

# GPS Application on Huge Construction Project — A Feasibility Study for Taipei MRT Long-term Network

P.Y.Chang<sup>1</sup>, C.J.Chang<sup>2</sup>, Martin W.Pei<sup>3</sup>

*Deputy Director General, Department of Rapid Transit Systems, TMG,  
ROC*

*Deputy Chief Engineer, Department of Rapid Transit Systems, TMG, ROC  
Associate Engineer, Department of Rapid Transit Systems, TMG, ROC*

**Abstract:** With numerous large-scale underground construction projects continuously carried out in Taiwan in recent years, a huge amount of excavated soil has been produced. However, legal dumpsites are scarce and the cost of dumping is relatively high. In order to save money, unethical contractors dumped the spoil maliciously into rivers and valleys, resulting in water pollution, blockage of surface flow and many other environmental problems.

Taipei Metropolitan Area Rapid Transit Project is now in its second phase of construction and two new lines, i.e., the Hsinchuang / Luchou Line and the Neihu Line, with a total length of about 40.9 km, are to be constructed. Construction is to start in the early part of 2001. About 7 million-cubic meter of soil is to be produced and dumping of this amount of soil is indeed a serious problem.

The Department of Rapid Transit Systems of Taipei Municipal Government has formed a task force to deal with the problem with the missions of reducing the quantity of excavated soil to be produced and stopping illegal dumping. One of the approaches studied is to monitor the movements of dump trucks by using global positioning system (GPS), in conjunction with geographic information system (GIS) and internet for telecommunication. The team also actively looks into the various ways of recycling soil and the possibility of developing new dumpsites.

The results of study are presented herein with emphasis on the application of GPS system.

**Key word:** Excavated soil, Dumpsite, Global positioning system (GPS)

## Introduction

According to a statistic published by the Construction and Planning Administration (CPA) of Ministry of Interior of ROC, the quantity of soil to be disposed reached 16 million cubic meters per year, with 5 million from construction sites in Taipei City and 9 million in Taipei County and Keelung City. The remaining capacity of dumpsites which are currently in operation is estimated to be 23 million cubic meters and it will not be long before all these dumpsites are full. The construction of the Neihu and Hsinchung-Luchou Lines of the Taipei Metropolitan Rapid Transit Systems is about to start in early part of 2001 and a total of 7 million cubic meters of soil is expected to be produced in the period between the years of 2002 and 2005. The disposal of this large amount of soil therefore deserves serious considerations.

Dumping of construction soil has always been a problem since the early 80's when the economy of

Taiwan picked up and the rapid development made lands scarce. Furthermore, people have become more and more conscious on environment issues and regulations on dumpsites become more and more stringent. It is very difficult to obtain the license for developing a new dumpsite nowadays. On the other hand, numerous major construction projects have been carried out, particularly in Taipei City, and most of them called for excavations to considerable sizes.

Because of the imbalance between demands and supplies, the cost of dumping escalated rapidly. It is not surprising to learn that unethical contractors just dumped soil at places which were unattended. Most of times they could get away with it and, even they were caught, the penalty is really minimal in comparison with the profits made. This has further encouraged illegal dumping.

The most frequent places for illegal dumping are rivers and valleys in suburbs and this has caused water contamination, blockage of surface flow and floods in raining seasons. Remedy of damages made

cost tax payers a tremendous amount of money each year. Some of daring contractors even dumped soil on streets and highways and several fatal accidents have been caused as a result.

Global positioning system (GPS) has been successfully used to monitor the movements of vehicles and it is commercially viable. It can further be integrated with geographic information systems, electronic maps and wireless communication technology, etc., to monitor the path, speed, and dumping of these trucks. The potential of using GPS for monitoring dumping trucks as a measure of stopping illegal dumping is studied herein.

## The Problem Faced

The problem of illegal dumping is really a complicated one and is a result of:

- a) Lack of national-wide soil management program

Soil from construction sites can be used for reclamation and many other purposes and could become a valuable resource material. The current practice is to treat soil as a waste and dump it whenever it is produced. The regulation does not differentiate reusable soil from wastes. This not only causes environmental problems, the practice itself is counter-productive and wasteful. Government, on the one hand, has to pay for dumping, but on the other hand, has to spend money to purchase soil to be used in some other projects. Taoyuan County Government is the only exception that allows sandy soils to be excluded from the regulations which require all soil from construction sites be dumped. In fact, the recycling program has been very successful in Taoyuan and there are many factories producing bricks using soil produced from construction sites.

- b) Lack of dumpsites and stockyards

Because regulation requires all the soil from construction sites be dumped, an extraordinary amount of soil has been dumped in the past and more is to be dumped in the future. Even soil is to be recycled, temporary storages are required. Legal dumpsites in Taipei County have a remaining capacity of 6.2 million cubic meters total and temporary stockyards for recycling have a remaining capacity of only 0.7 million cubic meters. This is far from being sufficient. New sites are difficult to find because of the lack of the lands which are suitable for the purpose and also because of the objections from local residents even a site

is suitable.

- c) Unhealthy competition and inadequate practice

Specifications usually stipulate that a certification shall be submitted to prove the availability of a dumpsite at the beginning, or even in the bidding process, of a project which calls for dumping. At the current market rates, a certificate will cost about NT\$180 per cubic meter of soil and dumping will cost an additional amount of NT\$180-200, giving a minimum of NT\$360. The compensation contractors receive is only slightly more than this amount because of unhealthy competition in the bidding. It is no wonder that contractors would look for ways to escape from this pitfall.

The operators of dumpsites usually issue certificates to contractors or bidders without commitment from either side. That means, the operators are not obligated to accept soil and the contractors are not obligated to dump the soil at the given sites. Because dumping is normally carried out in nights to avoid traffic congestion and there are usually hundreds of trucks mobilized each night, it is just impossible for the supervising staff to monitor all the movements. It frequently occurred that unethical truck drivers dumped soil at places which were unattended and got away with it.

Law enforcement has been difficult because of the involvement of gangsters and it is not possible for local police force to face organized crimes. Central government has to step in and take strong actions to backup local government in law enforcement.

## Taipei MRT Soil Management Approach

To deal with the problem, Department of Rapid Transit Systems of Taipei Municipal Government established a task force team in November, 1999. It has actively discussed with various governmental agencies and private sectors to look for optimum solutions. Over the past months, it has achieved the following missions:

- a) Establishment of databases for compiling relevant information
- b) Review of regulations, specifications and current bidding practice
- c) Studing the way to recycle soil
- d) Investigation of alternative construction methods to reduce soil
- e) Establishment of a web site for information to be accessible by public

- f) Promotion of the use of GPS as a means of monitoring movements of dump trucks

The team will continue its efforts on the above issues in the future and also look into the possibility of developing dumpsites by the Department itself or jointly with other governmental agencies.

## Global Positioning System

Most modern GPS receivers support the concept of waypoints and routes. A waypoint is a specific point (longitude and latitude) stored in memory. A route is a series of waypoints connected together to form a path from one point to another. This technology has been widely adopted in vehicle tracking and routing. The results can be shown together with electronic maps for better appreciation of the history of movements of objects. GPS has been used successfully in navigation and monitoring movements of vehicles in many countries. It can further be integrated with geographic information systems, electronic maps and wireless communication technology to monitor the path and speed of trucks for the purpose of stopping illegal dumping.

The use of GPS for the above-mentioned purpose is still conceptual at this moment. Such a monitoring system will include the following elements:

- a) GPS on trucks

The position of each truck is continuously monitored by GPS devices mounted on the truck and is broadcast through a modem which sends out radio signals. GPS devices with a precision of meters are nowadays inexpensive and affordable. Such a precision is sufficient for the purpose.

- b) Communication network

The signals from the truck are picked up by receivers at the bases of telecommunication networks which will in turn transmit the information to the control center by internet which has become backbone of telecommunication.

- c) Control center

The control center is equipped with servers with sophisticated hardware and software to monitor the whereabouts of all the dump trucks and display the

information on screens. The process would take anything from a few seconds to a few minutes and any wrong doing could be detected and corrected within minutes, or half an hour the most. Information stored in the databases can be used as evidences at courts in cases of prosecution.

## Conclusions and Recommendations

Illegal dumping of construction soil has caused serious environmental problems and has to be stopped. Recommended herein is a GPS system to be used in conjunction with GIS and internet communication for monitoring the movements of dump trucks. With this system, actions can be taken quickly against violations. In consideration of the tremendous manpower saved in comparison with the traditional approach, the use of GPS offers an effective, speedy and cost-saving solution to the problem of illegal dumping of construction soil.

It is further recommended that a nation-wide soil management program be implemented with emphasis on recycling aspect which will not only reduce soil but also turns wastes to profits.

The development of new dumpsites has to speed up in order to meet the future demands before it is too late. For this to be possible, legislation may be required to remove constraints in application for permits and to legalize compensations to local residents who are to be affected.

## REFERENCES

1. Chang, C. J. Urban Transit: Planning and design, Taipei, May 1999.
2. China Engineering Consultants, Inc, Spoil management program for the construction of Luchou Line, a study report submitted to the Department of Rapid Transit Systems, June 2000
3. TYLin/GIBSIN Engineering Consultants, Inc. Spoil management program for Construction Contract DK195, a study report submitted to the Department of Rapid Transit Systems, April 2000
4. China Engineering Consultants, Inc, Spoil management program for Construction Contract DL132/DL133, a study report submitted to the Department of Rapid Transit Systems, May 2000
5. Ministry of Interior, Management of construction spoil, June 2000.