

CON-AID in Uganda

Introduction

The Overall road system in Uganda consists of well-developed classified and feeder road network totaling approximately 30,000Km. The classified road network under the management of M.O.W.T & C currently extends to approximately 8,000Km of which 2,000Km are paved and 6,000Km are to gravel standard. The feeder road network under the management of the Ministry of Local Government currently extends to approximately 22,000Km. The rehabilitation and maintenance of these roads are priorities of the Government. However, conventional rehabilitation has proved very costly due to the following:

1. Good quality natural gravels (murrum) are not available in all parts of the country. Even where they exist, they are not always close to the road.
2. Many sources of natural gravel do not comply with the grading, plasticity and strength properties of road construction materials, rendering them unsuitable. Materials from such sources may be improved using lime or cement, which is costly.
3. Natural gravel used as wearing course for unpaved roads is easily lost through erosion, dust, trafficking etc. Regravelling is thus required frequently and maintenance becomes costly.
4. When natural gravels are stabilized with lime or cement, they must be sealed otherwise the stabilization process is reversed. Unpaved roads and shoulders have always been constructed using untreated gravels on this account.
5. Natural gravels have been used for Road Construction in this country for more than 40 years and are getting exhausted within economic haul distances.

In respect of the above, the use of CON-AID in Uganda has been deemed necessary. The application of CON-AID is intended to assist in the exclusion of water from soils, modify the material properties and to aid in the lubrication of material particles during compaction.

The Use of CON-AID in Uganda

An awareness seminar on CON-AID Technology, product and experience of all key players in the development and maintenance of road infrastructure was convened on 6th April 1995 at the Public Works Training Center, Kyambogo. During the Seminar the following observations were made:

1. CON-AID technology has spread worldwide. Users include government establishments, forestry estates, industry and mining, sugar estates and municipalities.
2. Its extensive application is in roads, deviations, parking areas, earth dams, mass fills floor foundation with greater success in non surfaced economical roads.
3. Various users have acknowledged the use of the chemical and strongly recommend it because they realized savings in road maintenance and vehicle operating costs - a factor linked to the effectiveness of CON-AID.
4. It is important for the chemical stabilizer and the soil to be compatible. Also the supplying company should be technically competent to support the product.
5. The construction process is simple using few equipment. The product is easy to store and it is applied on a wide variety of soils ranging from black heaving clays to silty sands. It increases the bearing capacity, workability and reduces clay activity and dust.
6. CON-AID roads have been subjected to wet/flood conditions (worst conditions). They continue to possess stability without reabsorption of water.
7. A cost comparison indicates that CON-AID treated road are cheaper than lime/cement treated roads under same conditions of construction. The option of using crusher run is the most expensive.
8. This technology is popular with a number of reputable organizations in South Africa like CSIR, Private Consultants, civil engineering contractors and municipalities. The technology appeared in a number of technical journals.

Main Projects where CON-AID has been applied

The following projects have so far been done with the help of CON-AID:

Date	Project	Length
1993/1994	Sipi-Kapchorwa Road	15 km
1994/1996	Kaserem-Sipi Road & Kapchorwa Town	10 km
1996/1997	Ntandi-Bundibugyo Road	23 km
2000	Nyakahita Rwakitura Road	45Km

Total Length	93 km
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Kaserem-Sipi-Kapchorwa Road:

Background

M.O.W.T &C selected the Kaserem-Sipi-Kapchorwa road because of its bad soils that would render the road impassible during the rainy season. It was common, before the application of CON-AID on this road, that Kapchorwa Town would be cut off during every rainy season forcing people to spend an average of 4 days to travel to Mbale, approximately 68Km from Kapchorwa. Tractors and donkeys were common means of transport. Furthermore, although Kapchorwa boasts of it's vast offer of natural tourist attractions, very few tourists could endeavor to reach the area.

A number of projects had been formulated, before the application of CON-AID, to have the road upgraded, without success. A detailed study was carried out by M/S John Burrow and Partners in 1972 and recommended upgrading of the road to Class II Bitumen standards but this never materialized. A labor-intensive rehabilitation programme under financing of the ILO was executed during the early 1980s but the road quickly deteriorated shortly thereafter. Attempts were made to rehabilitate the road in 1987 but the contractor, M/S Zakhem abandoned his equipment on site prior to commencement of physical works. This was probably because the contractor found out that he could not cope up with the complexity of the work.

In respect of the above, CON-AID stabilization was the only alternative, at that time, to rehabilitate the road.

Soil Properties and Stabilization

The soil along the road alignment is dominated by weathered red silt soils belonging to the A-7 AASHTO Classification group. Typical properties of the soil were as follows:

Property	In-Situ Soils	Borrow Material
Fines less than 75 microns	70%	60%
Liquid Limit	60%	54%
Plastic Index	30%	26%
BS Heavy MDD	1550Kg/m ³	1650Kg/m ³
OMC	21%	22%
Soaked CBR at 95% MDD	1-7%	5-44%

Representative soil samples were sent to South Africa to determine the reactivity of the soils to CON-AID and hence establish the application rate. This is imperative in the stabilization with CON-AID to ensure high performance. The construction consisted of shaping the road carriageway and drains to the required levels and crossfalls. Culverts were placed in specified locations to ensure a well functioning drainage system. CON-AID was applied at the rate of 0.03l/m² diluted with water in a ratio of 1:150 to 1:250, depending on the soil moisture content, and with the help of a water bowser. Mixing was done with the help of a motor grader. Compaction was done with a 15 ton Vibro Roller.



Quality Control and Monitoring:

Before CON-AID Application on Kaserem-Kapchorwa Road (beginning of escapment before Sipi Trading Center)
 Five years after CON-AID application Kaserem-Kapchorwa road (beginning of escapment before Sipi Trading Centre)

The Ministry of Works Transport and Communications carried out quality control tests at a site laboratory located in Kapchorwa town. It was further decided that the field performance of the treated section be monitored for a period of one year after the rehabilitation, from which the effectiveness of CON-AID would be assessed.

Observations and Findings

1. Field Densities were readily achieved in fine soils during construction, contrary to normal construction experience.
2. The moisture content of the wearing course reduced after treatment with CON-AID while that of the subgrade remained fairly constant throughout the monitoring period.
3. The Liquid Limit and Plastic Limits of the natural and treated soils do not change significantly.
4. The In-Situ CBR increased from about 53% (before treatment) to 78% (one year after). There was slight increase in the strength in the stabilized top 150mm after two years (field results available on request).

5. Slight rutting and corrugations of the wearing course appeared after the wet season of June 1994. This was rectified by slight grading which took 3 days to cover the entire 25Km (compare with grading on conventionally constructed roads, which used to take ten days). Rutting and corrugations for the last 4 years are more severe in areas where the side drains are easily silted due to the terrain resulting in large volumes of water flowing or flooding along the road. Severe erosion in the last four years has appeared on steep areas due to lack of adequate maintenance on drainage.
6. During the wet season a thin layer of mud forms and this results into the road getting rather slippery. This problem was reduced, in some places, by putting a gravely seal treated with CON-AID on top of the treated In-Situ material. The treated wearing course dries out faster than the untreated sections and the road becomes passable with ease within few hours after it has rained. On the contrary, the untreated sections are deformed and become muddy making the road impassible in the wet seasons.
7. There has been a reduction in the amount of dust since the treatment of the wearing course. Dust intensity has been assessed by observing the vegetation around the treated section as compared to that near the untreated sections.
8. Before stabilization with CON-AID, only tractors and strong four wheel drive vehicles were able to use the road. Treating the road with CON-AID has generated some traffic of all types including small saloon cars because road users have found out that even if it rains, the road dries out very fast and one is able to use the road within few hours after the rain.



Present Condition of the Road

Ntandi - Bundibugyo Road

Background

This road, similar to the Kaserem-Sipi-Kapchorwa Road, has been problematic especially during the rainy season. The section lies in a flat area surrounded by the Rwenzori Mountains. A big portion of the road gets flooded every rainy season because all the water from the surrounding mountains is trapped in this area. There are no adequate gravel (murrum) borrow pits which comply with the grading, plasticity, and strength properties of road construction. This makes conventional rehabilitation or maintenance very difficult such that the M.O.W.T & C had to repair the road after every rainy season to render it passable. This being the only road from Fortportal, Bundibugyo used to be cut off during the rainy season.

Soil Properties and Stabilization

The soil along the road is predominantly high compressible, high volume change clays belonging to A-7-6 AASHTO Classification group. Exposed stones of sizes ranging from 2cm to 15cm characterized more than 60% of the whole road section. These stones had been laid during earlier rehabilitation and originated from the borrow pit at Ntandi.

Construction was similar to Kaserem - Kapchorwa road. Material to cover the exposed stones was imported from Ntandi borrow pit and stabilized with CON-AID. The application rate was 0.025l/m².

Quality Control and Monitoring

The M.O.W.T&C carried out Quality Control and monitoring at a site laboratory in Bundibugyo town. Ntandi - Bundibugyo Road 4 months after CON-AID Application.

Observations and Findings

The observations and findings made are similar to those of Kaserem - Kapchorwa road. Generally, the road has improved tremendously after the application of CON-AID. After construction, the road experienced heavy-armed vehicles and heavily loaded World Food Program Vehicles. Although this was during the heavy El-Nino rains, the road performed very well.

A section of approximately 400m gets very slippery during heavy rains due to bad drainage. In this section, water floods on the road hence saturating the clay soils such that mud tends to form due to traffic wheels. However, when the floods clear, the section is easily passable. Some parts on steep areas were damaged by landslides but became passable after the removal of the landslides. The serious problem along the stabilized section was at Hymya Bridge whereby large volume of water cut across the road thus cutting off Bundibugyo from Fortportal for several days. The unstabilized roads in Bundibugyo were impassible in December 1997 and will require complete



reconstruction.

Cost Analysis for the use of CON-AID on gravel/earth Roads

Construction Costs

It has been observed from the above CON-AID Projects that considerable saving can be attained from the use of CON-AID as compared to the conventional methods of road construction or rehabilitation. The following table shows a comparison of construction costs between conventional construction and CON-AID construction. It should however be noted that Item 2 is only necessary in CON-AID Construction if the stabilized soils tend to be slippery after stabilization, as in the case of Kaserem - Sipi road.

It is important to send representative soil samples to South Africa for reactivity tests through which the application rate is determined. This ensures control of the:

Chemical:

- Suitability of the soil for treatment
- Danger of over application which may cause
 - i) Slipperiness in wet weather
 - ii) Lack of initial compaction

Maintenance Costs:

It has been observed that for the conventional road Construction, regrading is required after every rainfall or once in 4 months. With CON-AID construction, once the treated surface has become stable, light grading is done once in 1.5 to 2 years. This saving on maintenance can be used to upgrade or stabilize additional roads with the consequential improvement of the country's economy.