Revisions on the payline for overbreak in Tunnel

T. Park[1], B. Ahn[2], S. Baek[3], and Y. Tae[4*]

Abstract: Drill and blast method has been most widely used in tunnel excavation, after NATM (New Austrian Tunneling Method) was introduced in 1983. The NATM method utilized mass of shotcrete to secure the bearing capacity of tunnels. Overbreak defined how much larger the actual excavation was than the planned. When it became larger, more shotcrete was required to fill in it. Here, payline fixed allowable overbreak, referring to payable amounts of shotcrete. Since owner was not responsible for shotcrete exceeding payline, it was important to properly establish the standards for payline. Although the standards were provided in 'Poom-sam'(standardized quantity per unit), they did not properly reflect the actual conditions for excavation. Thus, this study reviewed existing domestic and foreign standards for overbreak, and estimated overbreak for each type of support using survey data, and finally provided the improvements on the current standards.

Keywords: Overbreak; Tunnel; Payline; Standard.

I. Introduction

Overbreak represented unwanted removal of rock beyond neat line [1] and payline implied a line which determined payable amounts of shotcrete. Since the payline for overbreak directly affected the financial feasibility of tunnel project, it was severely important to establish the payline properly.

After drill and blast method was adopted in tunnel excavation, a payline for overbreak has been a long debating issue between contractor and owner. Although, Poom-sam provided a payline for overbreak, it did not properly reflect actual conditions for excavation. Thus, the objective of the study was to review the exiting standards for the payline and provide a new provision in Poom-sam.

II. Various standards for overbreak

A. Korea

In Korea, there were various standards for allowable overbreak depending on the types of owners and projects. Table I showed the list of owner and corresponding standards.

TABLE I
Various Standards for Overbreak [2]

Agencies		Allowable overbreak (cm)	
		Arch	Side wall
Poom-sam (KICT)		15~20	10~15
Guideline for national highway design		15~20	10~15
Korea Rail Network Authority		15	10
Seoul Metro		20	20
Busan Metro		15	15
Expressway Corporation	Type-1,2	10	10
	Type-3,4	15	10
	Type-5,6	20	15

As seen in Table I, most agencies adopted allowable overbreak based on arch and sidewall classification except Expressway Corporation. Expressway Corporation followed the range of allowable overbreak in Poom-sam but it separated the standards based on the support types. Korea Rail Network Authority utilized minimum allowable overbreak in Poom-sam. Some agencies used their own values for application.

B. Other countries

In USA, there were various design specifications for tunnel but there was no representing standard for overbreak. Instead, owner negotiated the allowable overbreak with contractor based on geological survey. In Swiss, expected overbreak was estimated by contractor when signing the contract [3]. Even Europe did not have a provision for allowable overbreak [4]. Thus, it would be concluded that other countries admitted the variety of overbreak subject to project conditions and contractors should make a price allowance for overbreak in the contract.

III. Revision of standards using statistical analysis

To accomplish the practical revision of the existing standards, our research team visited and interviewed construction manager of 37 tunnel construction sites. After interviews, two issues of payline for allowable overbreak were identified. First, as seen in Table I, standards for allowable overbreak of arch was larger than that of side wall in most agencies. However, side wall often produced bigger overbreak than arch in sites. Second, type 5 and 6 had larger overbreak than type 1 and 2 in standards of Expressway Corporation. In contrast, lower type produced bigger overbreak in some cases. We analyzed survey data for overbreak of 37 tunnel to clear these issues.

A. Comparison of overbreak in arch and side wall

T-test and ANOVA analysis were applied to prove that there was no difference between arch and sidewall in size of overbreak. Two cases were reviewed; first case was

[1] Senior researcher, Korea Institute of construction technology, Goyangsi, Korea, taeilpark@kict.re.kr
[2] Senior researcher, Korea Institute of construction technology, Goyangsi, Korea, brahn@kict.re.kr
[3] Research fellow, Korea Institute of construction technology, Goyangsi, Korea, shbaek@kict.re.kr
[4] Research fellow, Korea Institute of construction technology, Goyangsi, Korea, yhtae@kict.re.kr (*Corresponding Author)

tested based on support type and second case was tested without classifications. The results were presented in Table II.

TABLE II
ANALYSIS RESULTS

Case	Method	Type	N	a-s (avg.)	F-value	P-value
1	ANOVA	1	398	-0.0175	0.1	0.9929
		2	180	0.0078		
		3	456	-0.0009		
		4	117	-0.0158		
		5	64	0.0033		
		6	20	-0.009		
Case	Method	Type	N	a-s avg.±st dev.	T-value	P-value
2	T-test	1~6	1,235	-0.0063	-0.45	0.605

Where, a= overbreak of arch, s= overbreak of side wall

In both cases, P-value was greater than 0.05. Thus, it could conclude that there was no difference in arch and sidewall.

B. Average overbreak based on support type

Overbreak was composed of lining overbreak and shotcrete overbreak. Fig 1 showed cross section of tunnel.

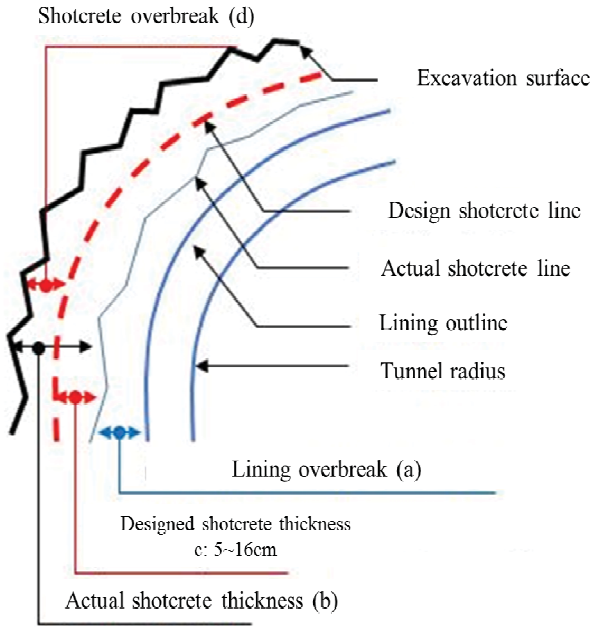

FIG 1. TUNNEL CROSS SECTION

As seen in Fig 1, lining overbreak represented distance between lining outline and actual shotcrete line. On the other hand, shotcrete overbreak meant thickness difference between actual and designed shotcrete. In this regard, this study estimated average overbreak for 1~6 support type using survey data. Table III showed the result of overbreak estimation.

TABLE II
AVERAGE OVERBREAK FOR TYPES OF SUPPORT

Type	Overbreak	Type	Overbreak	Type	Overbreak
1	17.8	2	18.4	3	20.4
4	15.2	5	15.9	6	16.2

Overbreak was the largest in type 3 support. In addition, overbreak of type 1 and 2 were larger than type 4, 5 and 6. These results were obviously contrary to the standards of Expressway Corporation.

IV. CONCLUSION

This study reviewed domestic and foreign standards for overbreak and provided significant findings for the improvements of current standards. First, type 3 support had largest overbreak. Second, there was no need for differentiation of arch and side wall in overbreak. Lastly, overbreak of type 1 and 2 were larger than type 4, 5, and 6. Consequently, this study is expected to assist the governmental agencies in revising current standards for overbreak.

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