

The First International Seminar on Road Tunnel Operations Management & Safety

18-20 October 2006 - Chongqing China

Sponsoring Organizations:
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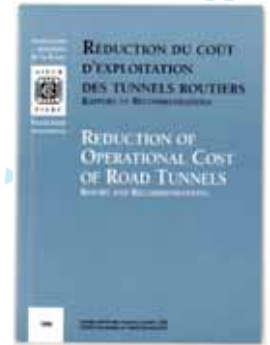
PIARC Report - Reduction of Operational Costs of Road Tunnels

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Introduction

The purpose of the report "Reduction of Operational Cost of Road Tunnels" is to:

- Identify the main operational costs for road tunnels
- Present examples and recommendations on how such costs should be reduced



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Outline of Presentation

- **Historical Background**
- **Classification for Operational Costs**
- **Reduction of Operational Costs**
 - Overview of O&M costs
 - Main areas for reduction of operational cost
- **Recommendations to Tunnel Managers**
- **Recommendations to Tunnel Designers**
- **Summary and recommendations**
- **Good Practice**

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Historical Background

- **1987** : PIARC Brussel Congress
 - Analysis of tunnels cost for 123 road tunnels (survey initiated in 1984)
- **1995** : PIARC Report
 - Recommendations for classification system
- **1996** : Working programme for 1996 to 1999
 - Update the PIARC report of 1987
 - Identify new techniques for reducing operation costs
 - Review standards for O&M to achieve cost reductions
 - Update earlier studies
 - Prepare future Best Practice Manual
- **1999** : Updated PIARC report – this presentation

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Changes 1987 to 1999

The collection and updating of data for the 1999 report showed the following trends:

- The energy share of total costs have decreases from 33% to 25% even with increase in AADT
- Maintenance cost have tended to increase (or stabilised)
- For older tunnels staff remain stable
For newer tunnels the staff requirements have decreased



Classification for Operational Costs

In order to compare operational costs of similar tunnels a classifications system can be established.

The classification system can be used to predict operating cost of different tunnels.

The most important factors are:

- Tunnel length
- Traffic flow and speed
- Method of lightning & ventilation
- Number of tubes, lanes per tube, one/two way traffic
- Type of all surfaces
- Manned or unmanned

Reduction of Operational Costs

Operational costs are made up of three main components:

- **Operating**
- **Maintenance**
- **Reinvestment**



Reduction of Operational Costs

Main areas for reduction of operational costs are:

- **Energy costs**
- **Cost of personnel and management**
- **Cost of maintenance**



Energy costs

The four main energy consuming systems are:

- Lighting
- Ventilation
- Pumping (in sub-sea tunnels)
- Air cleaning systems



Entrance lightning can be reduced by using sun louvres



Use bright walls and bright pavement

Energy costs ... Reductions

Achieving lower energy costs:

- Negotiate supply price of electricity
- Reduce peak consumption
- Log and analyse energy consumption to improve power management
- Select equipment based on power consumption and whole life costs
- Reduce tunnel lightning costs by applying tube lighting, traffic speed controlled lighting and counter beam lighting

Cost of Personnel and Management

Personnel are required for:

- Management and inspections
- Control centre operation
- Maintenance



The owner is responsible for all tasks - but some functions can outsourced to contractors, specialists, consultants etc.



Cost of Personnel and Management ... Reductions

Achieving lower staff cost:

- Use remote operation centres (ROC) – this leads to considerable staff reductions
- Establish facilities and protocols to allow the police to undertake remote traffic monitoring and management
- Install automatic vehicle identification systems and toll payment systems



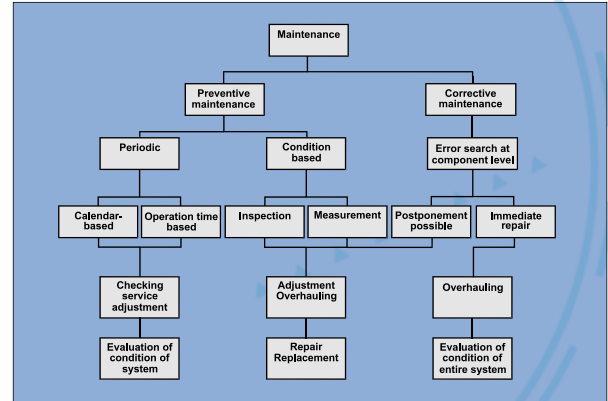
Cost of Maintenance

Issues to be considered:

- Method of maintenance
- Organization of maintenance
- Types of maintenance contract
- Selection of equipment
- Appropriateness of design
- Environmental factors



Method of Maintenance



Cost of Maintenance ... Reductions

Achieving lower maintenance cost:

- Provide easy access to all areas to maintain
- Install a properly planned and managed IT tunnel management system
- Use systematic maintenance
- Proper maintenance standard which addresses whole life cost without compromising safety and reliability



Recommendations to Tunnel Managers

There are several ways of achieving O&M savings:

- Use contractors for tasks that need extra personnel for a limited period
- Peak shaving, ie. reducing the energy cost without reducing the energy consumption
- Reduce lightning – use sun louvres, bright walls and pavements, etc.



Recommendations to Tunnel Managers

- Use a systematic maintenance system
- by applying *computerised systematic maintenance* ie. use a complete TMS system tailored to tunnel O&M
- Plan and gather all types of maintenance works for periodic "maintenance weeks"
- Tunnel maintenance should be Planned Maintenance



Recommendations to Tunnel Designers

The main objectives for economical tunnel operation is:

- Consult experienced tunnel operators before decision commitments are made
- Apply an approved safety concept
- Apply whole life cost optimization of installations and energy consumption
- Allow ability to reduce expenses on personnel



Recommendations to Tunnel Designers

Some simple guidelines:

- As many installations as possible should be located outside areas used for traffic
- Ensure easy and safe access to all installations
- Make it possible and easy to replace major installation components (e.g. ventilators) with fully functional spares while components are being repaired outside the tunnel
- Control as many tunnels as possible from one regional control centre
- Optimize power generators, tunnel lightning, need for ventilation, drainage system



Summary and recommendations

- Operational costs are evenly shared between energy, staffing and maintenance
- Reduction of energy cost is achieved through proper O&M management and selection of equipment
- Staffing may be reduced by using ROC, modern technology and outside contractors
- Maintenance cost may be difficult to decrease since refurbishments of equipment often involves more advanced equipment. Considerations and care is required during design

Good Practice

Establish a best practice for the purpose of comparison and improvement, i.e. "benchmarking".

Compare operational costs with those of other tunnels.

Set up year upon year target for improvement.

Apply the 2005 PIARC report: *"Good practice for the operation and Maintenance of Road Tunnels"*



Contents of "Good Practice ..."

- Quality Plans
- Safety and Risk Management
- Maintenance and Operation
 - Quality Plans
 - Tunnel Management System
- Training and Emergency exercises
- Renovation of Tunnels
- Risk Evaluation Tools
- Financial Decision-Making Tools
 - Whole Life Cost
 - Benchmarking



Obtaining the PIARC report

The report *"Reduction of Operational Cost of Road Tunnels"* may be bought from PIARC homepage at:

<http://www.piarc.org/>

or using the direct link to the publications page:

<http://www.piarc.org/en/publications/tech-report/maintenance-operation>



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