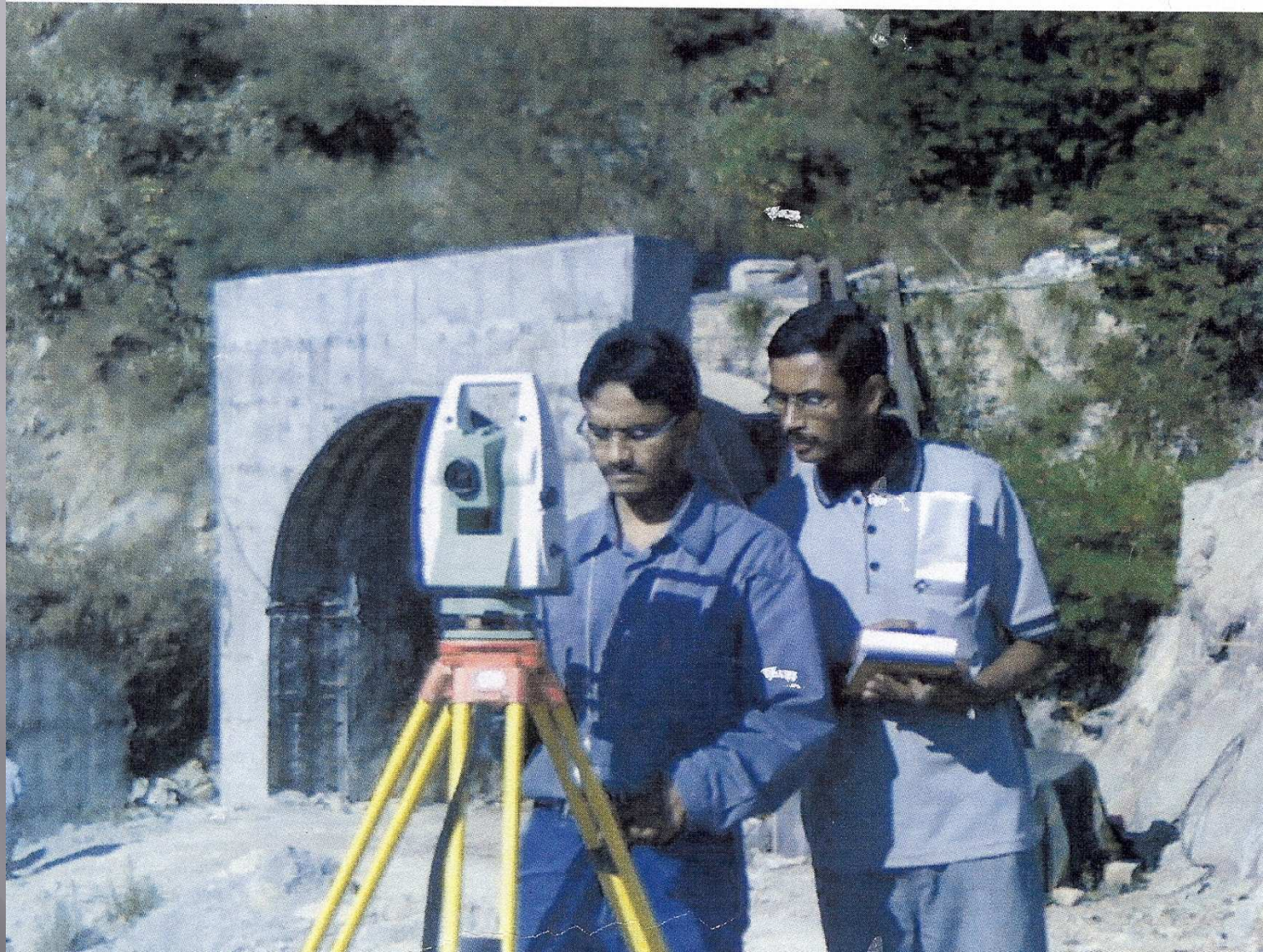


TERRESTRIAL LIDAR SURVEY
FOR TUNNEL NO. T1 OF
NORTHERN RAILWAY
BETWEEN UDHAMPUR AND
KATRA IN THE STATE OF
JAMMU AND KASHMIR

P.K.Choudhary
GGM/Civil, RITES Ltd. & Tunnel Expert GC
to DMRC Phase III

Introduction

- Tunnel No. T1 was got constructed by the Northern Railway from km 2/180 to km 5/320 between Udhampur and Katra in J&K. Steel ribs and concrete lining were used as major support system. The tunnel cross section was of D shape with flat invert. Major length of the tunnel is passing through Shivalik and Murry formations. Due to faulty design, the tunnel collapsed at km 4/800 near the junction of Shivalik formation & recent sediments. The invert heaving and substantial deformations in side walls and crown of the tunnel were observed in the tunnel at many locations. To know the present profile of the tunnel for making a comparison with the designed profile, a 3 D imaging of the un-collapsed portion of the tunnel was undertaken by RITES with terrestrial LIDAR survey. The present paper describes the terrestrial LIDAR survey undertaken for the work and its results.



Introduction to Laser Scanning

- ▣ A laser-scanning instrument works on the principle of LIDAR (Light Detection & Radar). The scanner emits laser rays, which hit the object to be captured and come back to the scanner. The scanner consists of an emitter and receiver. Depending upon the total traveling time the scanner calculates the point distance in X, Y & Z. Laser scanner enables the surveyor to collect the data at lightning fast speed with accurate 3D survey data. Within a very short period of time the scanner collects billions of points (point-cloud), this point cloud data can be used to create 3D models for a wide variety of spatial and volumetric tasks.



Advantages of using HDS ScanStation Laser Scanners

- ▣ Data acquisition is much faster than manual data capturing process. A Riegl Scanner measures upto 3000 pts/ sec where as a total station can captures one point at a time.
- ▣ Faster data acquisition leads to shorter project cycle, which leads to significant amount of cost & time savings. A single surveyor can carry out the entire job.
- ▣ Collection of additional measurements for futures use.
- ▣ Ability to capture data of hazardous area, which are physically inaccessible. In addition to this the scanner can capture data without disrupting the ongoing work.

Why HDS?

- ▣ Produce 3-Dimensional images that are accurate within a few millimeters
- ▣ Record hundreds of thousands (even millions!) of spatial points in minutes
- ▣ Measure precise dimensions of a scanned feature from a modeled image.
- ▣ Scan areas at any time of day or night, under any lighting conditions
- ▣ Superimpose elevation contours (of any interval) over captured data
- ▣ Superimpose reference grids (of any interval) over captured data
- ▣ Tie spatial reference points to an established coordinate system
- ▣ Take scans from one or more locations and elevations
- ▣ Rotate around a 3D image from any vantage point
- ▣ Connect multiple scans to cover an extensive area

How 3D Laser Scanning technology works?

- ▣ Just like an EDM or a Digital Theodolite, Riegl 15 is a portable, tripod-mounted system. However, Riegl uses an infrared laser in conjunction with an integrated digital camera and a Windows-based PC notebook computer in the field. The range finder electronics of the scanner is optimized to meet the requirements of high speed scanning (fast laser repetition rate, fast signal processing, and high speed data interface). The vertical deflection ("line scan") of the laser beam is realized by a polygon with a number of reflective surfaces. For high scanning rates and/or a vertical scan angle θ up to 270° , the polygonal mirror rotates continuously at adjustable speed. For slow scanning rates and/or small scanning angles, it is oscillating linearly up and down. The horizontal scan ("frame scan") is provided by rotating the complete optical head up to 360° . The gained information: RANGE, ANGLE and SIGNAL AMPLITUDE, is provided via TCP/IP Ethernet interface or parallel data output which can be connected directly to the ECP compatible LPT Printer port of a laptop running the Cyclone Scan Software.

How 3D Laser Scanning technology works? Contd.....

- ▣ The HDS ScanStation can scan at a speed of up to 3000 points per second, making it an extremely rapid data collection tool. The scanner does not require leveling prior to scanning an area, which means it can be placed in any location. It also does not have lighting requirements.
- ▣ The raw point cloud data can then be "shrink wrapped" to further enhance the image. Just like laying a blanket over the cloud of reference points, the shrink wrap process fills in the spaces between the points in the cloud, producing smooth, multicolored surfaces. The data from the Riegl scan may be used without enhancement, or it can be exported to Computer-Aided Design (CAD) software for further processing. Depending on the project goals, CAD software can be used to enhance the image to produce a 3D model complete with shadowing, accurate colors, and even landscape backgrounds that would allow an individual to experience a virtual "fly-through" of a resource such as a mine, a cave, or a landscape.
- ▣ A single scan can be integrated (or "registered") with other scans to show a larger area. This feature allows excavators at an archaeological site, for example, to tie together horizontal data layers between adjacent excavation units. It also means that data may be tied together at a later date, allowing flexibility in a project's schedule and resources.

Scope of the Project:

- ▣ The objective of this project was to survey the entire stretch of T1 Tunnel from Udhampur end and to compare the design cross-section with the actual cross sections obtained from 3D laser scan data and also to check the tunnel alignment at different chainage locations.

Location:

Place: Udhampur, Jammu & Kashmir



Instruments/software used:

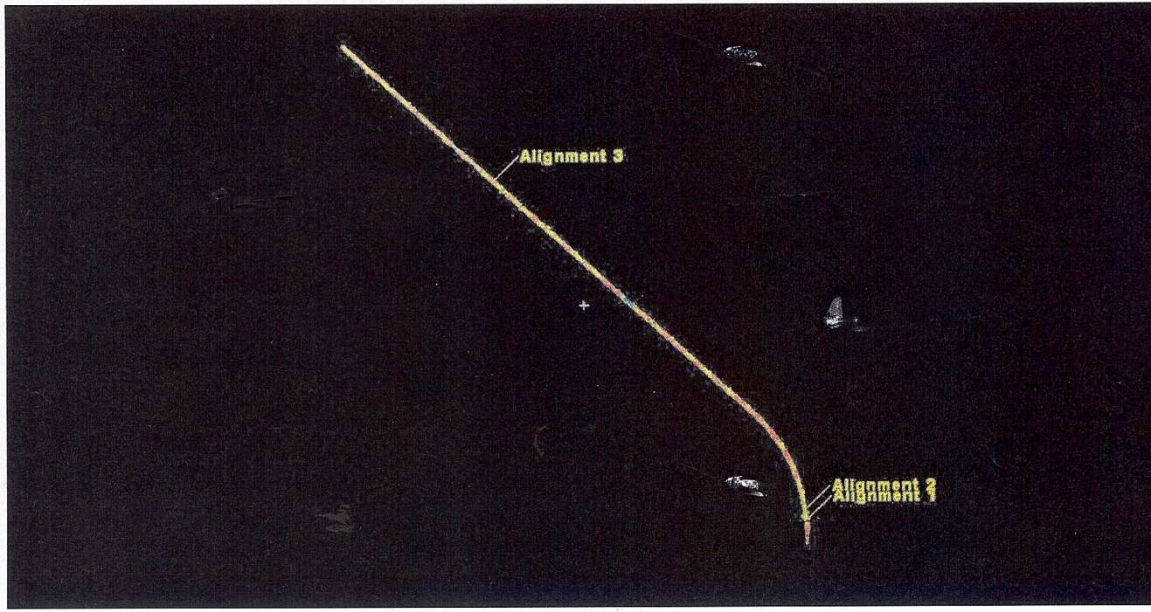
- HDS ScanStation1 3D Laser Scanner with enhanced laptop loaded with Cyclone Scan Software.
- TPS 1200 total station.
- System 120b GPS
- Cyclone Survey Module

Project Details:

- Total No. of scans: 42
- Total scanning time: 62 hours

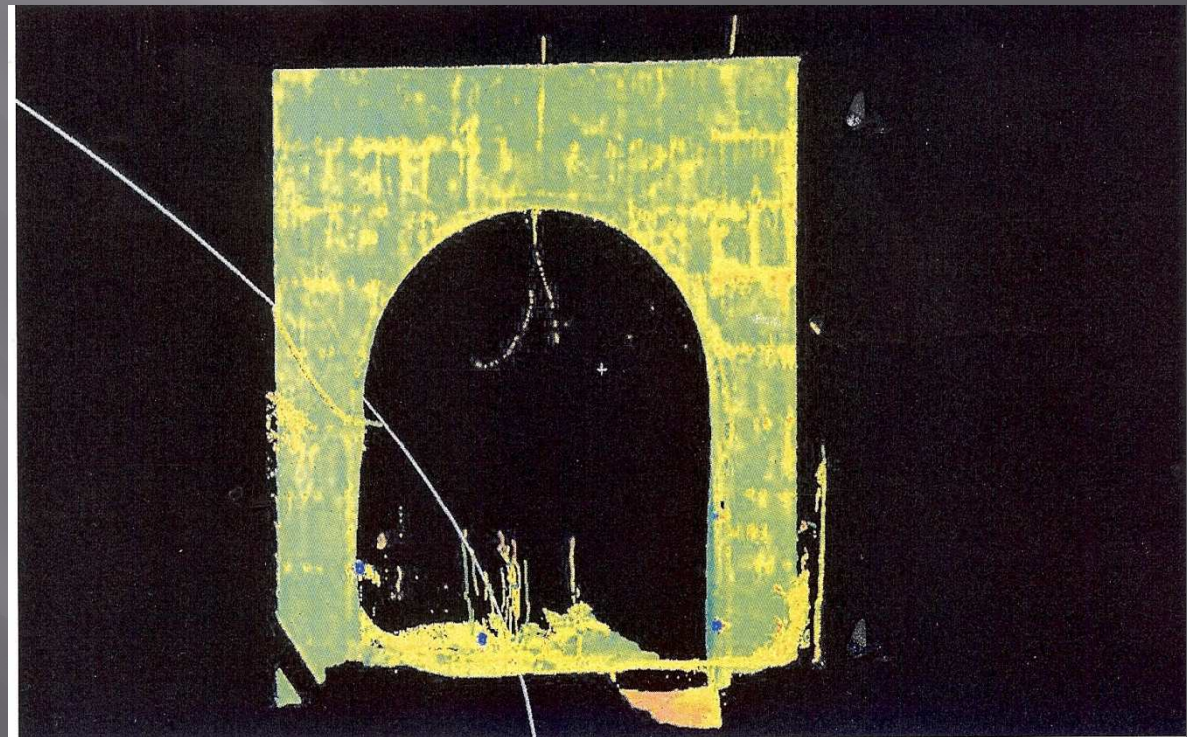
Methodology:

- ❑ Before starting the laser scan survey a total station survey was performed through the tunnel to check the centerline of the tunnel.
- ❑ The entire survey was conducted with two benchmarks (~T~E1BP) provided by Northern Railway. Scans were taken along the center line of the tunnel to get the maximum coverage. Each scan was registered at the field and checked with the tunnel alignment for any deviations. Five HDS reflectors were placed around the scanner at different elevations for registration purposes. These reflectors were in turn surveyed by Leica TPS 1200 total station to get maximum accuracy. On a stretch of 100 metres on an average 2-3 scans were taken to minimize scan shadows. On an average in a day six to seven scans were taken. Once the scanning was over all the scans were registered using Cyclone software. Then the scans were cleaned for profile check purposes.



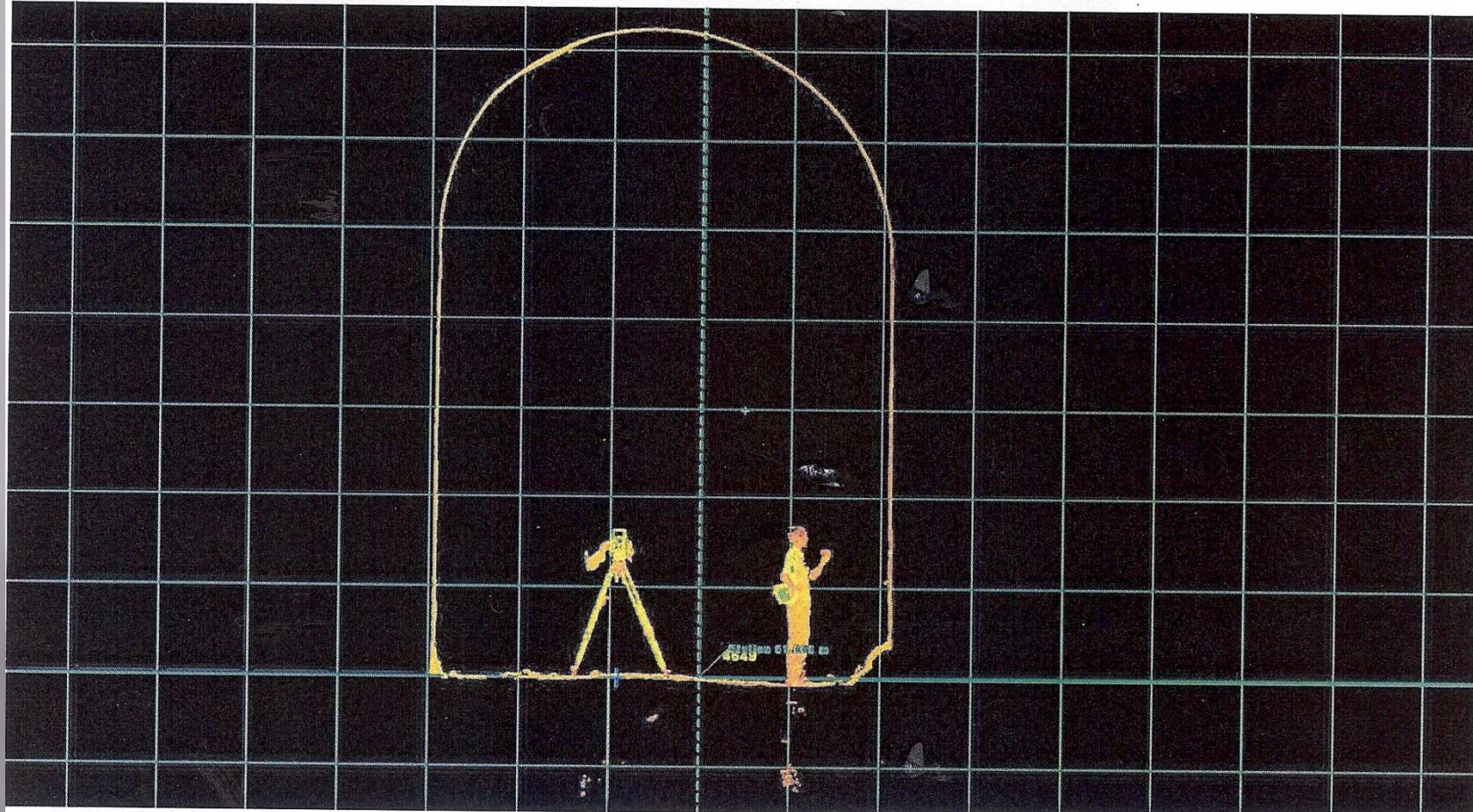
T1 Tunnel 3D Laser
Scan Data

Udhampur End with
Centre line as
Alignment

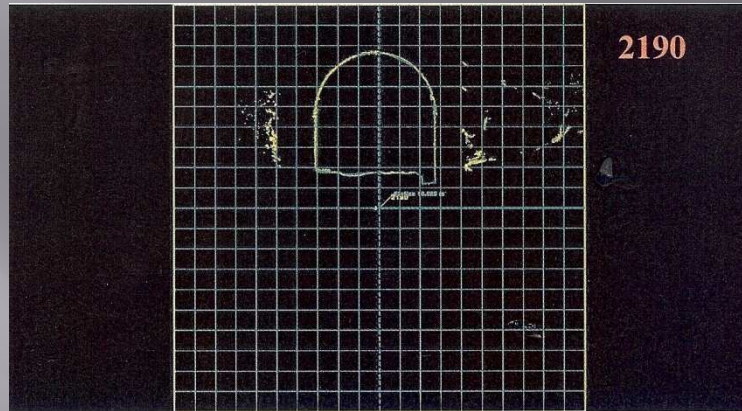


Details of Curve

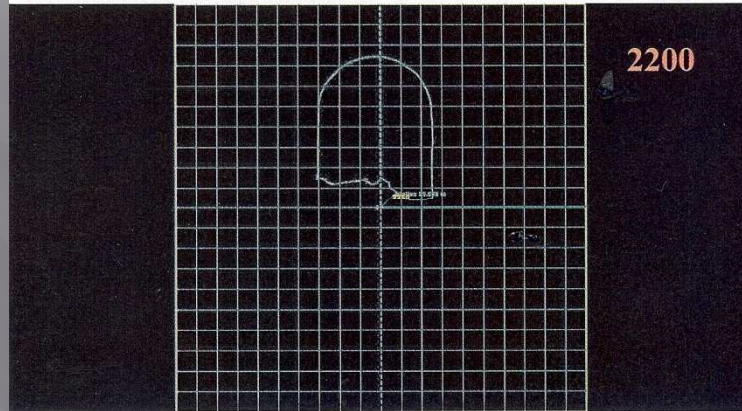
Degree of Curve	2.75	UDM portal	2180.061
Radius	636.565	KAT Portal	5289.342
Direction	Left 47° 43'		
Deflection Angle	15''		
Transition Length	100		
TTP1	2080.873		
CTP1	2180.873		
TTP2	2611.059		
CTP1	2711.059		



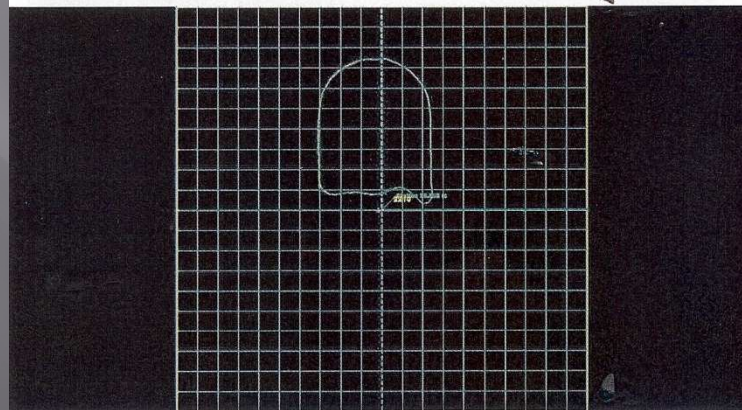
Sample High Resolution Scan



2190



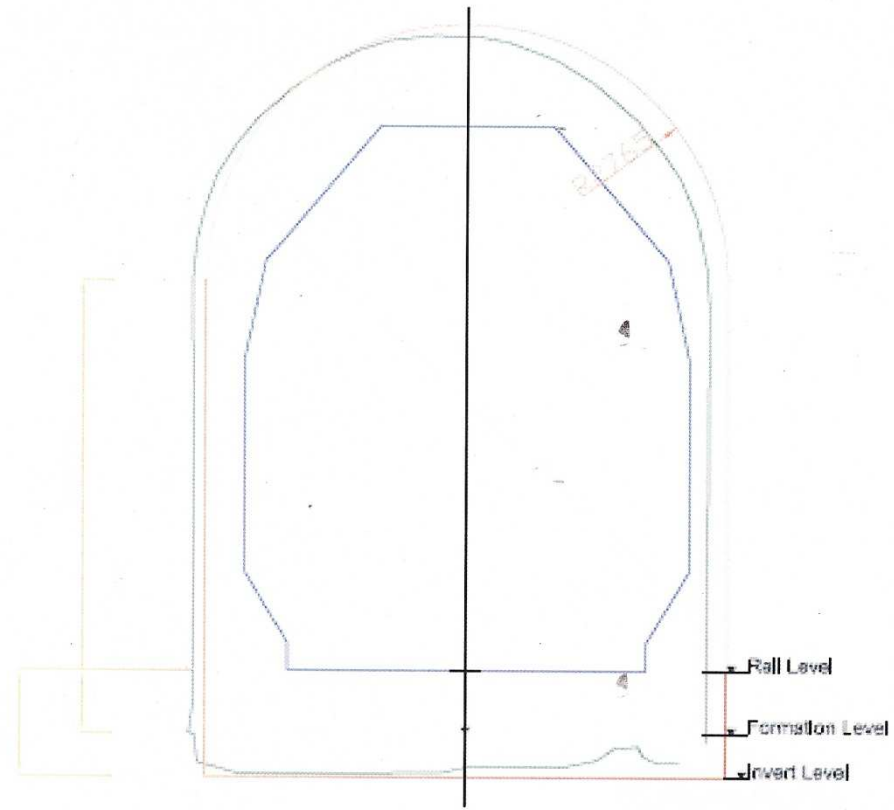
2200



2210

Sectional Analysis for
Chainage 2190, 2200,
2210

Comparison of Design vs Actual Profile



Design Profile _____
 Scanned Profile _____
 No Interference Box _____

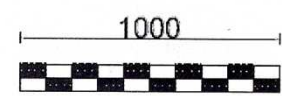
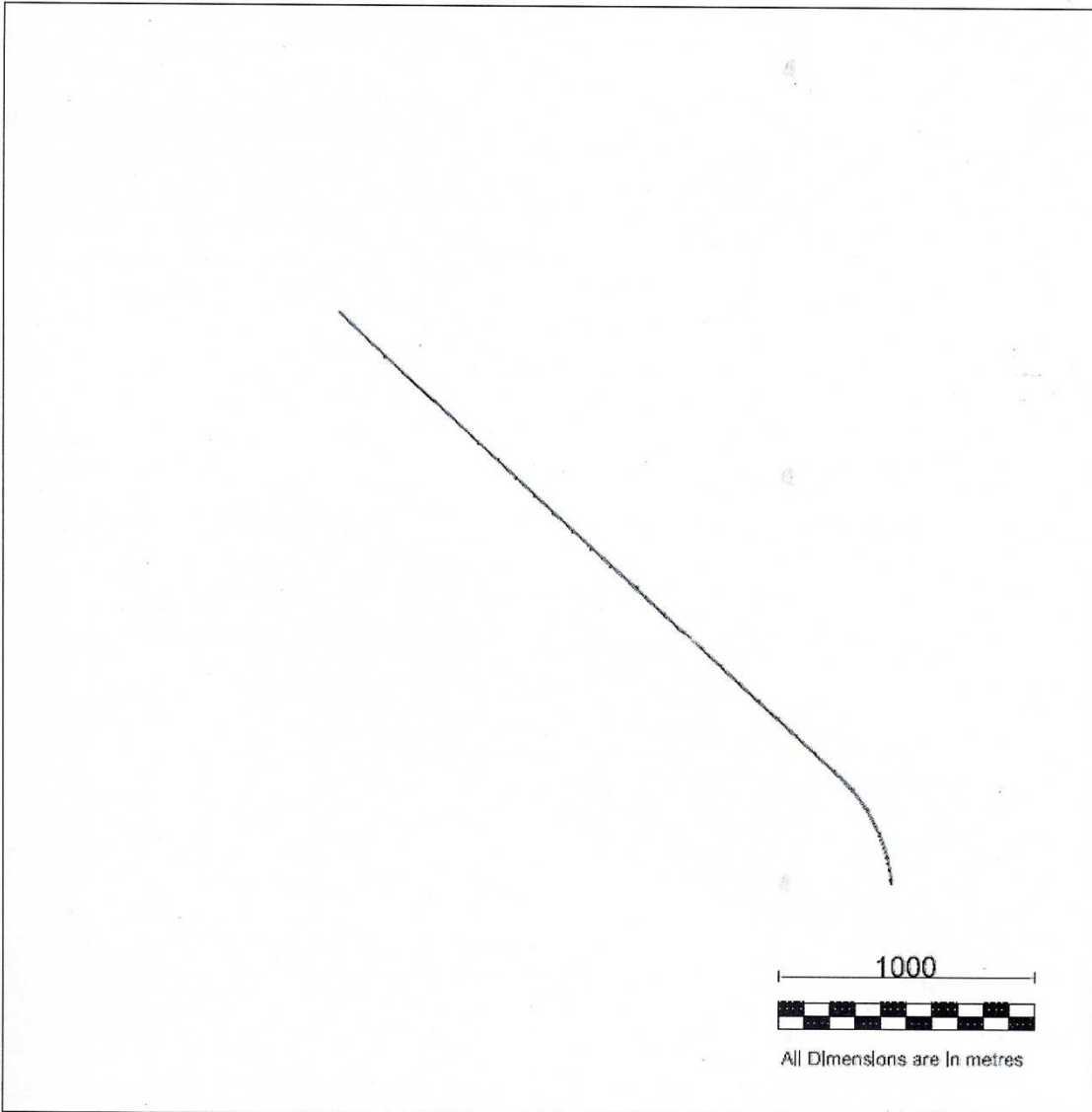
All Dimensions are in mm





Date	
Scale	1:100
Drawn by	AYDIN
Checked	AYDIN
Approved	
18/10/2023	18/10/2023

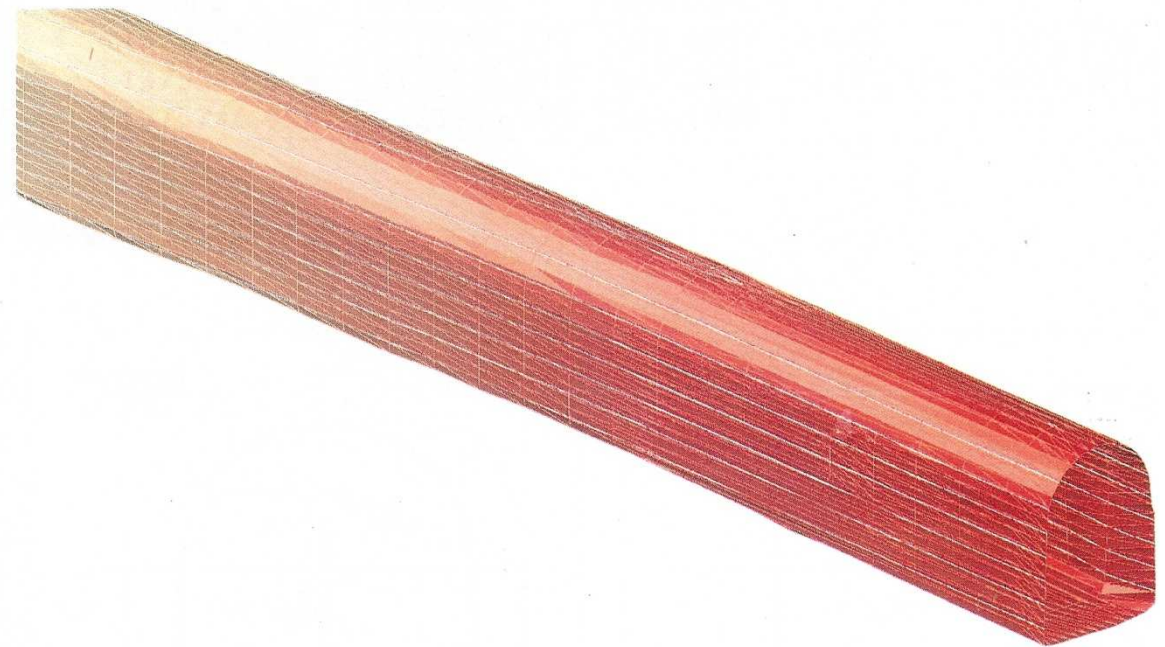
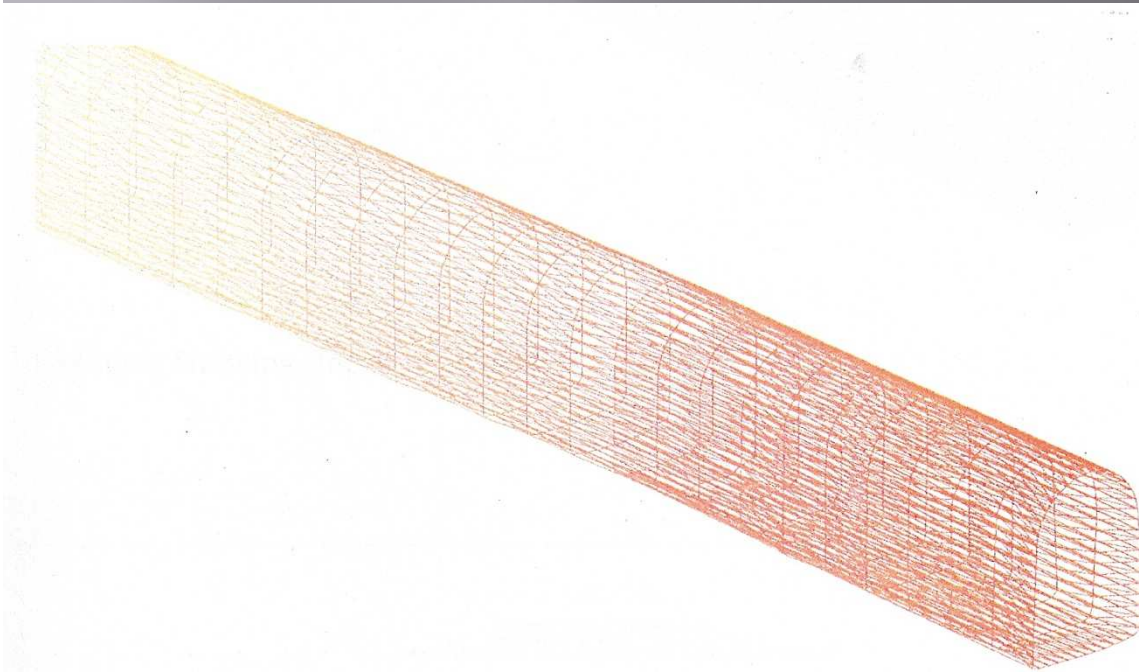
DETAILED DESIGN CONSULTANCY AND CONSTRUCTION SUPERVISION
 Tunnel No: 1
 No: 1/2023

NORTHERN RAILWAYS
 (KARADENİZ LİNYE)
 Karadeniz Bölgesi Karayolu ve Demiryolu
 Tüneli No: 1
 18/10/2023



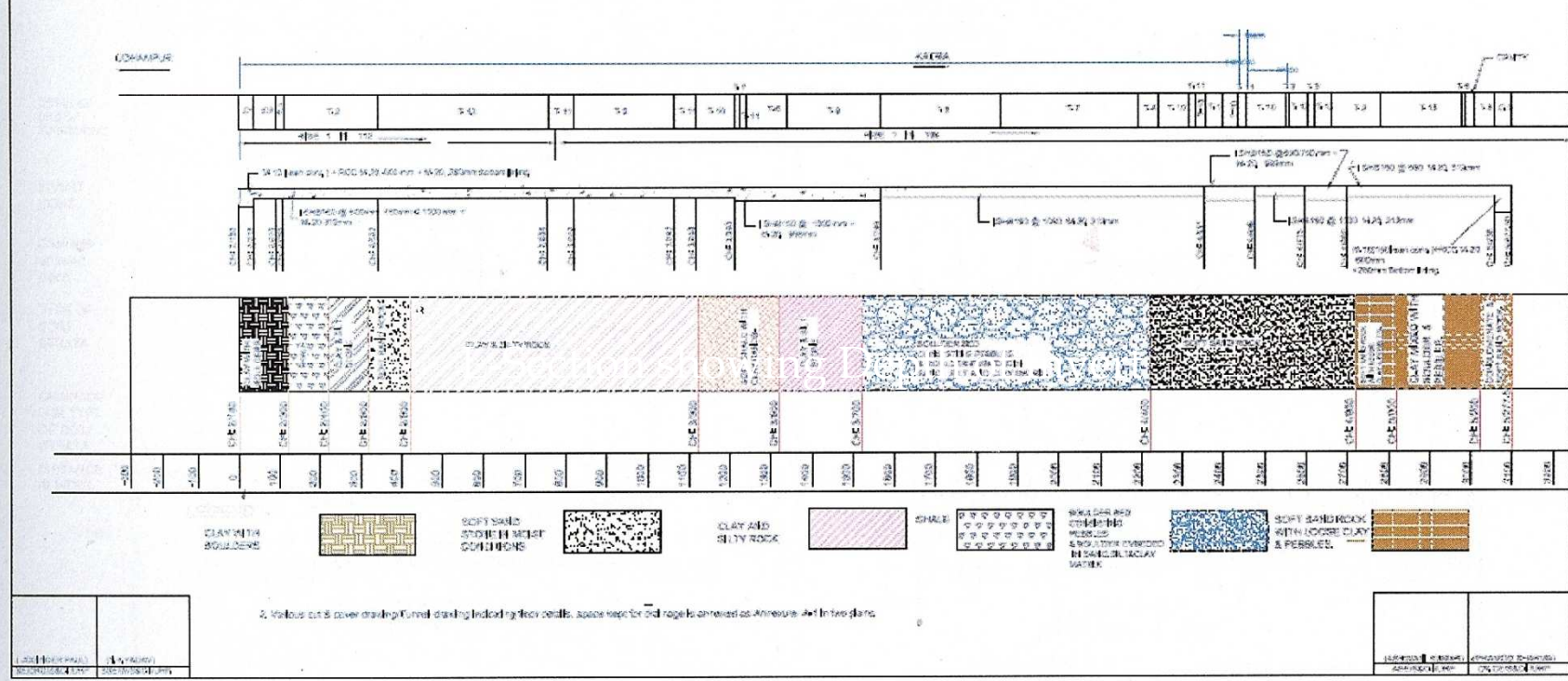
All Dimensions are in metres

 	Date:		DETAILED DESIGN CONSULTANCY AND CONSTRUCTION SUPERVISION	NORTHERN RAILWAYS UDHAMPUR (J&K) Udhampur - Katra Rail Link Tunnel No 1					
	Scale:								
	Drawn By:	SBP/CS		Tunnel No 1	dim	Sides	Type	Number	Sheet
	Checked:	SBP/CS		Result of Profile Checks	NRUJKI E QSPIC - - A 010				
Approved:		Plan View of T1 Tunnel							
GEOCONSULT 4299									

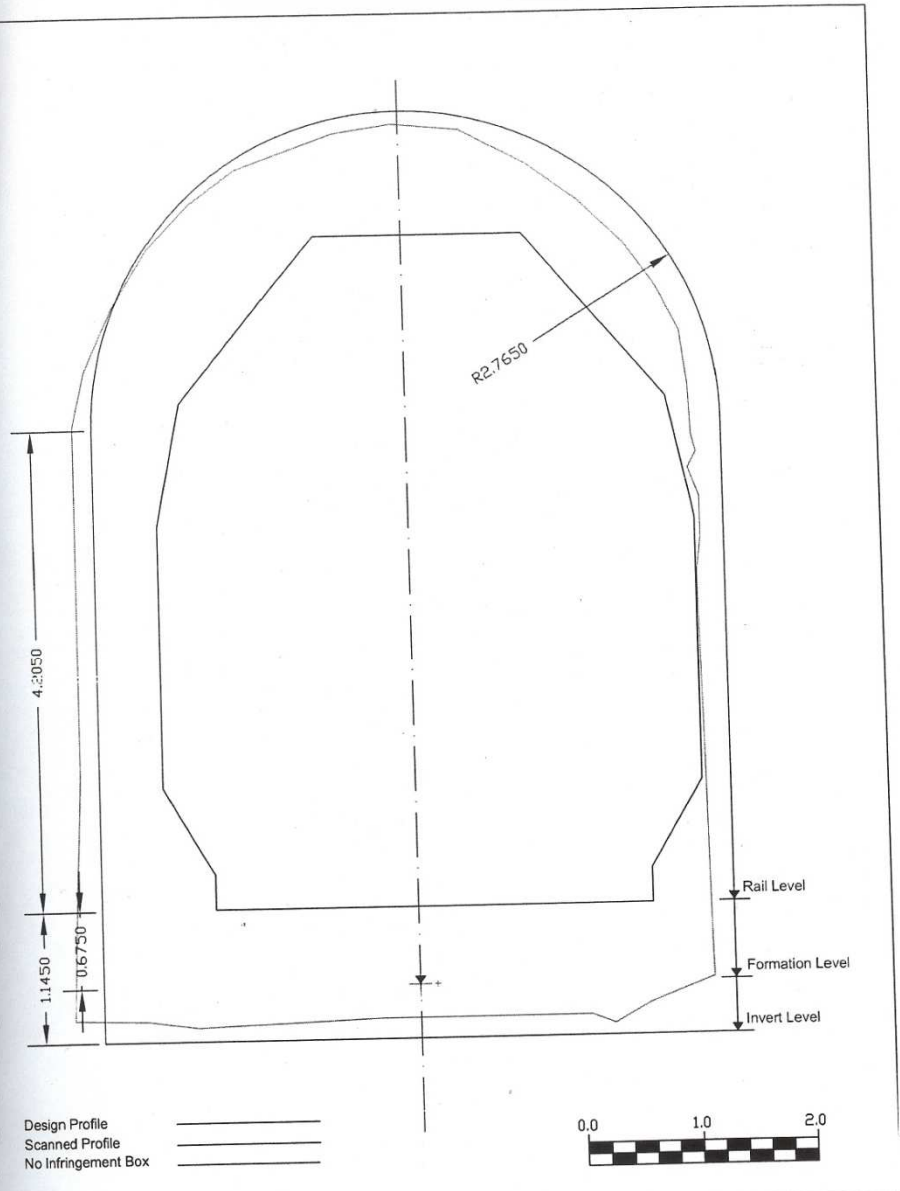


Contours with Mesh View

EASTERN BRANCH
DIRHAMPUR - KATRA SECTION
L-SECTION SHOWING DEPTH OF INVERT
CONCRETE IN DIFFERENT TYPES OF STRATA &
COMPLETION DRAWING OF TUNNEL C&C IN VARIOUS STRATA OF TUNNEL NO. 1



L-Section showing Depth of Invert

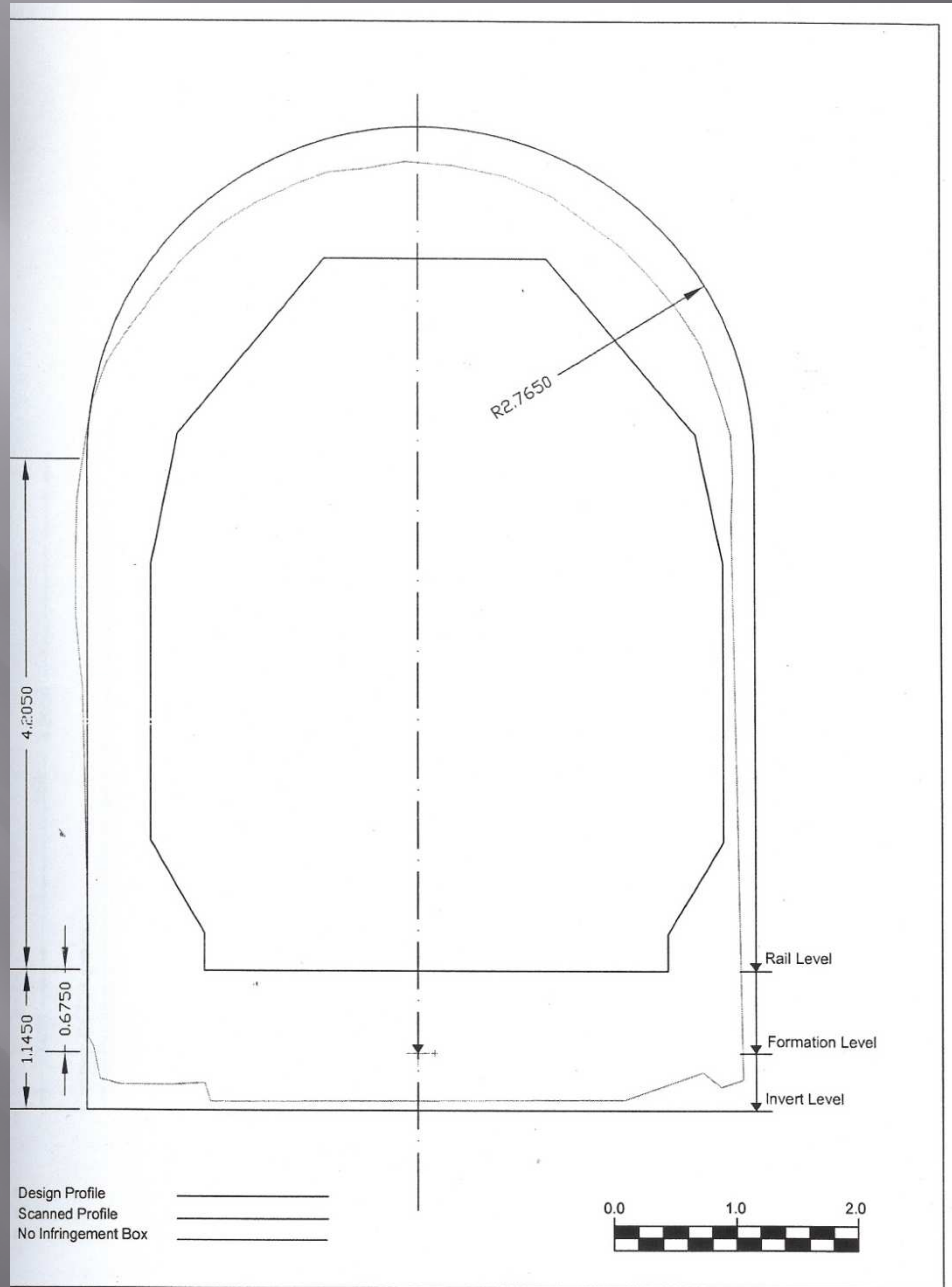


Design Profile _____
 Scanned Profile _____
 No Infringement Box _____



Date:		DETAILED DESIGN CONSULTANCY AND CONSTRUCTION SUPERVISION Tunnel No 1 Result of Profile Checks Chainage 2280
Scale:		
Drawn By:	S/S/PEGS	
Checked:	G/S/PEGS	
Approved:		
GEOCONSULT 4299		

NORTHERN RAILWAYS			
UDHAMPUR (J&K)			
Udhampur - Katra Rail Link			
Tunnel No 1			
Class	Stage	Type	Number
NRIJJKI	EI	S/PC	1-A/0.0

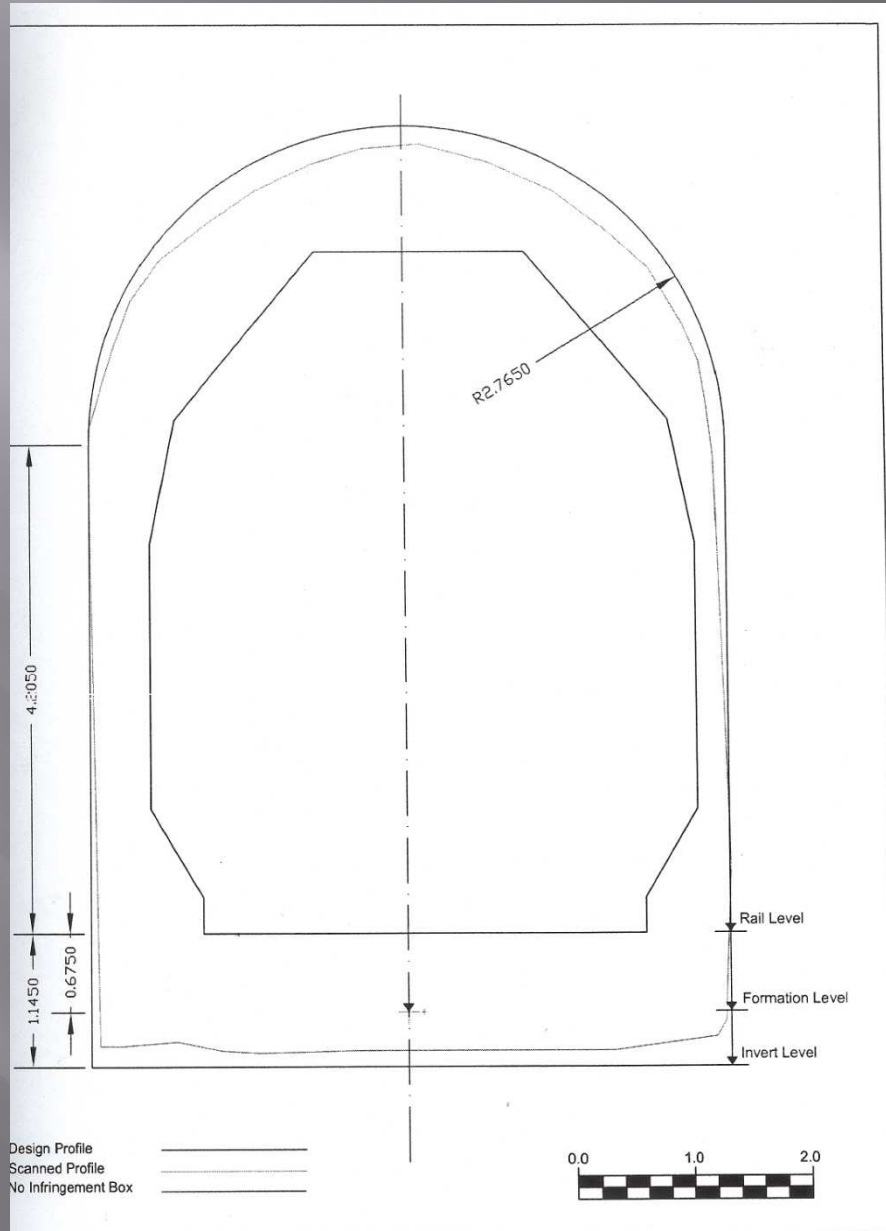


Date:	
Scale:	
Drawn By:	SISPEGS
Checked:	

DETAILED DESIGN CONSULTANCY
AND
CONSTRUCTION SUPERVISION

NORTHERN RAILWAYS
UDHAMPUR (J&K)
Udhampur - Katra Rail Link





Design Profile _____
 Scanned Profile _____
 No Infringement Box _____



Date:	
Scale:	
Drawn By:	S/S/PEGS
Checked:	G/S/PEGS
Approved:	
GEOCONSULT 4299	Chainage 2380

DETAILED DESIGN CONSULTANCY
 AND
 CONSTRUCTION SUPERVISION

NORTHERN RAILWAYS
 UDHAMPUR (J&K)
 Udhampur - Katra Rail Link
 Tunnel No 1

Class	Subject	Type	Number	Revision
NRUJKI	TEOSPC	-	A00	

Benefits of Laser Scanning:

- ❑ Significant savings in time-Fast data capturing reduces the no of days of field survey. Entire mine could be covered in a day or two. Mine plans can be updated daily/weekly basis.
- ❑ Significant amount of Savings in terms of cost- Accurate volume calculation of the excavated coal & overburden will result in significant savings.
- ❑ Significant amount of savings in Labor -Couple of personnel can be used to survey the entire mine.
- ❑ Accurate (min setups to cover max area)
- ❑ Safety- Safe data capturing from a distant location ensures highest level of safety for the surveyor. Does not interfere with the ongoing work at the site.

THANK YOU !