Considerations Concerning Using GPS Technology to Rehabilitate Constructional Works

Associate Prof .Eng. Ph. Dr. Gabriela Proca, Technical University "Gh. Asachi"
Eng. Drd. Mihaela Proca, Technical University "Gh. Asachi"

Abstrait : *Le papier actuel présente quelques particularités topographiquement des travaux effectués dans des programmes de réadaptation pour des routes et des chemins de fer en utilisant des technologies modernes, comme le GPS et les stations totales.*

1. Introduction

Old roads and existing railways need to be rehabilitated having in view new requirements concerning traffic's fluidity, high velocity (140-160 km/h) and security of transportations, generally.

Are met situations like sliding embankments, plants and trees on line platform and the joined embankments, on current way, (Photo.1) generated by water's action; damaged bridges as effect of inundations (Photo 2).

Photo 1 Embankment's Sliding

Photo 2 Damaged Metallic Bridge

Supplementary, the year of 2005 being a special one concerning the water's damages on built areas and human activities, can be named a referential period in order to evaluate better water's action on constructional works.

Even flood is a special charge, all built constructions, especially those serving in transportation area, must be repaired periodically and rehabilitated in order to prevent their collapse and to improve their resistance and stability.

For 2005 year can be mentioned over 2000 destroyed bridges having metallic, masonry and reinforced concrete structures. A special attention can be done for those having a metallic super structure, where the damages were remarkable, in negative sense.

Technically, a metallic super-structure must be verified each year, after Romanian regulations; constructional works must be repaired in local programs or national ones, when their life activity in order to be exploited in safe conditions expired. Generally, for bridges this period has around 60…80 years of safe exploitation.

A lot of damages can be observed on bridges where constructional works are not yet finished (by example: without constructed quarters of cones, back walls) or these aren't maintained safely in order to be exploited.

Another motive can be for new constructional works, those being in rehabilitation process, but not yet ready to be exploited. It's well known that general stability is lower than usual in these conditions.

Many bridges had lost their stability when the foundations were washed by water with high velocity than usual because of some ballast exploitations made in bridges' area.

These situations were generated by different motives as non-existing or not respecting a maintenance program in order to protect constructional works.

The first phases in rehabilitation were a topographical leveling up finalized with a situation plan and, after case, a following up plan. The terrain acknowledgment had generated other specifically activities as rehabilitee of geodetic network and following up the terrain movements.

2. Rehabilitation's Phases for Roads and Railways

In order to rehabilitate damaged roads and railways were analyzed and adopted solutions having in view the real situation, on terrain, following the next phases: complete inventory of unstable terrains in the railway areas; inventory of existing geodetically network; a land surveying fly in order to do photogram metric observations, and, designing new constructional works and monitoring of all works to be executed.

2.1 Topographically Works

Engineering topographically works were: verifying on area the geodetically network and rehabilitating it using a GPS technology; leveling up the way's route, designing crossing profiles of railways and the longitudinal profiles on line's axis.

In order to **verify and to rehabilitate a geodetic network** are indicated the following activities:

- A precise determination of the spatial coordinates X, Y, Z for all points materialized in the ground along the way segment using GPS technology, or if is possible to use these points also in the photogram-metric process, points pre-marked using a square of 50 x 50 cm.

Can be used as e**quipment**: for the surveying campaign systems JAVAD-Topcon GPS, L1/L2 + GLONASS, with extra options which ensures the quality and safety of the data; **software**: **PINNACLE package**, used for GPS measurements processing (basic calculus, processing the geodetic network, specific report's generation, etc.) - software produced of GPS manufacturer company JAVAD and the **GPS Tools package**, and **INTERGIS** software product, containing options to solve the coordinates' problem.

The **RGS materialization** must be executed as stipulated in Technical Norms (by example: materializing stations using FENO 10 x 10 types of benchmarks with anchor implantation up to 50 cm depth or using concrete benchmarks of the existing network). In the same time, must be made an acknowledgment of new benchmarks. For the benchmark installation, is necessary to have in view the visibility between the pairs of benchmarks, that they would be placed as much as possible in uncovered, stable zones.

For measurements and operations of verifying the support geodetic network, in the mentioned cases, was used a GPS technology.

The survey schedule was the following:

- The measurements campaign for the fix stations and for the junction stations with the National Geodetic Network;

- The measurements campaign for the determination the new stations, based on the measurements of the fixed ones. The measurement method was GPS static surveying. For the RGS junction with geodetic network used at the railways' construction, were identified the old stations included in the GPS network.

The precision of coordinates' values can be indicated individual errors of RGS less than 1…2 cm.

For **data processing** works had used Pinnacle software, other than the standard method (Static Method), also the Stop&Go, Rapid Static and Cinematic Methods. It can be processed any data combination simple or double frequency, GPS or GLONASS.

The network compensation module is extremely versatile and automated. Was selected, the compensation in two steps. In the first step, the compensation's vectors can be eliminated or re-pondered. In order to detect and to control the results of compensation were introduced special statistical tests. The second step was in constraining the network on the local control stations. This last, can be used as fixes or as stations having a certain weight in the network's constraint.

Coordinates transformation was accomplished using GPS Tools software developed by INTERGIS. The coordinated inventory was shown the 1D and 3D coordinate transformation that had lead to obtaining the RGS stations coordinates in the National Geodetic System Stereo 1970 and Black Sea for the heights.

As result of network verification, in many cases, were necessary to plant new concrete benchmarks with metallic anchored head, to replace the destroyed existing marks, to redoubling those benchmarks placed in non-stable terrains and to plant supplementary new benchmarks for leveling up works.

Supplementary topographically works were done in order to establish; the final route of railways and roads, tunnels, bridges, inferior under passages, areas corresponding to rivers, having in view the existing railways in the area as over passages, additional constructional works, etc.

3. Rehabilitation's Phases for Damaged Bridges

For many bridges the water's shockwave had produced sliding processes on both river sides, respectively at ground level. After, the micro-movements of river's sides had produced damages on embankment structure.

For the beginning, must be analyzed the stability of bridges in order to be safe in exploitation. By example, the study of RC piles' stability must be based on direct observations concerning the character of sliding process.

Topographically measurements give important information on consuming little or major micro-movements of piles or underground plates.

3.1 Topographically Works

Establishing the geodetic network support needs high precision observations. Having in view the situation created by inundations new or rehabilitated network was required in many cases. Can be mentioned that existing GPS' networks were used in order to build geodetic support network in order to analyze and to rehabilitate constructional works.

The main geodetic network support has points from a national network or, after case, the place's geodetic network.

Topographically and cadastre works were executed using the Stereo 1970 projections' system and the referential system Black Sea 1975 and a special technology, respectively the **total station Leica TC 705**, with automatic data registration system. For support geodetic network were made **GPS observations**.

For damaged bridges were effectuated on location: acknowledgement of field; reconstitution

of the status and tracing and support geodesic network; lifting up the level and plan area and making out the situation plan, scale 1:500, verifying the main axis of the road/railway situated on bridge, after inundations; establishing if micro movements of river's sides were consumed itself; checking the infrastructure elements (the underground plate).

Can be mentioned that were registered the water's levels belong inundation and after and leveled up the existent water-ditch system, constructed area near bridges location and all details for bridges, the rivers' sides and rivers' bed.

For the support geodetic network can be created new points' stations using the GPS network of place and building new points (for leveling up networks).

All registered data can be processed using a dedicated soft: SiPreg, AutoCad and Office.

4. Constructional Works

All constructional works were realized using topographically plans and techniques, after the rehabilitation of geodetic network. The rehabilitation's works for the mentioned cases are typically for railways and roads construction or rehabilitation.

Are included generally, supplementary works, like: at embankments (repairing the geometry in horizontal plan, in long - plan and cross- plan); reinforcement of understructure, rehabilitant RC piles of bridges, corrections of rivers' beds.

After finalizing all types of constructional works, is necessary to impose a serious schedule in order to follow the comportment of constructions and terrains in entire built area. Can be used fixed signs for the characteristically sections of constructional works to be executed, according the Romanian regulations in this domain.

5. Conclusions

The technical solution to rehabilitate roads, railways and bridges had in view he following activities: complex studies on the real situation available on terrain; topographically plans for constructional works, rehabilitation of National geodetic Network, particularly the local network and a serious schedule to follow up the comportment of constructed areas and buildings. In order to keep safe all constructional works on water's charge is necessary to apply and respect all regulations concerning design – performance – maintenance and following the comportment under special actions.

The situation created this year in Romania by inundations must recommend a better understanding of natural phenomena and their evaluation concerning effects on constructional works and society.

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