HOW CAN SAFETY BE CONSIDERED AS PART OF A TRANSPORTATION VE STUDY?

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ABSTRACT

This paper will detail how the use of the traditional customer FAST diagram and the innovative safety cost model can effectively produce greater creativity during the VE workshop for transportation studies. Far too often the VE team focuses in on the capital costs of a project in looking for cost savings and value enhancement, while often ignoring the greatest life cycle costs associated with highways which are related to safety. As an example, the results of a recent VE study on a freeway project will be presented. This VE study has lead to a patent application for the innovative VE proposal as well as the implementation of the safety VE idea on several sections of the new freeway in 1997 for this project in Ontario, Canada.

INTRODUCTION

This paper presents the benefits of considering safety as an integral component of a Value Engineering (VE) study for transportation projects. Although it seems obvious that safety and the societal cost of accidents would be included in the life cycle costs it seldom occurs in practise. Rather the VE effort is typically channelled to target high capital costs in order to meet a transportation authority's budget.

This paper presents two techniques (safety cost models and the use of the customer type FAST diagram) that can be considered for VE studies on transportation projects. They have been utilized for transportation VE studies to successfully focus the VE team on safety aspects of the project and can result in VE ideas that result in societal benefits by making highways safer often with little change to the overall capital cost of the project.

Specifically this paper illustrates how safety models can be used during the information phase and customer FAST diagrams during the function analysis phase of the VE workshop. A case study is presented that illustrates a specific safety VE idea that resulted from such a study that will result in significant societal savings through a reduction in future accident costs without changing the capital cost of the project.

HOW TO INTRODUCE GREATER CREATIVITY

The principal objective of the VE team leader as facilitator is to break down the mental roadblocks of the VE Team and develop greater creativity. By doing so results in a more productive group and greater number of alternatives generated. And, as a major tenant of VE, the best way to get a good idea is to have a lot to choose from.

One method is to include, as part of the workshop, a review of the existing and future accident costs of the project. Often the VE team can complete an entire VE Study focusing entirely on capital costs and lose sight of what is often the greatest societal life cycle cost of the project, namely accidents. This is a result of the tremendous pressure to reduce capital costs to meet ever decreasing budgets. Often this may have been the entire objective of initiating the VE Study. However, by applying the VE methodology and systematically considering the project by functions can often result in safety improvements that may not increase the capital cost of the project. This results in better value.
What are the societal costs of accidents? In Ontario, the largest of the Canadian provinces the value of each type of accident class is as follows:

$6,000	Property Damage Only
$27,000	Personal Injury
$800,000	Fatality

The province with a population of 11 million has 7 million licenced drivers and 6.5 million registered vehicles. In 1994 the Ministry of Transportation reported that the total cost of collisions in Ontario is 9.1 billion. These losses include:

- 99 people killed;
- 91,000 people injured; and
- 170,000 property damage crashes.

These values reflect one accounting system that measures "hard" costs such as lost income. In fact a higher value for fatal type accidents of $6,000,000 has also been quantified by the Province based on the value individuals are personally prepared to pay (i.e. safer cars, air bags, etc.). However, the current approach within Ontario is to use the lower, more conservative, value for fatal type accidents.

SAFETY TECHNIQUES

This paper presents two methods available for transportation studies to focus on safety, as one aspect of the project, are:

- Safety Cost Models; and
- Customer oriented Fast Diagrams.

The first of these techniques is the use of safety cost models during the information phase of the workshop in addition to construction cost or function cost models. Although it seems intuitive to do so when considering life cycle costs it is generally not done because of the lack of information, additional cost to prepare or because of the difficulty in predicting future costs. However, this step alone can trigger the group during the later function analysis and creative phases for innovative safety ideas.

A sample of a life cycle cost model including accident costs is shown in **Figure 1** and an accident model in **Figure 2**. The accident cost model on this project quantified what the net present value of accidents will be over the next 30 years for a future 4-lane freeway. The accident costs are summarized for each kilometre of highway and reflect changes such as rock cuts, guiderail, sideslopes in earth cut and fill areas as well as grades and horizontal curves. A safety cost model is just one tool and can be used in addition or to supplement the construction and function cost models.

The second technique which allows the safety elements of the operation of a highway to be considered is by using the customer oriented type of FAST diagram rather than the Technical FAST diagram during the function analysis phase of the workshop. The customer FAST diagram allows the supporting functions that satisfy the user to be shown and considered in greater detail. The supporting functions such as "reduce accidents," "assure dependability" and "satisfy users" can generate valuable ideas later during the creative phase of the workshop.

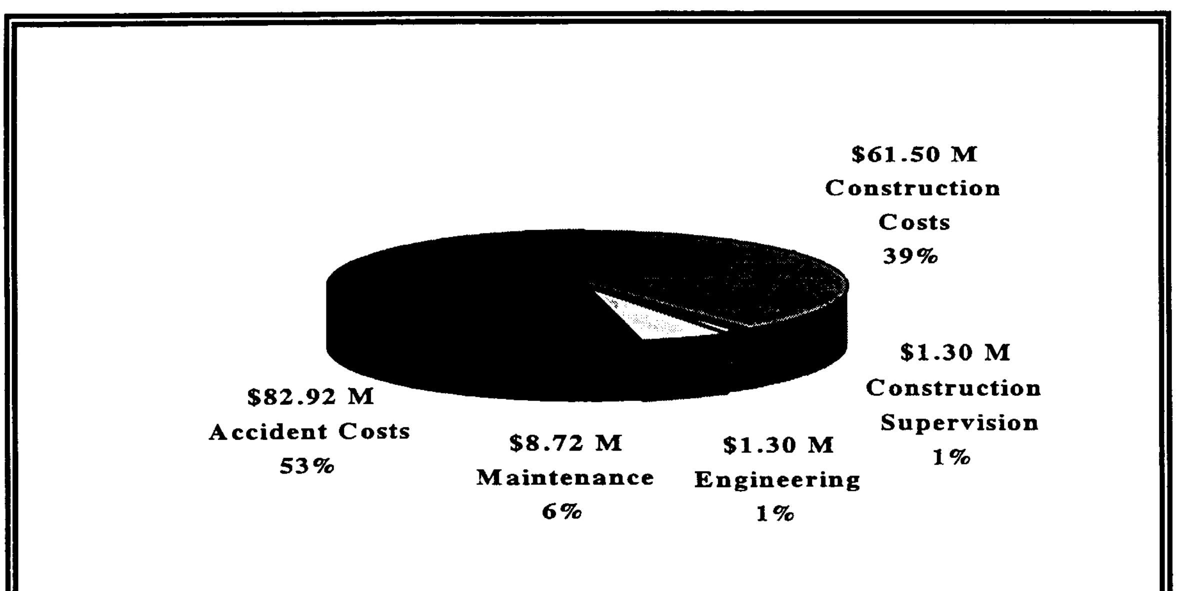
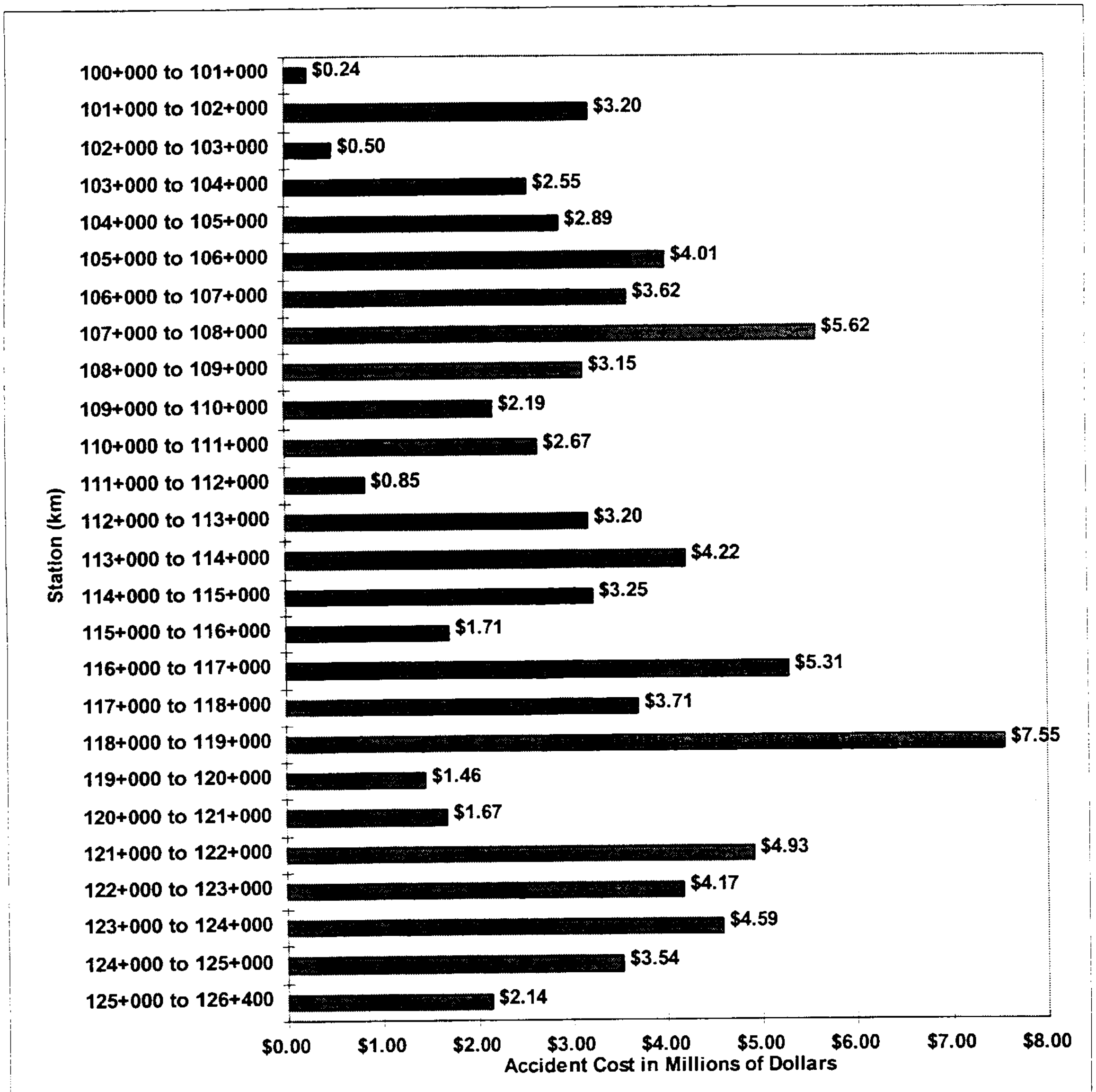


Figure 1 Sample Life Cycle Cost Model for a Highway Project



Notes: 1. Represents a 30 Year Planning Period
2. Based on a Discount Rate of 6%

Figure 2 Highway 69 VE Study Accident Cost Model

Choosing the Customer oriented FAST diagram rather than focusing on the technical elements of a project by using the Technical FAST diagram allows, and often forces, the group to consider more than the capital costs. A sample customer FAST diagram for a transportation project is shown in **Figure 3**. This type of FAST diagram also illustrates the cost and worth analysis completed by the team. It illustrates under supporting functions "remove hazard" "protect hazard" and "reduce severity" that the road user, and ultimate customer, is willing to pay for elements that provide him value. Therefore the VE Team assigned greater worth than had the original design for these functions. By doing so can force the VE Team to consider ideas that improve value, which in this case is safety. One such example is illustrated in the following section.

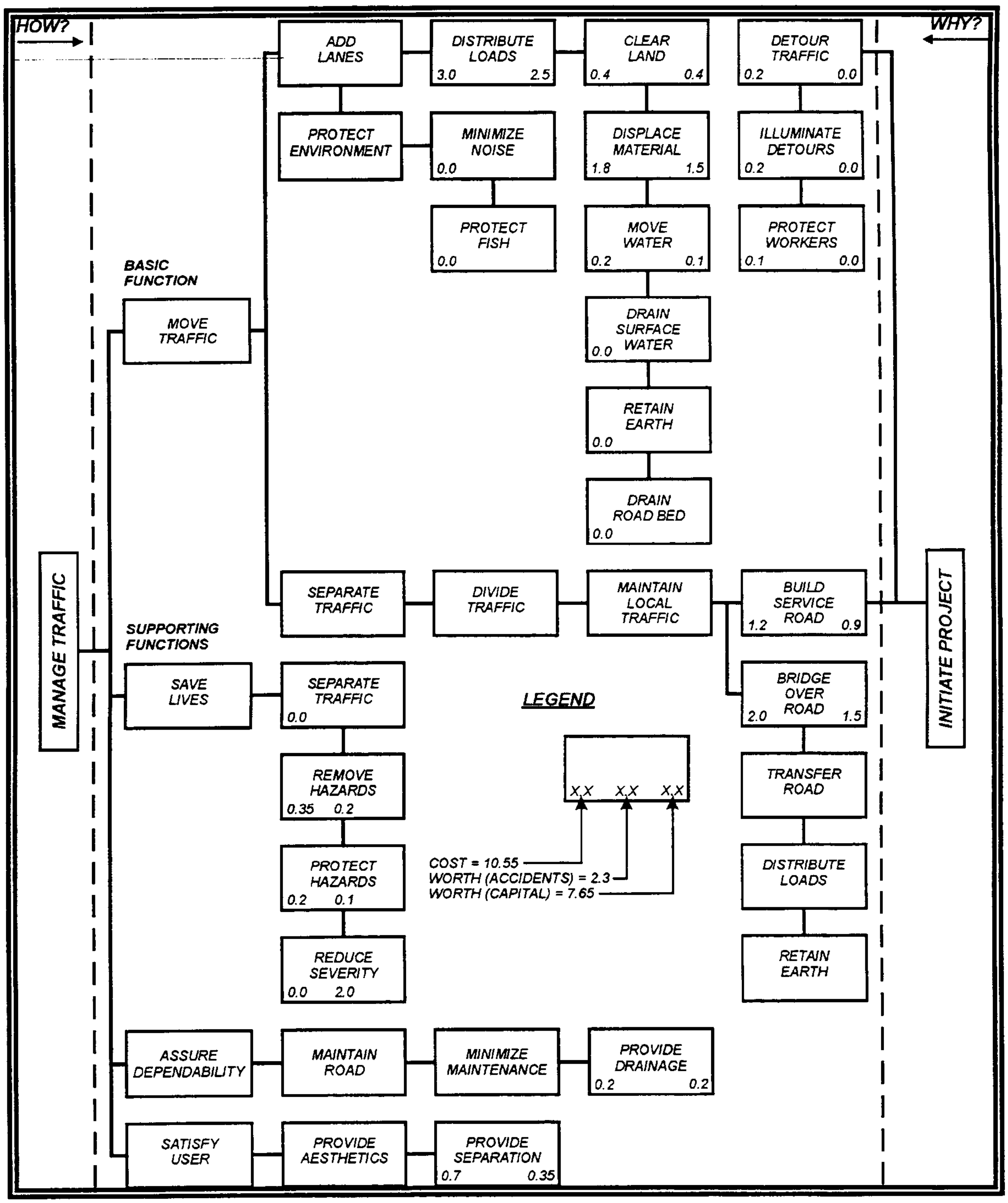


Figure 3 Sample Fast Diagram

CASE STUDY

The case study presented is a section of a new 75 km, 4-lane freeway, the new Veteran's Memorial Highway (Highway 416), being constructed in the Province of Ontario. This study was completed from December 1997 to April 1998 in conjunction with the construction company building one 12 km section of the new freeway. The recommendations of the study were submitted to the road authority as a Value Engineering Change Proposal (VECP). The VECP was accepted and was constructed in 1998 and is now being monitored in 1999.

The project is located in the Province of Ontario, Canada and leads from the Nation's Capital to an international bridge at the border of New York State.

For this contract the tender included a Value Engineering Incentive Clause as a separate special provision that encourages contractors to undertake and submit VECP's. The use of this type of special provision is only a recent initiative of the Province's Ministry of Transportation. This is an excellent process from the owner's perspective in that it allows, at no cost and no risk, the talents and expertise of contractors to be utilized. In the last calender year approximately 50 percent of VECP's were accepted in the Province.

It is interesting to note. This project underwent a VE Study prior to tender, resulting in several modifications to the original design. However, the point of this paper is to demonstrate that using the techniques described in this paper resulted in greater creativity, more VE ideas, and more value improvements that benefit both the road authority, contractor and travelling public.

One major VE Idea was a VECP to change the provincial standard within rock cut zones. A rock cut is an area where the highway is constructed below the original ground and has resulted in both earth and rock excavation. Typically the rock excavation is completed by blasting.

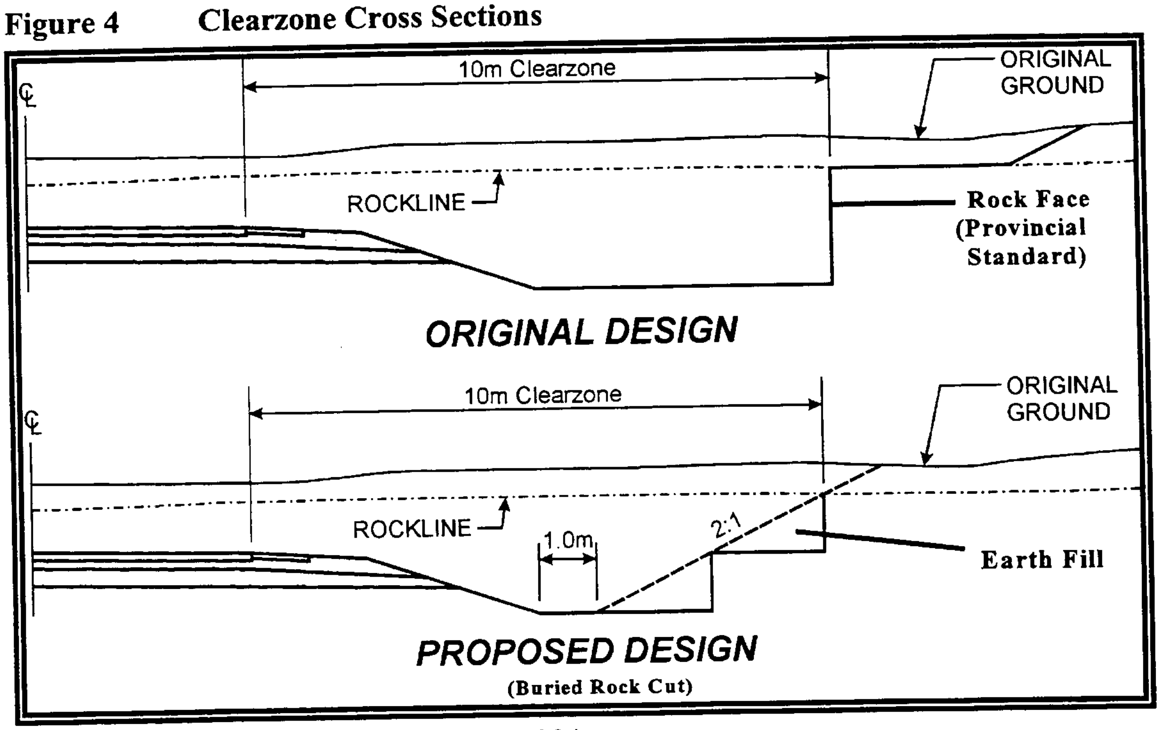
The twinning of the highway passes through an area of shallow rock that would have created a number of rocks cuts along the new highway similar to those that currently exist along the existing 2-lane road. The standard practice of the Ministry of Transportation Ontario (MTO) is to remove all of the rock to a distance of 10 metres from the edge of the travelled lanes. This clear space, free of any hazards, is defined as the clearzone.

Based on statistical data the probability of an errant vehicle travelling beyond the clearzone, if it leaves the travel lane, is 20%. Therefore 20% of vehicles who leave the road are predicted to reach a rock face. The clearzone standard as per current MTO policy is shown in **Figure 4**.

In contrast, the VE Team developed an alternative design to eliminate the vertical face of the rock cuts by using an alternative blasting pattern. The elimination of the vertical rock face was achieved by removing the rock in stepped levels, as shown in **Figure 4**, and filling the steps with surplus earth fill. The result was a 2:1 backslope with a safer severity index for errant vehicles reaching the hazard.

The accident savings were estimated more than $4 million for this 12 km section of freeway over the 30-year planning horizon.

Figure 4 Clearzone Cross Sections



Photos in **Figure 5** demonstrate a typical rock out crops along Highway 416 south of Ottawa where errant vehicles leaving the highway can hit the vertical face of the rock cut. These demonstrate the current provincial standard for constructing rock cuts. If the vehicle leaves the road before the cut, it can also impact the blunt protruding end of the rock cut.

In contrast, photos in **Figure 6**, illustrate the construction of the accepted VECP which includes the operation of filling the 2:1 rock cut over the blasted rock. The completed cross section includes earthfill, topsoil, seed and mulch covering the rock hazard.

This test section was initially accepted for the new southbound lanes within the project as part of the Contractor's VECP. These were constructed in 1999. Following the acceptance the Ministry of Transportation initiated implementing this VE idea on the adjacent northbound lanes on this project as well the adjacent section of freeway. With the success of this VE proposal, the Ministry featured this VE effort as the cover story of the Province's *Road Talk Newsletter,* in the Fall 1998 edition.

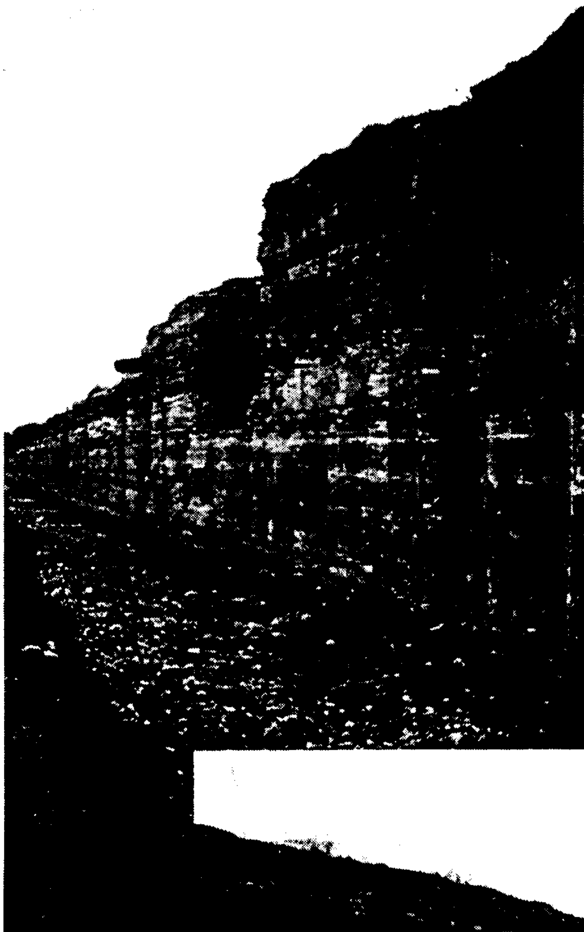


Figure 5 Highway 416 Typical Rock Cuts Existing Provincial Standard