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ROAD 582 SELET-BODEN

Demonstration of three different rehabilitation structures on a Swedish Low Volume Road

ABSTRACT

Rutting of the road surface due to the development of permanent deformations, both in the road structure itself and in the underlying subgrade, is in most cases the dominant distress mechanism on low volume roads of the Northern Periphery area.

From a road users' point of view rutting both lowers driving comfort and reduces traffic safety. This is particularly the case when surface water is trapped in ruts, thereby increasing the risk of aquaplaning in summertime and of icing in the wheel path in winter when temperatures fall below 0°C. In addition, rutting can also be very harmful to the structural condition of the road, as it speeds up water infiltration into the road structure, increases the effects of dynamic wheel loads etc.

Rutting can develop in a road for a number of reasons. It may develop in the structural layers due to poor quality material, or as a result of poor drainage making the material more susceptible to permanent deformations. It may also develop in a weak subgrade material if the overall thickness of the structural layers is low. This is a very typical situation on the low volume roads of the Northern Periphery area, particularly during the spring thaw if the subgrade material is frost-susceptible. Rutting mechanisms are discussed in greater detail in the ROADDEX reports available at www.roadex.org, together with a new method of classifying rutting modes.

This report describes three ROADDEX demonstration exercises carried out on Road 582 from Selet to Boden, a low volume road north-west of Luleå in Northern Sweden. The total length of rehabilitation of the road suffering from various types of distresses was about 17 km. Out of that length three demonstration sections, each of approximately 80 metres long, were selected for closer follow up.

The first demonstration section was suffering from severe pavement damages, most likely resulting from the degradation of the base/sub-base course layer consisting of air-cooled blast furnace slag combined with the effect of poor drainage. The second section was damaged by rutting and other types of distresses so badly that the asphalt concrete wearing course had already been removed by the start of the rehabilitation works. Meantime, on the third demonstration section the dominant type of pavement damage was longitudinal cracking of the road surface resulting from uneven frost heave across the road caused mainly by the combined effect of frost-susceptible subgrade material and poor drainage.

The respective rehabilitation structures were as follows: on demonstration Section 1, an addition of new base and sub-base layers with a total thickness of 300 mm, and on demonstration Section 2 a partial addition and partial mass replacement of base and sub-base course with a total thickness of 500 mm. On demonstration Section 3 the structure was similar to Section 1 except that a steel net reinforcement was also installed in between the new base and sub-base course layers. In addition to these measures, the drainage was improved on all of the demonstration sections by excavating the side ditches to at least a depth of 1.3 m below the road surface.

This report describes the execution of the construction works on Road 582 during the autumn 2011 until winter conditions halted the site works in December. The works are currently planned to be resumed in summer 2012 after which the road will be exposed to the normal condition monitoring operations of the Swedish road network.

KEYWORDS

Rutting, cracking, pavement distress, drainage problem, rehabilitation, reinforcement, steel net, low volume road, Northern Periphery

PREFACE

Tampere University of Technology (TUT), in close co-operation with the other ROADEX partners, has been responsible for the design, follow up and documentation of a number of demonstration sites carried out under the ROADEX IV project task D4 'Rutting, from theory to practice'. These demonstration sites showcase innovative ROADEX solutions to various types of rutting problems on low volume roads of the Partner areas. This report presents the selection and execution of three different rehabilitation structures on Road 582 from Selet to Boden in Northern Sweden near the town of Luleå. On all three demonstration sites new base and sub-base layers were constructed, in addition to which one of the demonstration sections was additionally reinforced with a steel net.

This report has been made jointly with the Luleå University of Technology (LTU) in Sweden and TUT. The main author of the report from the Swedish side has been Linn Sunberg, M.Sc student from LTU, under the supervision of Professor Sven Knutson. Some parts of the report, not possible for Linn Sundberg to complete, have been supplemented jointly by Professor Pauli Kolisoja from TUT and B.Sc Johan Ullberg from the Swedish Transport Administration, Trafikverket.

Special thanks are given to Kenneth Enbom, project manager from the Swedish Transport Administration, and to Peter Lindstöm from Asfalbeläggningar i Boden AB, site manager of the contractor, for their kind co-operation throughout the project.

Ron Munro from Munroconsult Ltd checked the language of the report. Mika Pyhähuhta from Laboratorio Uleåborg designed the report layout.

Finally, last but not least, the authors would like to thank the ROADEX IV Project Steering Committee for their guidance and encouragement during the work.

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1. INTRODUCTION

1.1 THE ROADEX PROJECT

The ROADEX Project is a technical co-operation between road organisations across northern Europe that aims to share road related information and research between the partners. The project was started in 1998 as a 3 year pilot co-operation between the districts of Finland Lapland, Troms County of Norway, the Northern Region of Sweden and The Highland Council of Scotland and was subsequently followed and extended with a second project, ROADEX II, from 2002 to 2005, a third, ROADEX III from 2006 to 2007 and a fourth, ROADEX “Implementing Accessibility” from 2009 to 2012.



Figure 1-1 The Northern Periphery Area and ROADEX Partners

The Partners in the ROADEX “Implementing Accessibility” project comprised public road administrations and forestry organisations from across the European Northern Periphery. These were The Highland Council, Forestry Commission Scotland and the Western Isles Council from Scotland, The Northern Region of The Norwegian Public Roads Administration, The Northern Region of The Swedish Transport Administration and the Swedish Forest Agency, The Centre of Economic Development, Transport and the Environment of Finland, The Government of Greenland, The Icelandic Public Road Administration and The National Roads Authority and The Department of Transport of Ireland.

The aim of the project was to implement the road technologies developed by ROADEX on to the partner road networks to improve operational efficiency and save money. The lead partner for the project was The Swedish Transport Administration and the main project consultant was Roadscanners Oy of Finland. The project was awarded NPP funding in September 2009 and held its first steering Committee meeting in Luleå, November 2009.

A main part of the project was a programme of 23 demonstration projects showcasing the ROADEX methods in the Local Partner areas supported by a new pan-regional “ROADEX Consultancy Service” and “Knowledge Centre”. Three research tasks were also pursued as part of the project: D1 “Climate change and its consequences on the maintenance of low volume roads”, D2 “Road Widening” and D3 “Vibration in vehicles and humans due to road condition”. All of the reports are available on the ROADEX website at www.ROADEX.org.

1.2 THE DEMONSTRATION PROJECTS

Twenty three demonstration projects were planned within the ROADEX IV project. Their goal was to take selected technologies developed by ROADEX out on to the local road networks to have them physically used in practice to show what they could achieve. The projects were funded locally by the local Partners, designed and supervised by local staff, and supported by experts from the ROADEX consultancy.

The demonstrations were managed in 6 groups by a nominated lead manager from ROADEX:

- D1 - "Drainage Maintenance Guidelines", lead manager Timo Saarenketo
- D2 - "Road friendly vehicles and Tyre Pressure Control", lead manager Pauli Kolisoja
- D3 - "Forest Road policies", lead manager Svante Johansson
- D4 - "Rutting, from theory to practice", lead manager Pauli Kolisoja
- D5 - "Roads on Peat", lead manager Ron Munro
- D6 - "Health and Vibration", lead manager Johan Granlund

1.3 D4 "RUTTING, FROM THEORY TO PRACTICE"

The aim of the 'Rutting, from theory to practice' task was to demonstrate the practical applications of innovative ROADEX solutions in the rehabilitation of low volume roads suffering from permanent deformation problems in the Partner areas. The leading idea in the demonstrations was to use 'fit for purpose' solutions selected after a sound analysis and understanding of the reasons behind the problems encountered on the individual sites. As the name of task suggests, the main focus was on those problems that appear in the form of permanent deformations, i.e. rutting, which can be the result of different forms of underlying mechanisms. These mechanisms are dealt with in greater detail in a range of ROADEX reports available at www.roadex.org.

The first stage in the problem analysis of each site was to develop a clear understanding of the deterioration mechanisms at work using simple, low cost means of investigations, such as visual observation. This was then supplemented, when required, by Ground Penetrating Radar (GPR) measurements, easy to use site investigation methods, e.g. the Dynamic Cone Penetrometer (DCP) test, and some basic laboratory tests like grain size distribution analysis and Tube Suction (TS) tests. More sophisticated laboratory investigations were not used as these are seldom available to the ROADEX Partners due to the limitations of both budget and time.

All of the demonstrations were carried out as part of scheduled road rehabilitation projects by the local ROADEX Partners, and in practice this meant that some operational adjustments were necessary to suit their needs, i.e. none of the demonstrations were carried out just for the ROADEX project alone. This fact naturally set some limitations for the design of the demonstrations, particularly with regard to the available time for preliminary investigations, but this was accepted to be a normal fact of life in practice for most Partner roads operations, and in fact added realism to the work.

2. DESCRIPTION OF ROAD

2.1. LOCATION

Road 582 is located in the north of Sweden, about 30 km west of Luleå and travels from Boden to Selet, a distance of 17 km. Three demonstration sections, selected for closer follow-up are marked with red circles in figure 2.1.

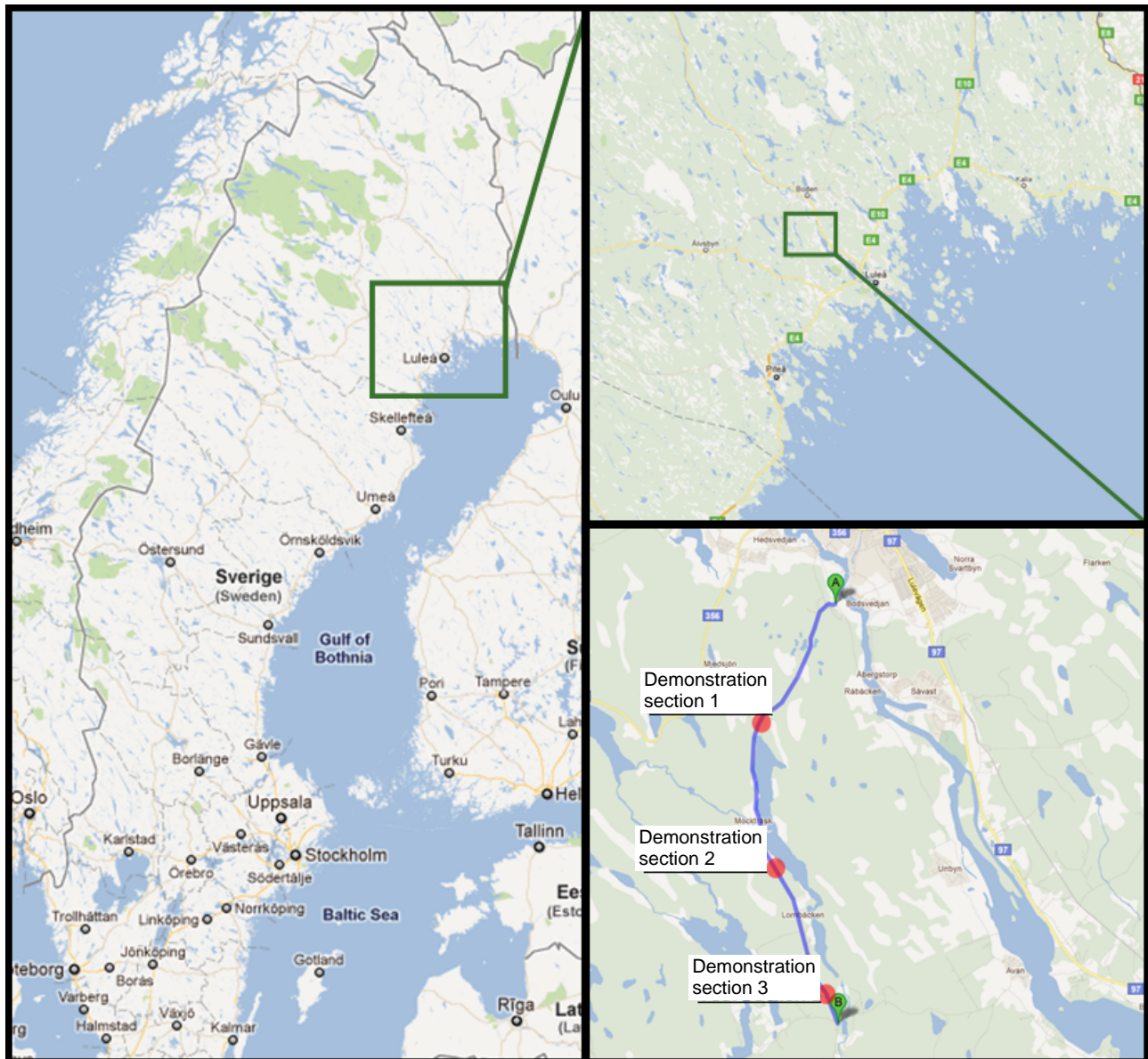


Figure 2.1 Location of Road 582 Selet – Boden (Google Maps).

2.2. TRAFFIC

Road 582 connects the small town of Boden with the small village Selet. The road is important for commuters within the communities of Luleå, Boden and Älvsbyn. It is also used by local inhabitants and logging trucks. The Annual Average Daily Traffic (AADT) on the road is 380 vehicles per day of which about 5 percent exceeds a weight of 3.5 ton.

The northern part of the road is surrounded by fields and forests used for military exercise. Therefore, some crossings are commonly used by military vehicles.

2.3. ROAD STRUCTURE

The existing road is 17 km long and between 5.5 and 6.5 metres wide. Road 582 consists of two general types of road structures. From km 14/050 (Selet) to km 27/350 the road base consists of 0.15-0.25 m air-cooled blast furnace slag (ACBFS) covered with 100 mm base course and 10 to 50 mm of asphalt pavement. This road structure was, according to local inhabitants, built in the mid 80s. In some places, the old wearing course remains beneath the ACBFS layer.

The remaining part of the road structure consists of an older road base with base course. In some areas there is also a layer of 0.2-0.4 m sub-base material. Paving thickness varies from 35 to 85 mm.

2.4. LOCAL LANDSCAPE AND TERRAIN

Road 582 mostly passes through nearly flat forests and runs parallel to the lake Mockträsket, see Figure 2.2. Along the way, the road crosses some shallow marshes, where the road structure practically “floats” on the mire.

Through the small village of Mockträsk and towards the north end of the lake, the road passes through agricultural land and near small groups of houses, see Figure 2.3.

North of Mockträsk the landscape shifts into sandy moorland. Here the terrain is more hilly and covered with pine trees, see Figure 2.4. Traces of ancient settlements have been found in this area and must be protected during the construction work.

The soil along road 582 consists of silty sediments, silty moraine and sandy glacial river sediments.



Figure 2.2 Forest in the south area of Road 582.



Figure 2.3 Fields near Mockträsk



Figure 2.4 Sandy moorland, highly affected by military activities, in the north area of Road 582.

2.5. ROAD PROBLEMS

Moraine and fine-grained silty sediments cause frost heaving because of their frost-susceptible nature indicated by high capillarity (Figure 2.5). They allow ice-lenses inside the road structure to grow by adding water from the ground. This reduces the spring time bearing capacity and leads to frost heave damages where the road is poorly drained. Wide, longitudinal cracks are common in these conditions. They occur when the top of the road is bent by the swelling ice underneath.



Figure 2.5 Frost-susceptible, erosion sensitive silty subgrade material of the area.

Generally, the standard of the road is very low with lots of cracks and deep holes. The maximum traffic speed is currently set to 90 km/h, except near the villages where it is lowered to 50 km/h or 70 km/h. The damaged road however is not suitable for speeds higher than 70 km/h.

In some places the old asphalt pavement has been left beneath the new ACBFS structure, which causes damage when heavy loads crush the porous ACBFS between the two stiff layers and results in a bumpy road surface.

The road is very poorly drained, since most existing culverts are broken or clogged with mud. Most ditches are overgrown and not deep enough.

In the northern part, where the road consists of glacial river sediments, the condition is good and there is less need for rehabilitation actions.



Figure 2.6 Longitudinal cracks in the pavement at demonstration Section 3, km 25/020 to km25/100.

3. DATA COLLECTION / AVAILABLE DATA

3.1. FIELD INVESTIGATIONS

The main site investigation on Road 582 was carried out in 2008. It included the following actions:

- Visual observation of the road condition
- Investigation of the frost problems in spring 2009 (twice)
- Falling Weight Deflectometer (FWD) measurements with a spacing of 40 measurement points per km
- Two lines of Ground Penetrating Radar (GRP) measurements along the whole road length
- Sampling of the structural layers and subgrade at 17 locations
- Sounding of the structural layers and subgrade at a number of points along the road length

Based on the site investigation results, different rehabilitation actions were selected by Tyréns AB who made the rehabilitation design of the road. Before the construction work started, Kenneth Enbom and Johan Ullberg from the Swedish Transport Administration visited the site in early spring 2011 to make an inventory of the road damage once again. This led to some changes in the rehabilitation plan, since many sections had become worse during the three years since the original site investigation.

3.2. LABORATORY INVESTIGATIONS

3.2.1. Base course material

Grain size distribution curves of the base course material indicate that in most of the sampling points proportion of the fine grained fractions of the material is very near to the maximum allowable limit of the Swedish regulations indicated by the upper dotted line in Figure 3.1, or even exceeding it. Grain size distribution of the base course material in the sampling points located at or near to the demonstration sections are summarized in Appendix 1.

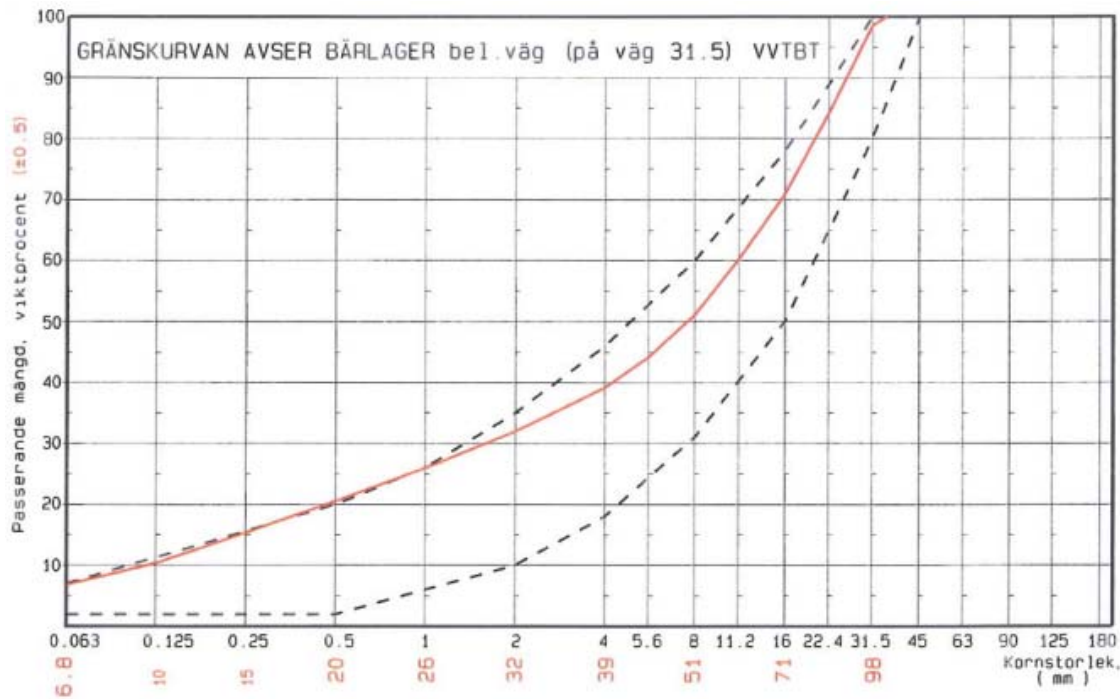


Figure 3.1 Grain size distribution curve of the base course material at km 15/750 (Tyréns 2009).

An important finding from the base course sampling data was that on the area of demonstration Section 1 air-cooled blast furnace slag had been found also in the layer immediately below the thin asphalt surface layer while in most of the other areas there is at least about 100 mm of aggregate base course layer on top of the ACBFS.

3.2.2. Sub-base course material

Grain size distribution curves of the sub-base course material in the sampling points located at or near to the demonstration sections summarized in Appendix 2 indicate that the material is in most cases well within the acceptable limits even though the proportion of the most coarse grained fractions is fairly low, i.e. the grain size distribution curves tend to bend towards the upper limit of the acceptable range of grain sizes at their rightmost end.

3.2.3. Subgrade material

According to the laboratory investigations performed, the earthworks fill and subgrade material of the area consists mainly of moraine in which the proportion of fines, i.e. particles smaller than 0.063 mm, varies from 15 to 30 %. Grain size distribution curves of the subgrade material in the sampling points located at or near to the demonstration sections are again summarized in Appendix 3.

A special feature of demonstration section 2 is that the structural layers of the road are underlain by a layer of peat with a thickness of about one metre. According to the laboratory investigations, however, the water content of the peat layer is less than 200 %, which suggests that the peat has been compacted reasonably well over time by the weight of the road structure.

4. PROBLEM ANALYSIS

4.1. DEMONSTRATION SECTION 1 KM 15/750 TO KM 15/830

The first demonstration section selected for closer follow up was km 15/750 to km 15/830. On the section there were a number of deep holes and other types of pavement damages (figure 4.1).

The main reason for the problems on this demonstration section was assumed to be the degradation of the air-cooled blast furnace slag (ACBFS). This was covered with only a thin base course layer of about 100 mm, or less, and 10 to 50 mm of asphalt pavement. The damages had been accelerated by poor drainage of the section.



Figure 4.1 Demonstration section 1 at km 15/750 to 15/830 in September 2011. Logging work has started along the roadside. The photograph is taken northward from point 15/750.

4.2. DEMONSTRATION SECTION 2 KM 20/100 TO KM 20/180

The second demonstration section selected for closer follow up was km 20/100 to km 20/180. The main problem on this demonstration section had been overall low bearing capacity of the road that had resulted in such severe rutting and other types of pavement damages that the AC wearing course had already been removed by the time of the start of the construction works (figure 4.2).

The obvious reasons for the distresses on this section were poor drainage combined with inadequate material quality. In addition, the problems of low bearing capacity had evidently been enhanced by the layer of peat at the depth of 1 to 2 metres below the road surface.



Figure 4.2 Demonstration section 2 from km 20/100 to km 20/180 in September 2011, south of point 20/180. The wearing course was in very bad condition and has already been removed.

4.3. DEMONSTRATION SECTION 3 KM 25/020 TO KM 25/100

The third demonstration section selected for closer follow up was km 25/020 to km 25/100. This section was mainly suffering from longitudinal cracking of the road surface (figure 4.3). An obvious reason for this type of pavement damage is known to be uneven frost heave along the road cross section if the materials of road structure and/or the underlying subgrade are frost-susceptible, and at the same time drainage system of the road is not functioning properly. These factors had clearly been the main reasons for cracking of the asphalt concrete wearing course on this section as well.



Figure 4.3 Demonstration section 3 from km 25/020 to km 25/100 in September 2011, northward from 25/020.

5. REHABILITATION SOLUTIONS

5.1. PROPOSED REHABILITATION STRUCTURES

As described in Chapter 4 above, three demonstration sections, each with different planned rehabilitation actions, were selected for closer follow up. Common for all sections, was that the old wearing course should be removed and the drainage improved.

In the first demonstration section from km 15/750 to km 15/830, the new structure was placed on the old subbase as shown in figure 5.1. The structure consisted of:

- 50 mm wearing course (1)
- 100 mm base course (2)
- 200 mm sub-base course (3)
- 300 mm road edging (4)
- 50 mm boarding strip/support strip (8)
- New ditches, minimum 1.3 m below road surface.

The same road structure was used for demonstration section 3, km 25/020 to km 25/100, but in this case one layer of 10 mm diameter steel net was installed under the base course.

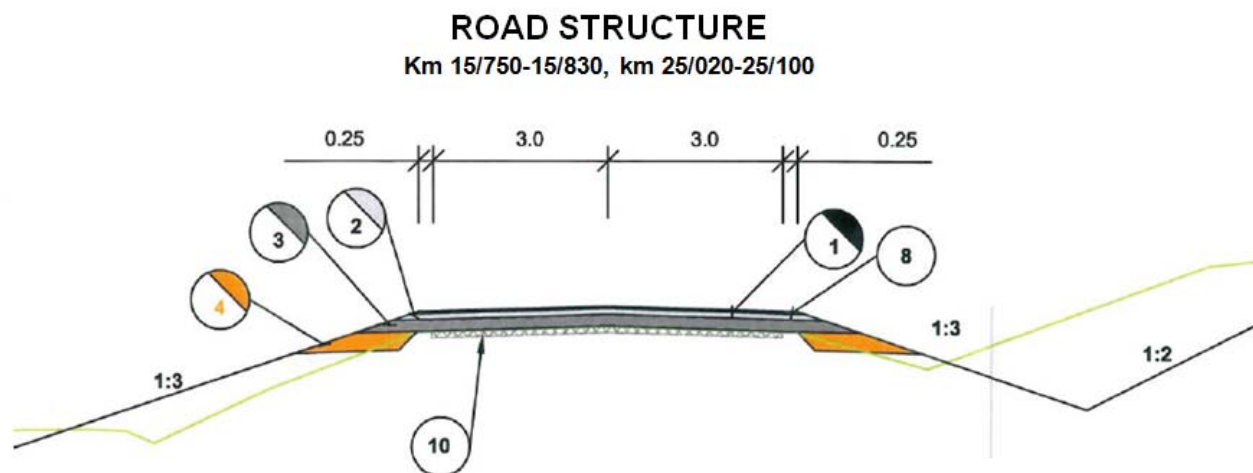


Figure 5.1 New road structure used for demonstration sections 1 and 3.

In the middle section, km 20/100 to km 20/180, another type of structure was used, see Figure 5.2. After removing the old wearing course (10), parts of the road body was removed to free enough space for the new road structure, which comprised of:

- 50 mm wearing course (1)
- 100 mm base course (2)
- 400 mm sub-base course (3)
- 50 mm boarding strip/support strip (8)
- Excavating for new road structure (9)
- New ditches, minimum 1.3 m below road surface

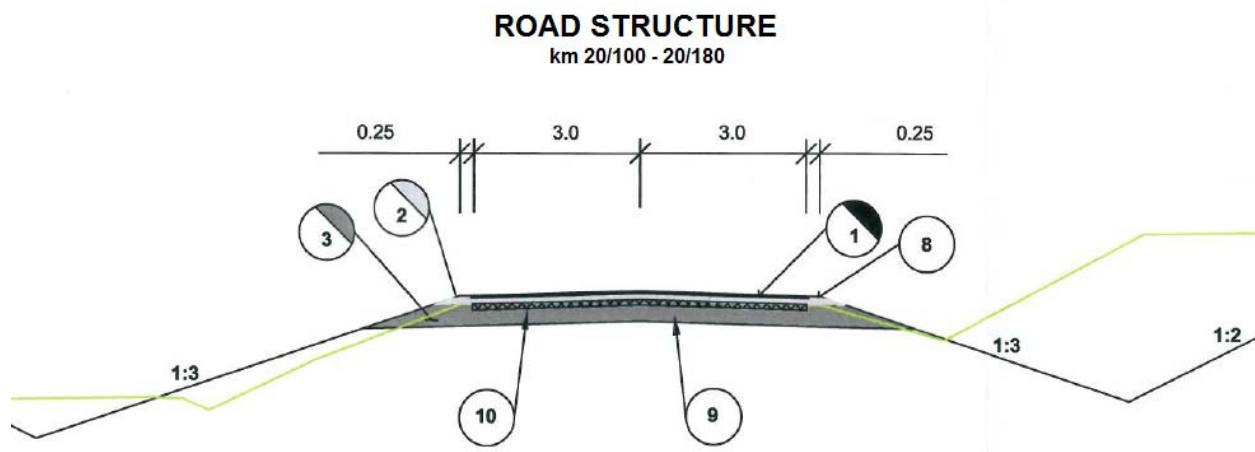


Figure 5.2 Rehabilitation structure used for demonstration section 2.

5.2. RATIONALE FOR THE SELECTED SOLUTIONS

Provided that the reasons for the pavement damages presented in Chapter 4.1.1 are correct, the addition of new base and sub-base layers on demonstration section 1 is a well justified rehabilitation measure. The additional thickness of the structural layers above the air-cooled blast furnace slag will reduce the stresses on the ACBFS caused by wheel loads on the road surface. As a result of this the risk of degradation of the ACBFS material will also reduce. Even if it still happened to some extent, it would not have such a direct effect on the pavement surface as before the rehabilitation.

On demonstration section 2 the thickness of the new sub-base course layer was greater than on demonstration section 1. This was carried out partly by replacing some of the old poor quality structural materials, and partly by increasing the overall thickness of the road structure. The aim of this solution was to improve the overall bearing capacity of the road to make it more resistant to both permanent deformations taking place inside of the road structure itself (Mode 1 rutting), and in the underlying subgrade (Mode 2 rutting).

The development of longitudinal cracking in a road surface as a result of uneven frost heave is shown schematically in Figure 5.3. This type of cracking regularly occurs in areas with permanent snow cover in winter when snow accumulates on the roadsides during and after snowclearing operations on the road. This snow is a very porous material and a good heat insulator. Frost penetrates deeper below the road surface in the middle of the road than towards the edges of the road that are partly protected by the snow. As a result of these different frost penetrations, frost-susceptible subgrade materials heave differently between the middle of the road and the edges. This develops tensile stresses in the upper part of the road structure and when these stresses exceed the tensile strength of the frozen structure, cracks develop.

Steel is well-known to be a material with high tensile strength that can combat tensile stresses. A steel net reinforcement installed in the upper part of the road pavement can help to keep the road structure in one piece. Cracks may still develop, but if the steel net reinforcement is made wide enough, it can transfer the crack from the road surface to the road edges where it is much less harmful than in the middle of the road.

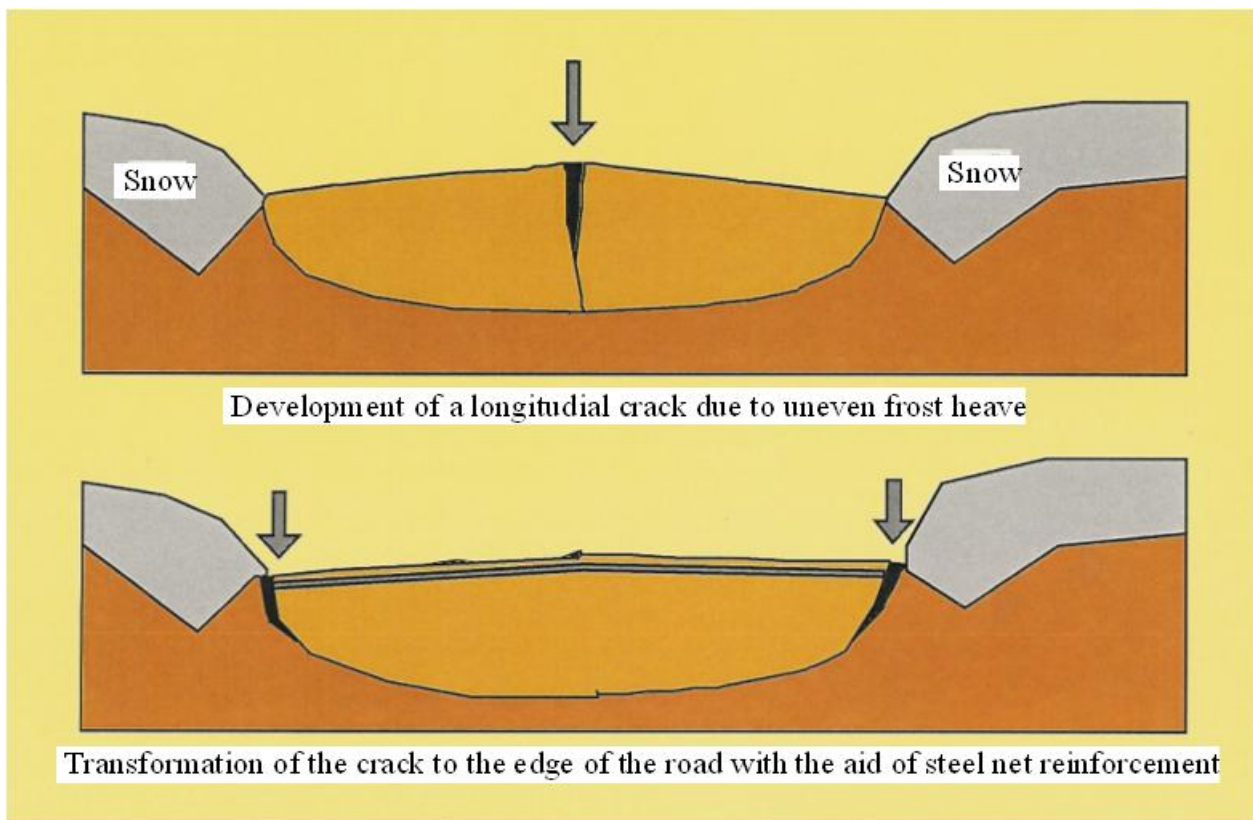


Figure 5.3 Diagrams showing longitudinal cracking due to uneven frost heave and reinforcement of the structure against cracking.

6. DESCRIPTION OF THE REHABILITATION WORK

6.1. DEMONSTRATION SECTIONS

The rehabilitation works on Road 582 were commissioned by the Swedish Transport Administration and carried out by contractor Asfaltbeläggningar i Boden AB (ABL).

Three demonstration sections were selected for closer follow-up during construction as described in Chapter 4. These sections were marked and documented by photographing (see figures 4.1 – 4.3) during the first construction site visit on 23rd September 2011,

6.2. PREPARATORY WORKS

The construction work started in early September 2011. It was considered that many of the problems on Road 582 were due to poor drainage and as a first step the contractor began to replace all existing concrete culverts with plastic culverts, diameter 800 mm, see Figure 6.1.

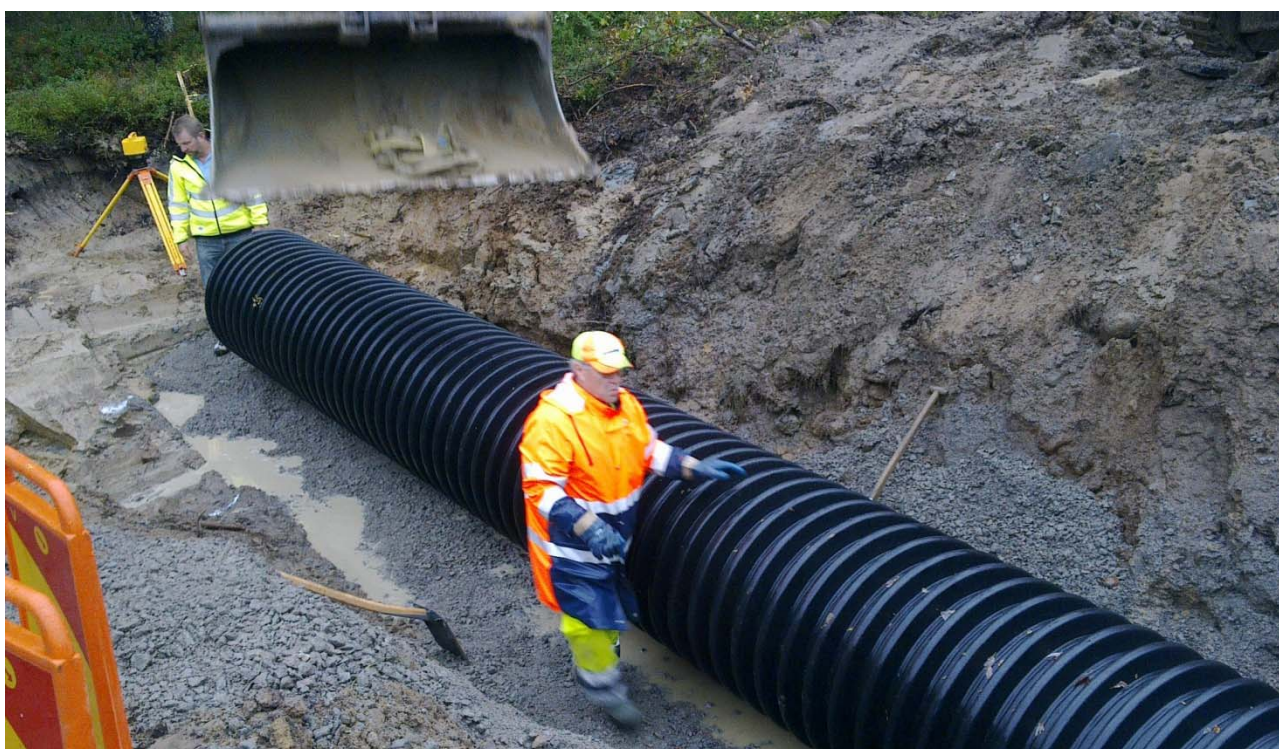


Figure 6.1 The drainage system is improved with new 800 mm plastic culverts

A large TrenchCoat culvert (PE-covered galvanized steel) with diameter 1800 mm was installed in a stream at km 18/745. While excavating for this pipe an old narrow concrete bridge was found and parts of this had to be removed in order for the new pipe to fit in.

The work in improving drainage systems continued for the next four weeks. During that time, the area had three times more rain than usual, see Figure 6.2. This caused large water flows and forced the workers to dam the water and employ pumps to drain the worksite. An old ordnance mine was uncovered in one of the culvert trenches and had to be dealt with by military staff.



Figure 6.2 Even some of the new larger drainage culverts were overfilled during the heavy rains in September.

6.3. WORKING METHODS

On October 12th, the work of removing the old wearing course started at the south end near Selet. This was done by a road grader and was continued north as the drainage systems were completed one by one in the same direction. After the rainy September an unusually warm period with less rain and temperatures around 5-7 °C followed.

With the old pavement gone, the work of excavating the widened road formation and providing new ditches began. All machines were equipped with GPS systems and screens that showed their exact position in relation to the new profile at the current cross section, see Figure 6.3.

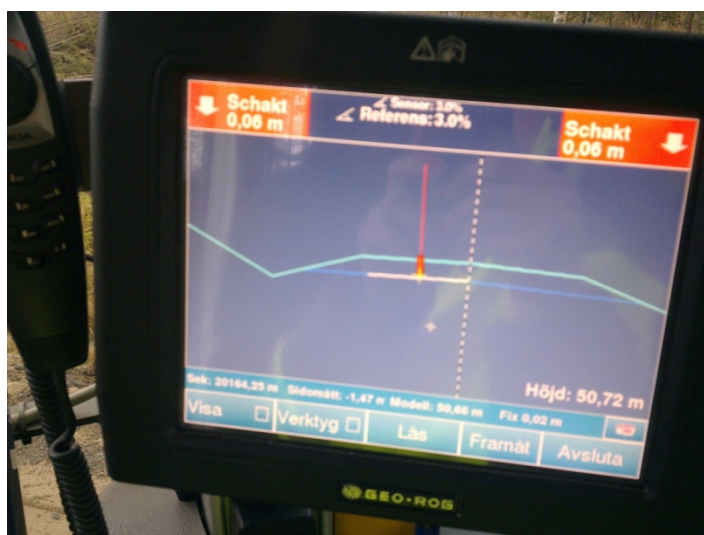


Figure 6.3 One part of the machine control system in a wheel loader. The screen shows the exact position to the operator.

In the middle of November, the average daily temperature fell below 0°C and the remaining works had to be done in partly frozen ground, see Figure 6.4.



Figure 6.4 The new widened road formation at demonstration section 1 in November 2011. The old wearing course has been removed and new ditches excavated.

Once the whole road had frozen, the contractor started to lay the aggregate materials for the sub-base course and base course. Gravel was transported from a nearby quarry by ten trucks, spread out by a wheel loader and grader, and finally compacted.

The contractor was lucky that the first real snowfall did not come until 7th December, which was very late for the area. By that time, they had already started to lay the new sub-base and base course, and only parts of that work had had to be done in winter conditions, see Figures 6.5-6.7. The temperature fell very fast and was below -20°C at times during this work. It was the last part of the job to be done that year.

The remaining work on the road is planned to be carried out in June and July 2012. The base course and road profile will be adjusted at that time and the new wearing course added.

In places where a steel net will be needed (for example demonstration section 3) a thinner temporary wearing course, consisting of a finer gravel fraction, was laid directly onto the sub-base in 2011. The steel net will be installed in 2012 and the new base course and wearing course will be constructed. If the steel net and base course were laid in autumn 2011, the steel net could have risen to the surface during spring-time.



Figure 6.5 New aggregate materials are laid on to the frozen widened formation, and spread by a grader and compacted.



Figure 6.6 The new base course is finished.

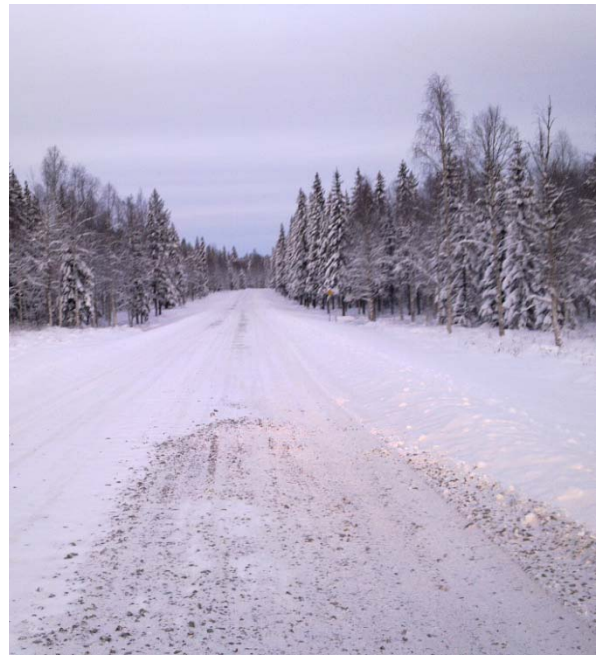


Figure 6.7 Demonstration section 3 covered in snow.

6.4. PROBLEMS ENCOUNTERED ON SITE

Generally, the project progressed according to plan. There were some surprises, although none of them concerned the demonstration sections.

Solid rock was found both in the road structure and in the ditches at km 26-27. This prevented the surface water from reaching the drainage pipes, and forcing it into the road structure. In March 2012 the contractor, ABL, will blast off some of the rock on the sides to free the way for the water.

The only planned rehabilitation action through the village of Mockträsk, was to replace the wearing course. However, base course samples showed that the quality of the material did not reach a sufficient standard for this and 100 mm was replaced with new base course.

Near Boden, at km 30, the whole road structure had to be replaced with material to a depth of 1.9 m. The existing road did not have ditches at that subsection and the road material was submerged in water.

7. SITE MONITORING

7.1. CONDITION OF THE DEMONSTRATION SECTIONS IN JUNE 2012

Johan Ullberg from the Swedish Transport Administration visited all of the demonstration sections in the beginning of June 2012 to check the condition of the sections after the winter period. As Figures 7.1 – 7.3 indicate there were not any unexpected features on any of the sections. All of the demonstration structures were in good condition and the finalizing works of the contract, including construction of the new asphalt concrete wearing course, were authorised to proceed as planned later in summer 2012.



Figure 7.1 Views on demonstration section 1 in early June 2012.



Figure 7.2 Views on demonstration section 2 in early June 2012.



Figure 7.3 Views on demonstration section 3 in early June 2012.

7.2. FUTURE MONITORING OF THE DEMONSTRATION SECTIONS

No specific site instrumentation or monitoring systems were installed on the demonstration sections. The construction contractor is required however to inspect the site daily during the construction period to monitor its condition and traffickability. Thereafter, on completion of the construction works the project area will be covered by a normal "guarantee period" of five years, during which the contractor will be responsible for repairing any unexpected faults or distresses if such appear.

After that time period the road will become part of the normal Swedish road network and their road maintenance practices will take care of the regular investigation measures. These include a visual inspection made by a representative of the Swedish Transport Administration a couple of times per year, and surface condition monitoring of the road in terms of rut depth and IRI value measurements at least every second year.

8. CONCLUSIONS

Road 582 Selet – Boded, a low volume road north-west of Luleå, in Northern Sweden was subject to rehabilitation over the years 2011 and 2012. Three demonstration sections in the rehabilitation were selected for reporting and follow-up during the works in autumn 2011. Each of the sections had a different type of “fit-for-purpose” rehabilitation solution that depended of the type and severity of the underlying problems.

Demonstration section 1 was suffering from severe pavement damages most likely resulting from degradation of the base/sub-base course layer consisting of air-cooled blast furnace slag combined with the effect of poor drainage. Demonstration section 2 was damaged by rutting and other types of distresses so badly that the asphalt concrete wearing course had already been removed by the start of the rehabilitation works. On demonstration section 3 the dominant type of pavement damage was longitudinal cracking of the road surface resulting from uneven frost heave across the road caused mainly by the combined effect of frost-susceptible subgrade material and poor drainage.

The respective rehabilitation structures were as follows:

- 1) on demonstration section 1, an addition of new base and sub-base layers with a total thickness of 300 mm
- 2) on demonstration section 2, a partial addition and partial mass replacement of base and sub-base course with the total thickness of 500 mm
- 3) on demonstration section 3 the structure was similar to section 1, except that a steel net reinforcement was installed in between the new base and sub-base course layers.

In addition to the above specific rehabilitation measures, the road drainage was improved on all of the demonstration sections by excavating the side ditches at least to the depth of 1.3 m below the road surface. According to the results available from the earlier phases in the ROADEx project, improving of the drainage is clearly the most cost efficient rehabilitation measure and, therefore, ensuring the operability of the drainage system should always be included in proper execution of a low volume road rehabilitation project.

In the event, the construction works proceeded mainly as planned and without any major problems despite very rainy weather conditions during autumn 2011. Exceptionally mild autumn temperatures allowed the site works to be continued until early December, when snow and frost halted construction operations. It is planned that the rehabilitation works will recommence in June/July 2012.

9. REFERENCES

1. Enbom, Kenneth, project manager, Swedish Transport Administration (Trafikverket).
2. Lindström, Peter, site manager, Asfaltbeläggningar i Boden AB (ABL).
3. Arbetsplan beskrivning (2009-05-31, rev.2010-03-31), Väg 582 Selet – Boden, Norrbottens län.
4. Tyréns AB, Rapport Geoteknik, R-Geo, Objekt 8211831-582, Väg 582, delen Selet-Boden.

APPENDICES

Appendix 1. 1(2)

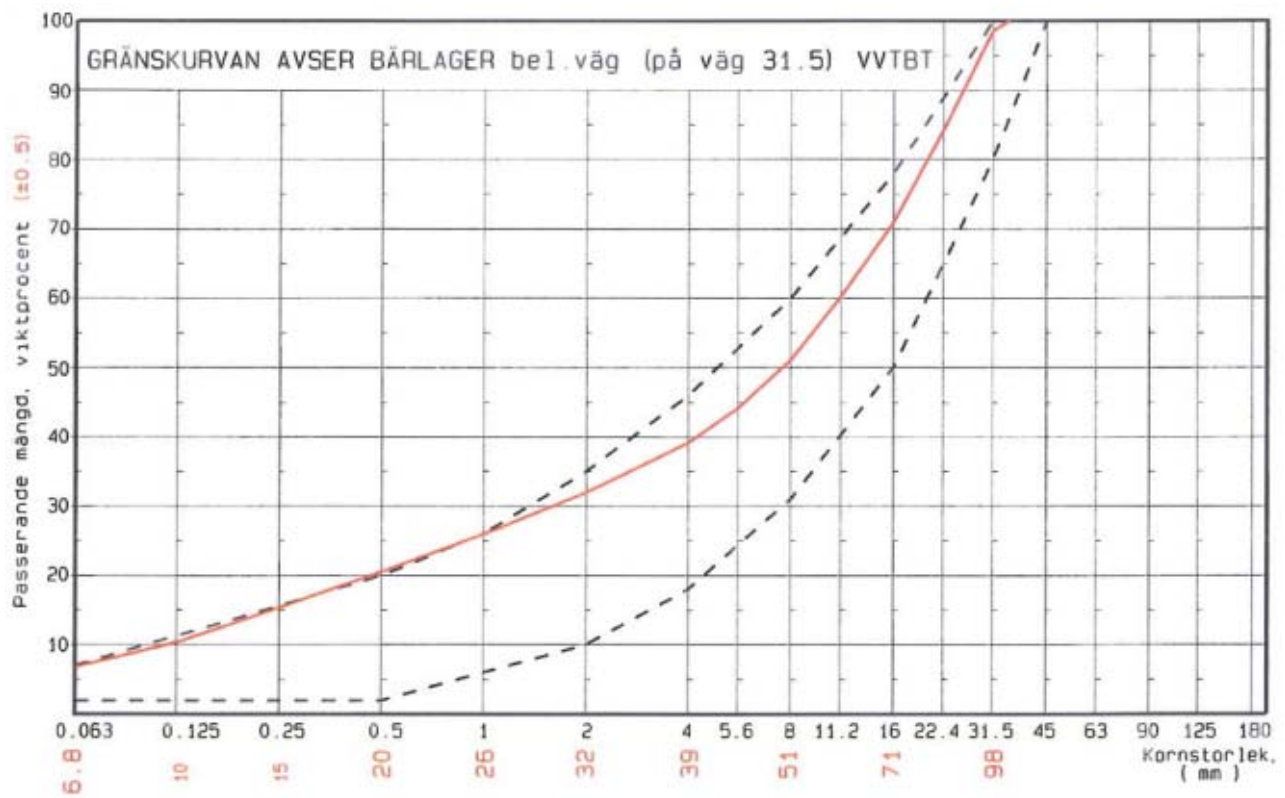


Figure A1.1 Grain size distribution curve of the base course material at km 15/750.

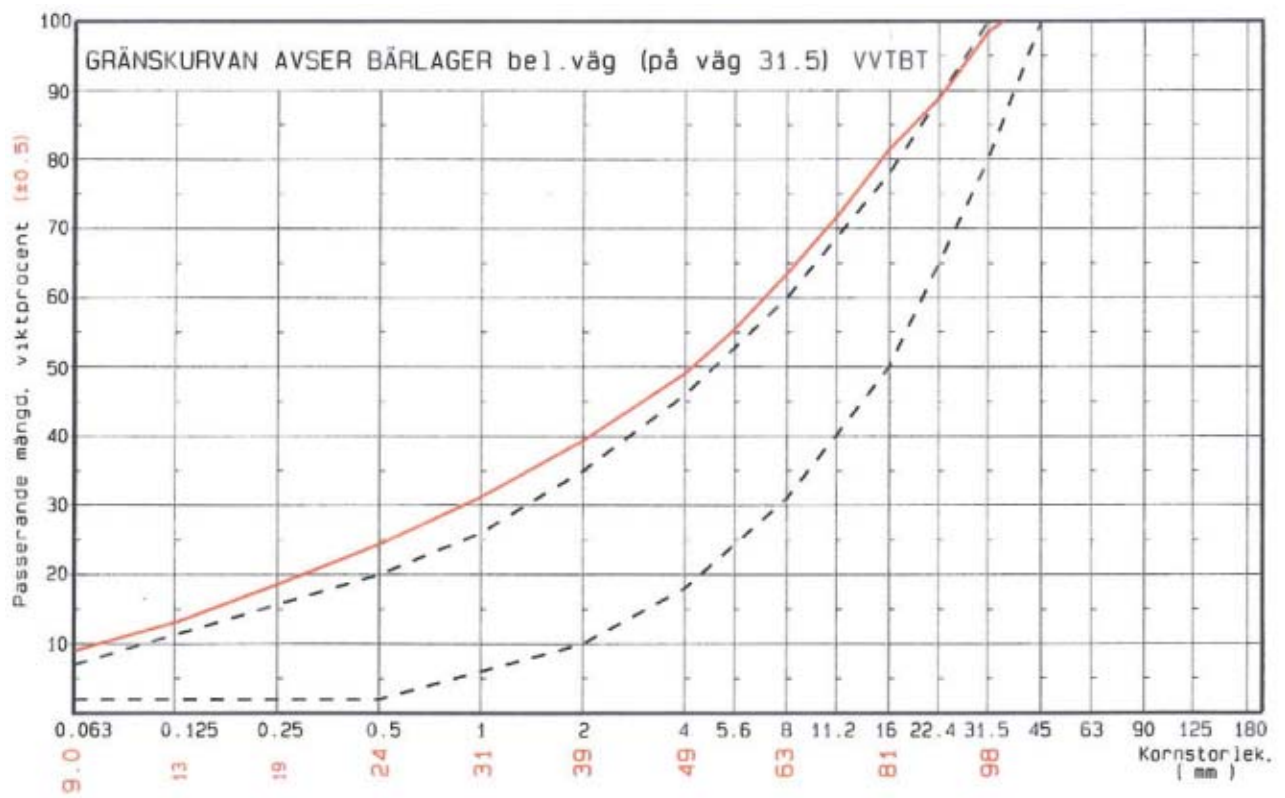


Figure A1.2 Grain size distribution curve of the base course material at km 20/920.

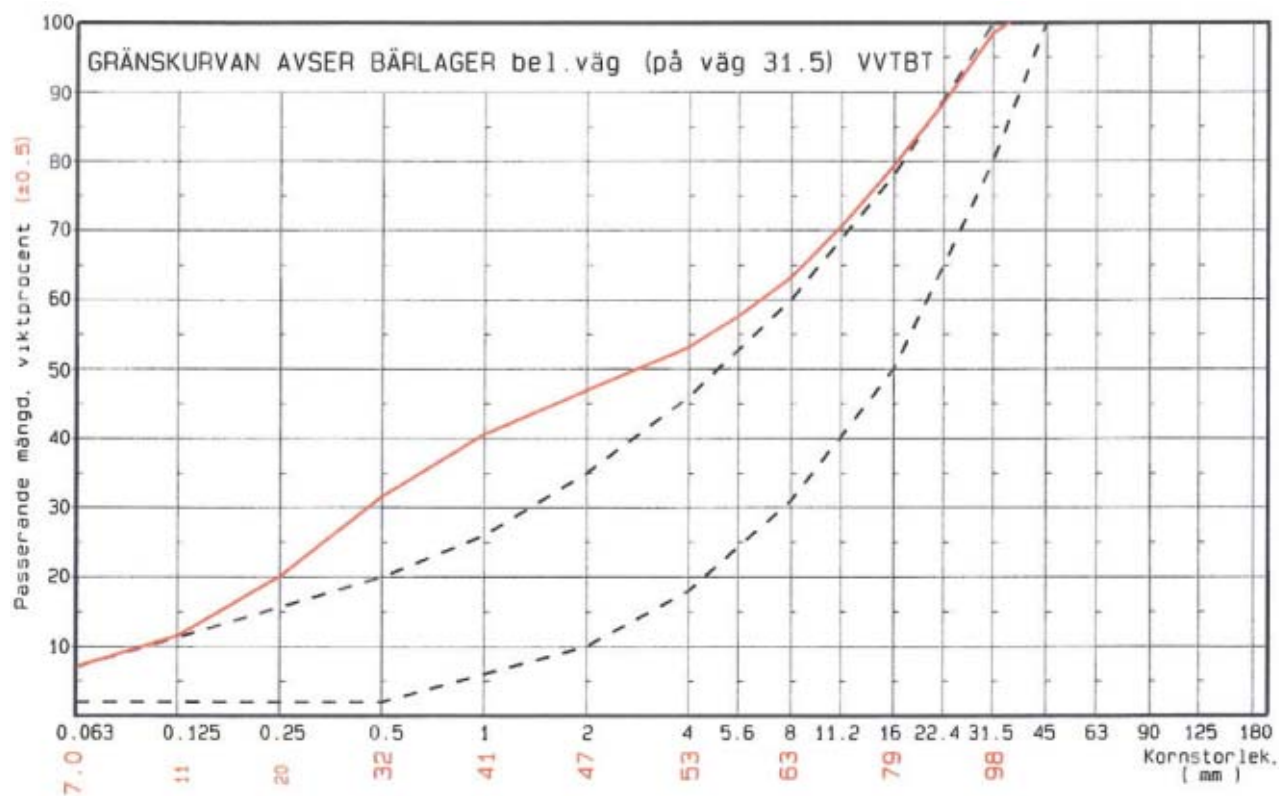


Figure A1.3 Grain size distribution curve of the base course material at km 24/150.

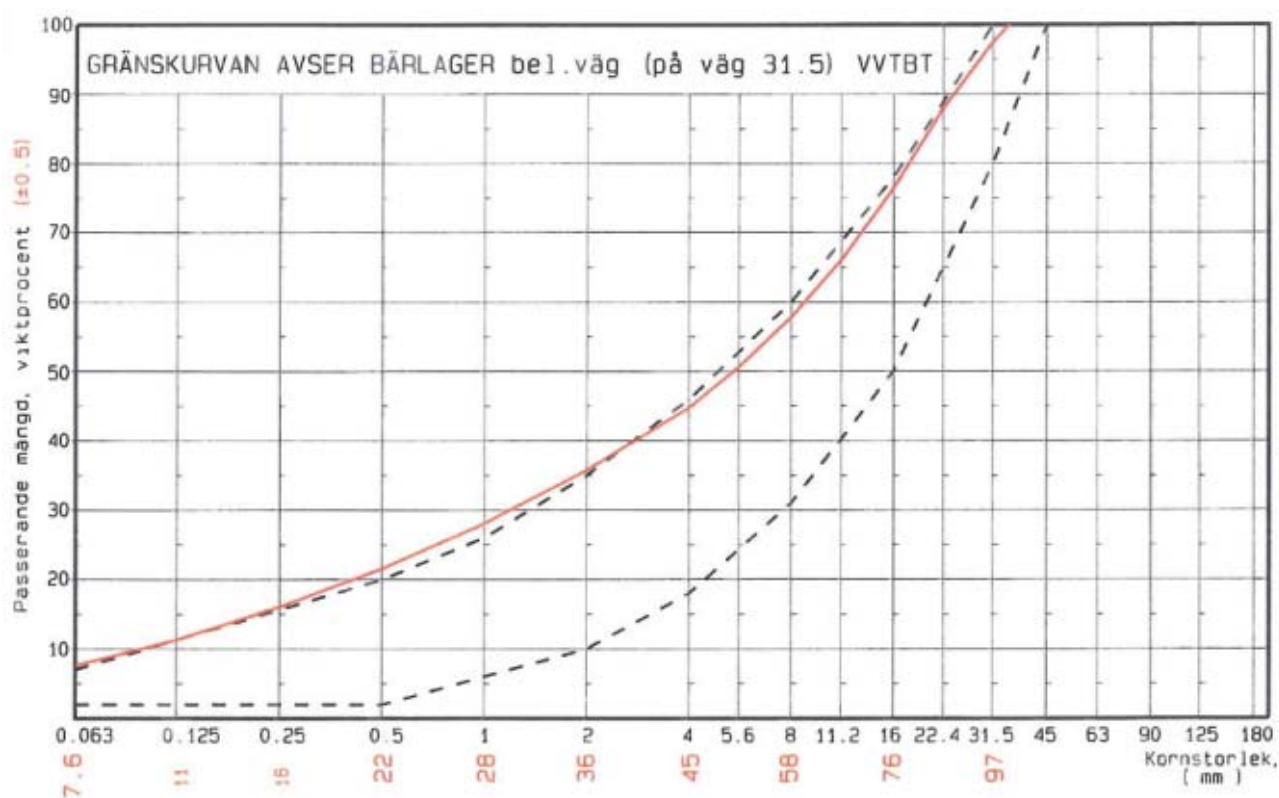


Figure A1.4 Grain size distribution curve of the base course material at km 26/020.

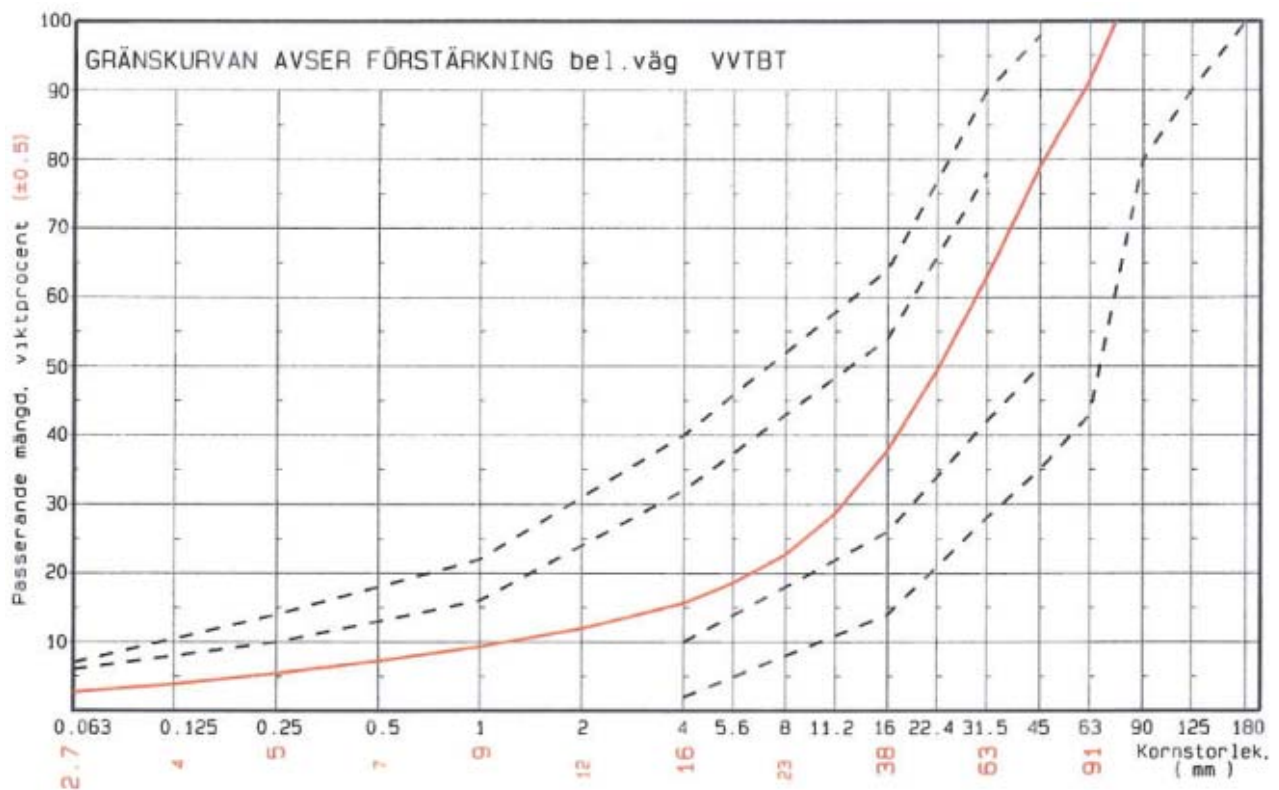


Figure A2.1 Grain size distribution curve of the sub-base course material at km 15/750.

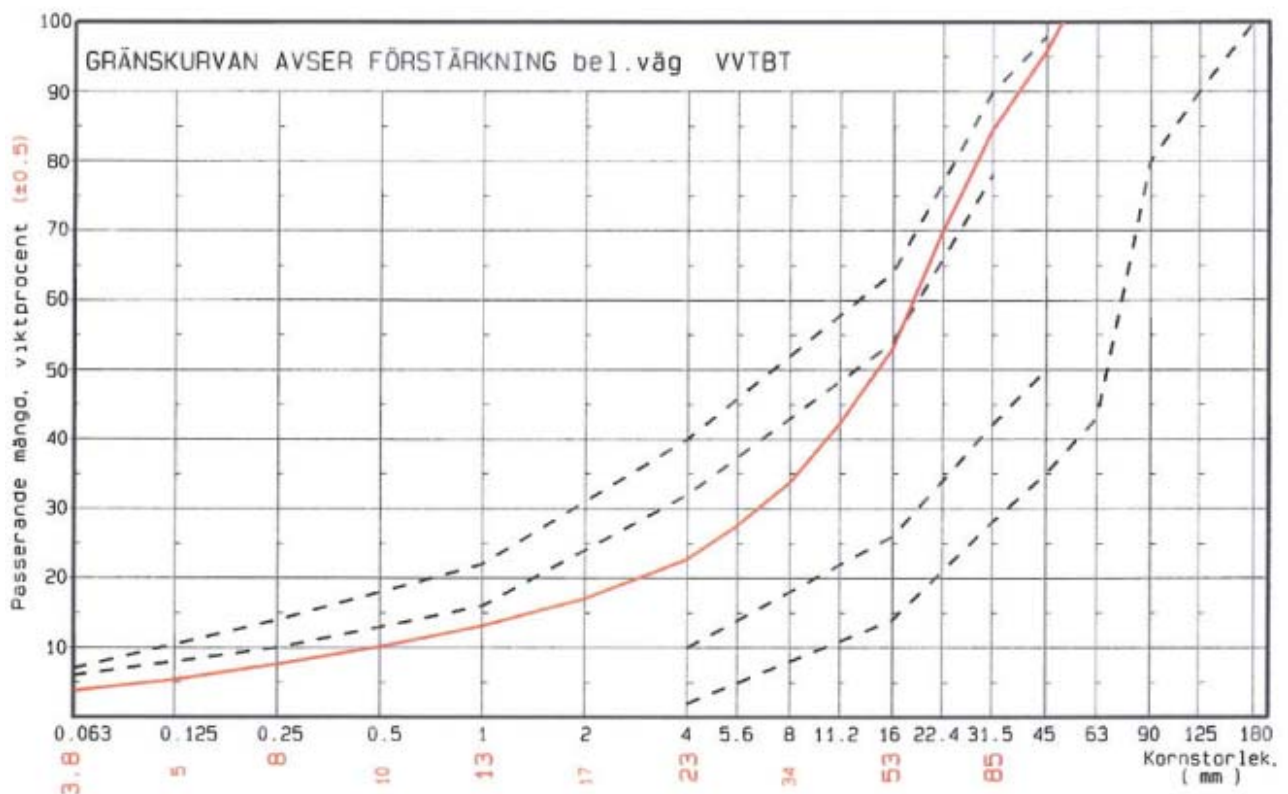


Figure A2.2 Grain size distribution curve of the sub-base course material at km 20/920.

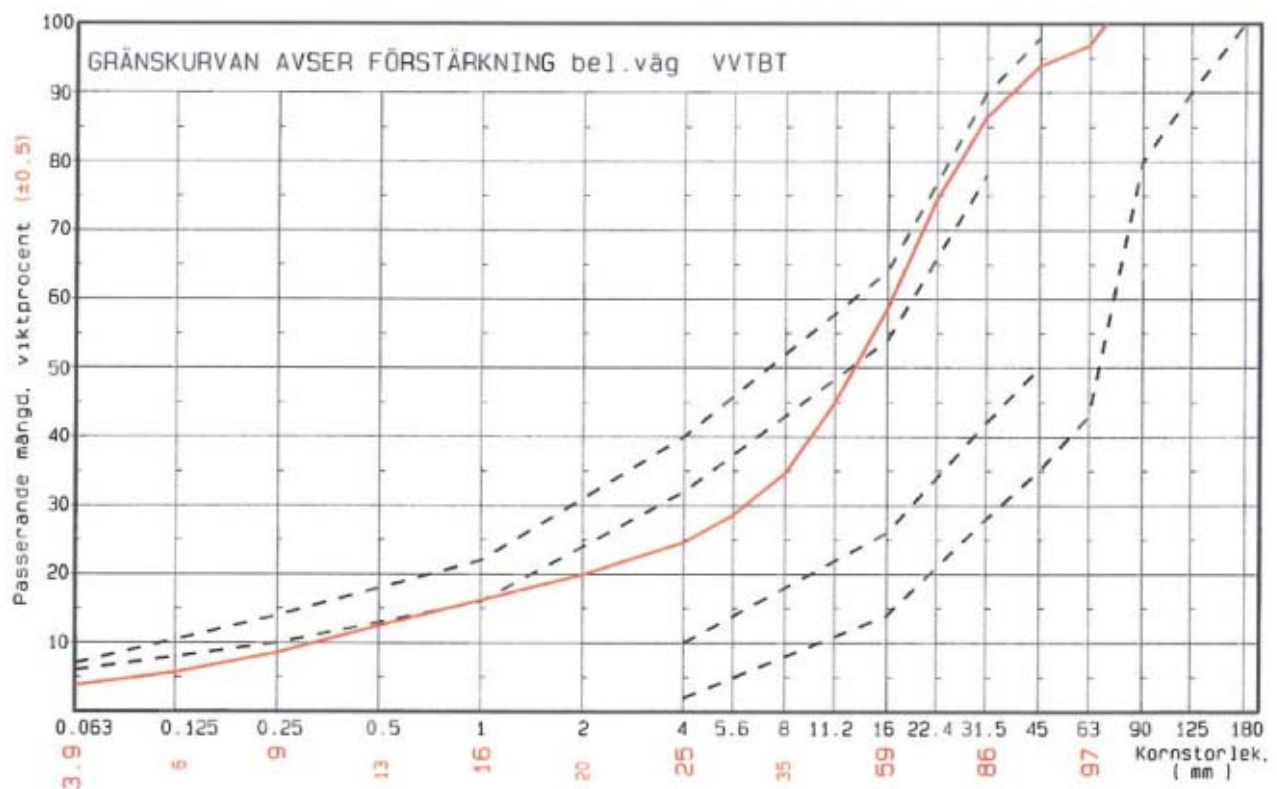


Figure A2.3 Grain size distribution curve of the sub-base course material at km 24/150.

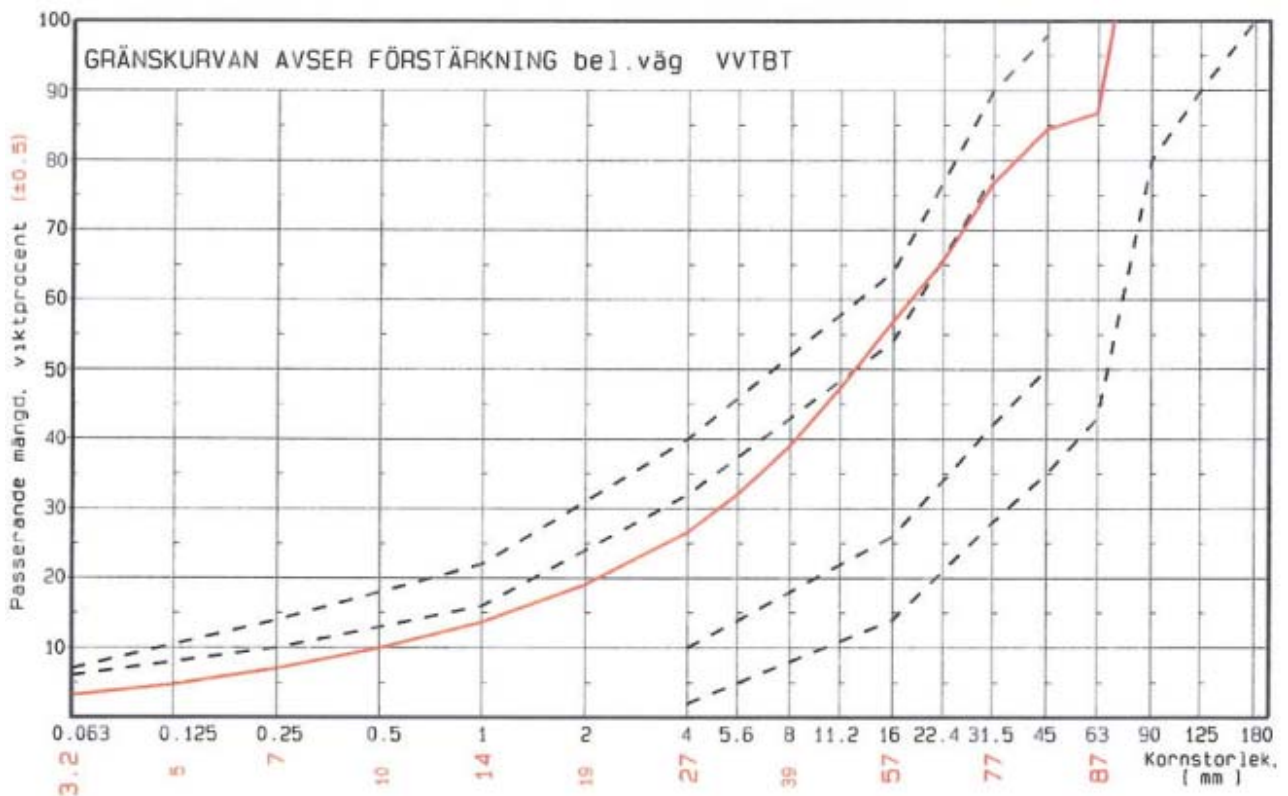


Figure A2.4 Grain size distribution curve of the sub-base course material at km 26/020.

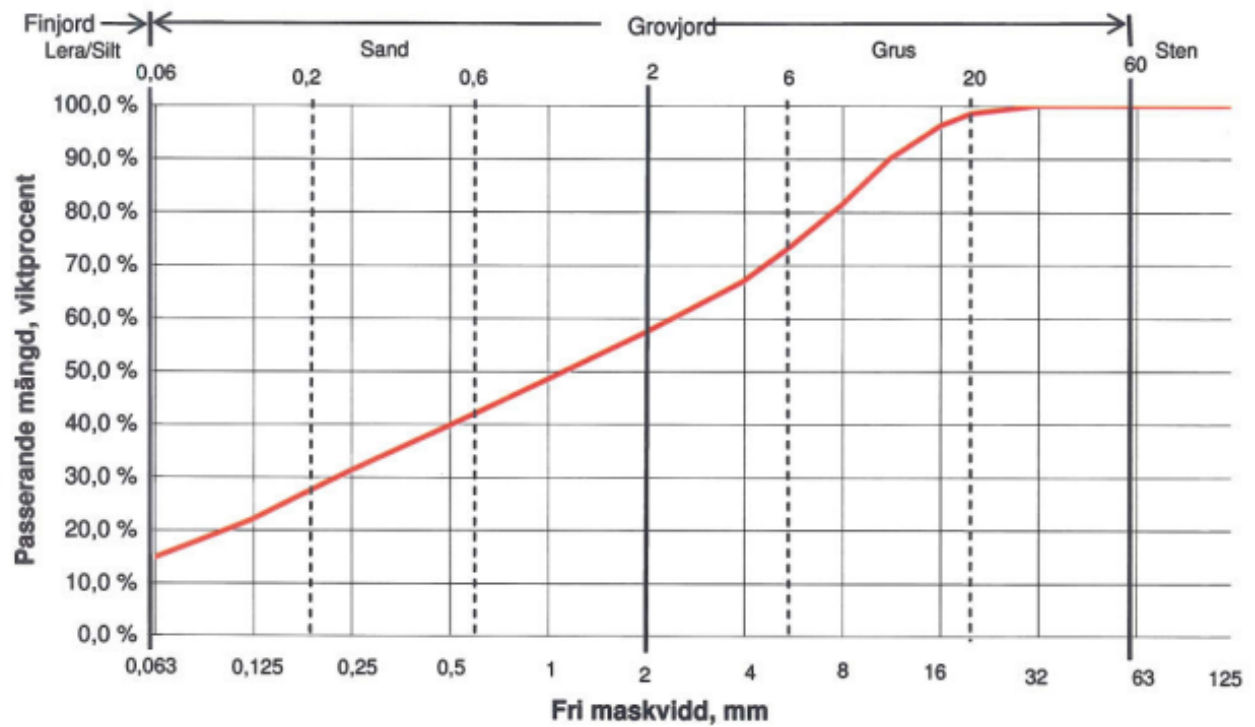


Figure A3.1 Grain size distribution curve of the subgrade material at km 15/904, depth 0.3 – 0.7 m.

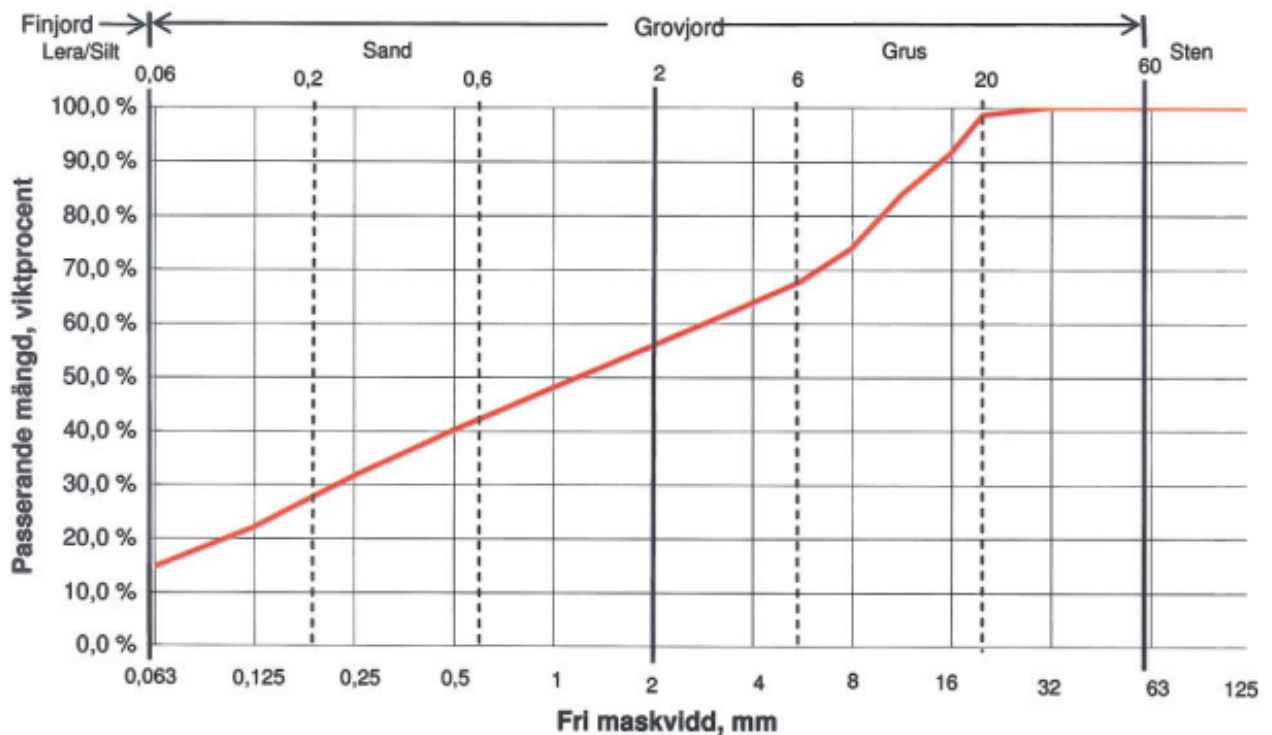


Figure A3.2 Grain size distribution curve of the subgrade material at km 20/533, depth 0.3 – 0.8 m.

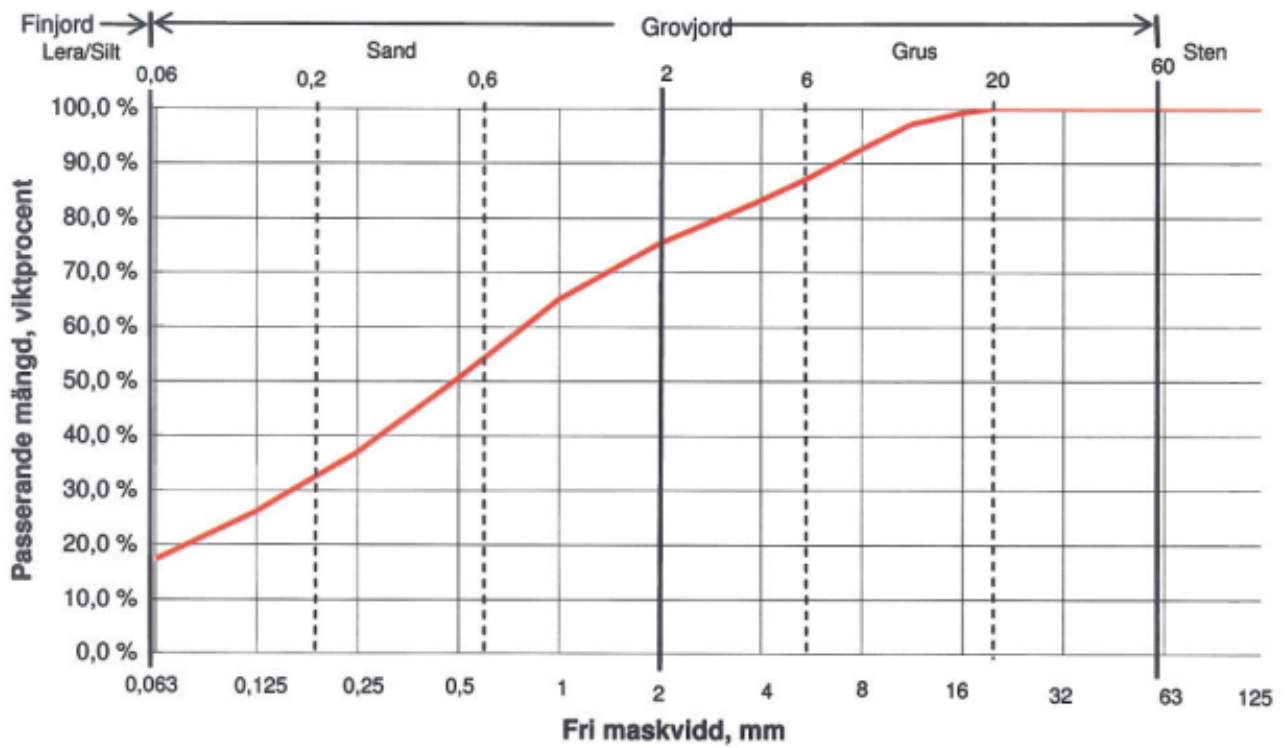


Figure A3.3 Grain size distribution curve of the subgrade material at km 26/735, depth 0.6 – 1.2 m.



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This report is one of a suite of reports and case studies on the management of low volume roads produced by the ROADEX project over the period 1998-2012. These reports cover a wide range of topics as below.

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- Cost savings and benefits accruing to ROADEX technologies
- Dealing with bearing capacity problems on low volume roads constructed on peat
- Design and repair of roads suffering from spring thaw weakening
- Drainage guidelines
- Environmental guidelines & checklist
- Forest road policies
- Generation of 'snow smoke' behind heavy vehicles
- Health issues raised by poorly maintained road networks
- Managing drainage on low volume roads
- Managing peat related problems on low volume roads
- Managing permanent deformation in low volume roads
- Managing spring thaw weakening on low volume roads
- Monitoring low volume roads
- New survey techniques in drainage evaluation
- Permanent deformation, from theory to practice
- Risk analyses on low volume roads
- Road condition management of low volume roads
- Road friendly vehicles & tyre pressure control
- Road widening guidelines
- Socio-economic impacts of road conditions on low volume roads
- Structural innovations for low volume roads
- Treatment of moisture susceptible materials
- Tyre pressure control on timber haulage vehicles
- Understanding low volume pavement response to heavy traffic loading
- User perspectives on the road service level in ROADEX areas
- Vehicle and human vibration due to road condition
- Winter maintenance practice in the Northern Periphery

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