCP, giving an additional saving of about R 50.00 / m².

UTRCP does not require resealing every 10 years as with asphalt or double seals, and the concrete (aggregate and cement) is readily available in most areas, compared to other surfaces.

5 CONCLUSIONS

Ultra Thin Reinforced Concrete Pavements (UTRCP) is a sustainable construction technique that can be used to create work opportunities in South Africa. As UTRCP consists mostly of concrete and steel, it will not be affected by the inconsistent bitumen supply. The high rising cost of bitumen also makes UTRCP a more economical construction technique compared to asphalt and other forms of surfacing and since less maintenance is required after construction, it requires less maintenance.

UTRCP has been successfully used at Ga-Rankuwa X10 as well as many other sites, where it has proved to be a very suitable solution for the surfacing of roads and streets.

6 REFERENCES

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