GGT
German-GreenTec

# Test Report Explanatory Notes
# TÜV Rheinland LGA Bautechnik GmbH

**Date 25/08/2011; Test report no.: BBV113096 / SAP 69627373**

| | |
|---|---|
| Customer: | **Underbold GmbH**<br>Nibelungenring 18<br>76297 Stutensee |
| Person to contact: | Klaus Beck (CEO) |
| Test institute: | TÜV Rheinland<br>LGA Bautechnik GmbH<br>Verkehrswegebau<br>Tillystraße 2<br>90431 Nürnberg |
| Person to contact: | Mr Dipl. Ing. Ernst Stapff |

September 2011

**TÜV Rheinland LGA Bautechnik GmbH**

**Traffic route construction**

By DAP Deutsches Akkreditierungssystem Prüfwesen GmbH
accredited test laboratory DAP-PL-1524.16.

Certified according to DIN EN ISO 9001.

# Test report

**BBV1113096 / SAP 69627373** **Date: 25.08.2011**

**Customer:** Underbold GmbH
Nibelungenring 18
76297 Stutensee

**Order from:** 29.06.2011

**Contents of order:** Sampling, carrying out of field and laboratory experiments and production of a test report for the field test with 3% binder-Underbold-soil mixture

**Sampling material:** see appendices

**Sampling:** TR LGA Bautechnik GmbH

**Sample receipt:** see appendices

**Sampling designation:** see appendices

This test report includes 2 document classes.

The test results are only based on the sample material stated in the test report. The test period corresponds to the period between receipt date and the findings date.



We have saved essential data and your address in order to process the order. Data protection is guaranteed.

TÜV Rheinland
LGA Bautechnik GmbH
Verkehrswegebau (traffic route construction)
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90431 Nürnberg

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**TÜV Rheinland LGA Bautechnik GmbH**
**Traffic route construction**

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Test report explanatory notes
TÜV Rheinland LGA Bautechnik GmbH

Date 25/08/2011;
Test report no.: BBV113096 / SAP 69627373

# Explanatory note

## to "1. Objective"
## of TÜV Rheinland LGA Bautechnik GmbH test report:

**UNDERBOLD®** is an additive mixture for improving the properties of soils and rocks in association with the use of hydraulic binders.

As an aqueous polyethylene wax dispersion, free of solvents and plasticizers **UNDERBOLD®** reduces soil property effects on the structural formation and setting behaviour of the binder matrix.

Hydrophobing soil or rock using **UNDERBOLD®** produces a final product that is almost waterproof when used in conjunction with the hydraulic binder.
As a result the treated mineral mixture becomes permanently frost resistant.

Working **UNDERBOLD®** into the ground produces a crack-free base course that is independent of the type of ground material and the amount of binder added. This can then easily be built over with a very thin or thick asphalt package.
The specified single-axial compressive strengths for hydraulically bonded base layers under asphalt type constructions (e.g. according to ZTV concrete 07) do not need to be taken into consideration when **UNDERBOLD®** dispersion is used.

The final product of a mixture of soil, additive and binder is used as a layer of the superstructure.

# 1 Objective

Global Underbold System GmbH requested the setting up of a test field at the TÜV Rheinland LGA Bautechnik GmbH, Nürnberg site.

TÜV Rheinland LGA Bautechnik GmbH was contracted by Global Underbold System GmbH to carry out field and laboratory experiments at the test field. Test field investigation results for a 3% binder-Underbold-soil mixture are compiled in the following document and an evaluation of test results is also included.

# Explanatory notes

## to "2. Production of the test field" of TÜV Rheinland LGA Bautechnik GmbH test report:

A binder addition of 3%, based on the dry weight of the soil to be used, was specified by Global **UNDERBOLD®** System GmbH as part of the practical experimentation. The additive was mixed at a ratio of 1:50 with water and worked in at 2% w/w based on the dry weight.

The performance of the entire system can be most clearly demonstrated using the minimum binder addition of 3%.

# 2 Production of the test field

The test field was produced according to the specifications and the construction supervised by Global Underbold System GmbH on the 25/05/2011.The Stetter company carried out the work. A milling machine and single drum roller from BOMAG were used.
Production of the test field is described in a separate report.

**Table 1:** Test field

| Area | Binder | Milling depth | Comment |
|---|---|---|---|
| 1 | 3% cement + Underbold | 40 cm | In situ - on the site |

The type of cement incorporated and quantity as well as additive "Underbold" were not tested by TÜV Rheinland LGA Bautechnik GmbH.

The investigations by TÜV Rheinland LGA Bautechnik GmbH were carried out on completed test fields.

TÜVRheinland®
LGA
Genau. Richtig.

## Versuchsprotokoll, Dichte- und Wassergehaltsbestimmungen mit der Isotopen-Troxler-Sonde

**Projekt: TÜV Rheinland, Probefeld 3% Zement + Underbold**

**Auftragsnummer: Global Underbold System GmbH** — **Anlage: 1.1**

**Zusätzliche Bezeichnung**

| Grundwerte: | Tiefe m | Messzeit Min. | Zählung D = | M t/m³ | $\rho_{pr}$ t/m³ | Datum: |
|---|---|---|---|---|---|---|

| Isotopen/ Sondierung Nr. | Lage | Dichte | | Wasser- | | Verdichtungsgrad | Bemerkungen |
|---|---|---|---|---|---|---|---|
| | | Feucht- (WD) (t/m³) | Trocken- (DD) (t/m³) | Menge (M) (t/m³) | Gehalt (M) w (%) | $D_{pr}$ (%) | |
| 1 | T=0,3m | 2,247 | 2,041 | 0,206 | 10,1 | | |
| | | 2,234 | 2,017 | 0,216 | 10,8 | | |
| | | 2,241 | 2,029 | | | 102,7 | |
| 2 | T=0,2m | 2,222 | 2,004 | 0,218 | 10,9 | | |
| | | 2,227 | 2,010 | 0,217 | 10,8 | | |
| | | 2,225 | 2,007 | | | 101,6 | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**übergeben am:** | **an Frau/Herrn:** | **Bearbeiter: H. Schwemmer**

Dateiname: Probefeld 3_ Isotopen-Troxler-Sonde.doc
Erstelldatum: 25.11.2009
Bearbeiter: Dr. stapffe

| Laborzentrum Bau<br>Geotechniklabor | Proctorversuch<br>Bestimmung der Proctordichte<br>nach DIN 18127 | TÜVRheinland®<br>LGA |
|---|---|---|

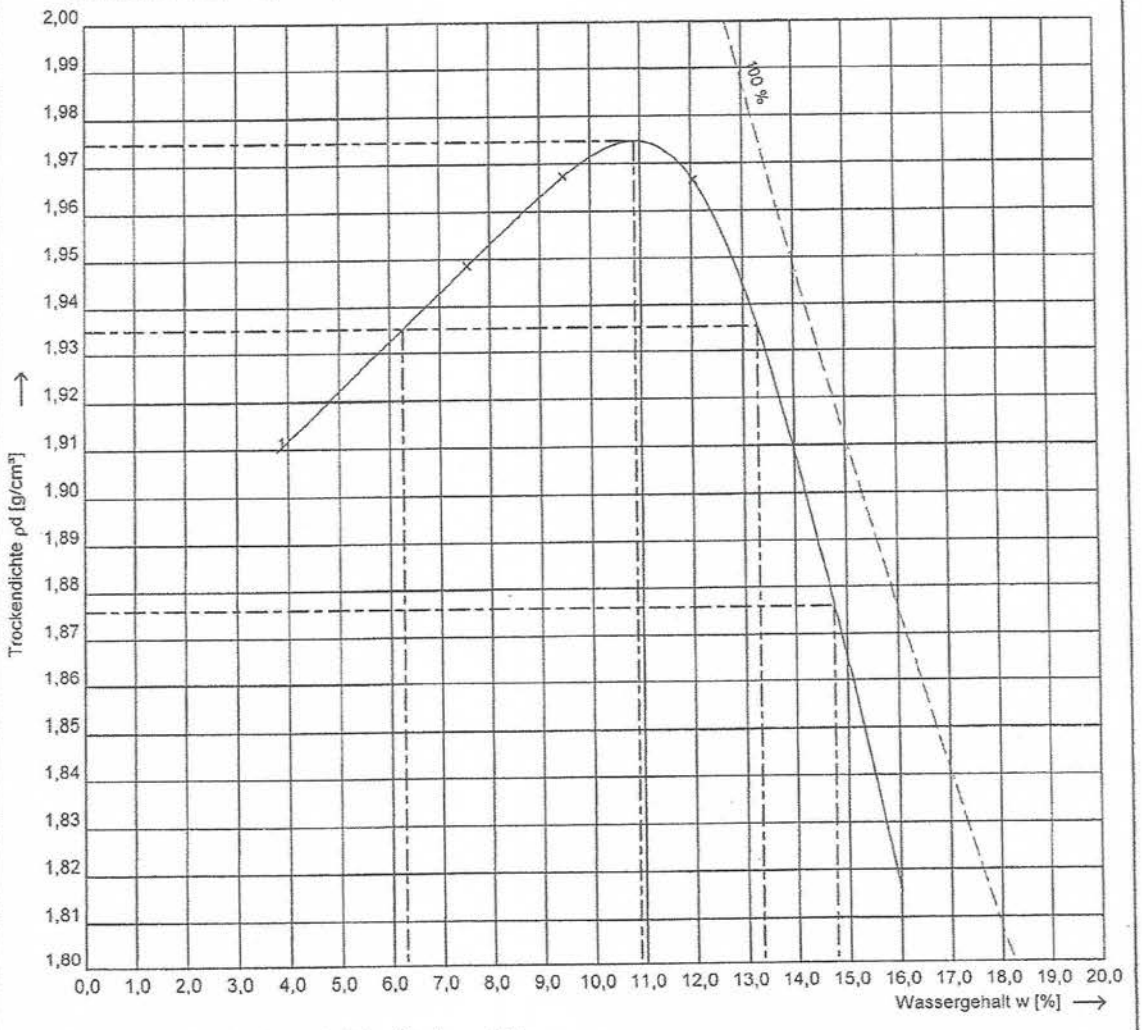
Projekt : TÜV Probefeld
Auftrags-Nr.:
Anlage :

Prüfungs-Nr. :
Bauvorhaben : TÜV Probefeld

Ausgeführt durch : H. Schwemmer
am : 25.05.2011
Bemerkung :

Entnahmestelle : Probefeld
Station : m rechts der Achse
Entnahmetiefe : 0,00-0,40 m unter GOK
Bodenart : S, g, u'
grau
Art der Entnahme :
Entnahme am : 25.05.2011 Probe-Nr. :

Vorhandene Probe: $w_n$ = 7,600 %




Korrektur für Einfluß des Überkornanteils
Nichtkorrigierte Kurve
Sättigungslinie
Sättigungslinie für bestimmten Luftporengehalt

| | | | |
|---|---|---|---|
| 1 | 100 % der Proctordichte ρPr' = g/cm³ | optimaler Wassergehalt wPr' = % |
| | 100 % der Proctordichte ρPr = 1,975 g/cm³ | optimaler Wassergehalt wPr = 10,9 % |
| | 98 % der Proctordichte ρd = 1,935 g/cm³ | min/max Wassergehalt w = 6,3 / 13,3 % |
| | 95 % der Proctordichte ρd = 1,876 g/cm³ | min/max Wassergehalt w = / 14,7 % |

| Laborzentrum Bau<br>Geotechniklabor | Proctorversuch<br>Bestimmung der Proctordichte<br>nach DIN 18127 | TÜVRheinland®<br>LGA |
|---|---|---|

Projekt : TÜV Probefeld
Auftrags-Nr.: Anlage :

Prüfungs-Nr. :
Bauvorhaben : TÜV Probefeld

Ausgeführt durch : H. Schwemmer
am : 25.05.2011
Bemerkung :

Entnahmestelle : Probefeld
Station : m rechts der Achse
Entnahmetiefe : 0,00-0,40 m unter GOK
Bodenart : S, g, u'
grau
Art der Entnahme :
Entnahme am : 25.05.2011 Probe-Nr. :

| | | | | | |
|---|---|---|---|---|---|
| Versuchszylinder | d1 = | 150,00 | mm | zulässiges Größtkorn | 31,50 mm |
| Zylinderhöhe | h1 = | 163,50 | mm | Anzahl der Schichten | 3 |
| | a = | 9,00 | mm | Anzahl der Schläge je Schicht | 22 |
| | s1 = | 14,00 | mm | Korndichte der Probe ρ s = | 2,680 g/cm³ |
| Fallgewicht = | | 4,50 | kg | Überkornanteil ü = | 0,00 % |
| Fallhöhe | h2 = | 450,00 | mm | Wassergehalt des Überkorns wü = | 0,00 % |
| Durchmesser | d2 = | 75,00 | mm | Korndichte des Überkorns ρ sü = | 0,000 g/cm³ |

| Nr. des Versuchs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bestimmung der Trockendichte ρ** | | | | | | | | | | |
| Masse der Feuchtprobe mit Zylinder m + mz [g] | 10834,0 | 11217,0 | 10945,0 | | | | | | | |
| Masse des Zylinders mz [g] | 6304,0 | 6304,0 | 6304,0 | | | | | | | |
| Masse der feuchten Probe mw [g] | 4530,0 | 4913,0 | 4641,0 | | | | | | | |
| Höhe Zylinder + Aufsatzring - Stahlplatte [mm] | 163,50 | 163,50 | 163,50 | | | | | | | |
| Abstand von Zylinder-rand bis Probe [mm] | 41,20 | 34,40 | 44,30 | | | | | | | |
| Volumen der Probe V [cm³] | 2161,22 | 2281,39 | 2106,44 | | | | | | | |
| Feuchtdichte m/V = ρ [g/cm³] | 2,096 | 2,154 | 2,203 | | | | | | | |
| Trockendichte ρ / (1 + w) = ρ d [g/cm³] | 1,949 | 1,967 | 1,966 | | | | | | | |
| **Bestimmung des Wassergehaltes w** | | | | | | | | | | |
| Masse der Feuchtprobe mit Behälter m + mB [g] | 6868,9 | 7252,0 | 6163,8 | | | | | | | |
| Masse der trock. Probe mit Behälter md + mB [g] | 6551,1 | 6827,6 | 5665,7 | | | | | | | |
| Masse des Behälters mB [g] | 2348,3 | 2344,7 | 1529,1 | | | | | | | |
| Masse des Porenwassers mw [g] | 317,8 | 424,4 | 498,1 | | | | | | | |
| Masse der trockenen Probe md [g] | 4202,8 | 4482,9 | 4136,6 | | | | | | | |
| Wassergehalt mw/md = w [%] | 7,56 | 9,47 | 12,04 | | | | | | | |
| **Korrektur für den Einfluss des Überkornanteiles ü** | | | | | | | | | | |
| Korr. Wassergehalt w' = w*(1-ü) + wü * ü [%] | | | | | | | | | | |
| Korr. Trockendichte ρ d' =ρd*(1-ü)+0.9*ü*ρsü | | | | | | | | | | |
| Wert in Kurve darstellen ? | ☒ | ☒ | ☒ | | | | | | | |

Bemerkungen :

German-GreenTec

# Explanatory notes

## to "3. Test field studies“ of the TÜV Rheinland LGA Bautechnik GmbH test report: Section 3.1 "Determination of the compaction rate"

The use of **UNDERBOLD®** in mineral mixtures and soils helps to promote and support the compaction rate.
Even when the conditions are not optimal (not enough water content in the soil-additive binder mixture, and barely enough underground support) the minimum requirements can be achieved more be easily, a compaction rate of 98% of the determined proctor density, due to the lubricating action of the **UNDERBOLD®** particles. This ensures the management of an important quality parameter, which can often in practise lead to problems if conventional binder-improved base layers are used.

Determination of the compaction rate is an important construction material inspection criterion and must always be carried out in sufficient scope.

## to "3. Test field studies“ of the TÜV Rheinland LGA Bautechnik GmbH test report: Section 3.2 "Determination of the load bearing capacity"

The implementation of static plate-bearing tests as an indirect way of testing, can be used to support density tests and for making the first estimation of how successful laying was.

Using the previous correlation of density and bearing capacity based on field and laboratory experiments; static plate-bearing tests can be used as a easily implemented experimental set-up and provide a partial contribution to quality assurance.

# 3 Test field investigations

## 3.1 Determination of the compaction rate

After producing the test field, the water content and the density were determined (2 measurements) using a radiometric probe (isotope probe).
In addition material was taken from the test field and the simple Proctor density and optimal water content determined according to DIN 18137.

The results of the compaction rate determination are summarised as follows:

**Table 2:** Density determinations

| Area | Binder | Dry density [g/cm³] | Compaction rate [%] | Comment |
|---|---|---|---|---|
| 1 | 3% cement + Underbold | 2.029<br>2.007 | 102.7<br>101.6 | |

Detailed investigation results of the density determinations and the Proctor experiment are given in the documents in **Appendices group 1.1**.

## 3.2 Determination of the bearing capacity

The test field bearing capacity with 3% binder-soil mixture was also measured using the static plate-bearing method according to DIN 18134. Testing took place on the 26/05/2011 approx. 1 day after production of the test field.

**Table 3:** Bearing capacity determination

| Area | Binder | Bearing capacity $E_{v2}$ [MN/m²] | Ratio $E_{v1}$ / $E_{v2}$ [-] | Comment |
|---|---|---|---|---|
| 1 | 3% cement + Underbold | 296.1 | 1.69 | |

Detailed investigation results of the bearing capacity determinations are given in the test form in **Appendix group 1.2**.

The test field was visually inspected on the 25/08/2011 for the presence of cracks in the improved layer. There was no recognisable cracking.

| TÜV Rheinland<br>LGA Bautechnik GmbH<br>Tillystraße 2<br>90431 Nürnberg | Plattendruckversuch nach<br>DIN 18134 - 300 | TÜVRheinland®<br>LGA |
|---|---|---|

Projekt: **Probefeld LGA**

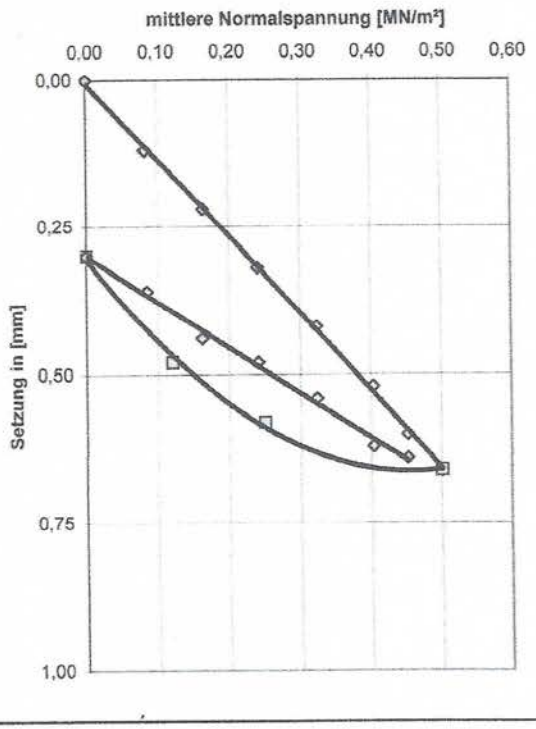
Aktenzeichen: **BBV 1113096**
Bauvorhaben: Probefeld LGA
Witterung:
Messstelle: Feld 1
3% Bindemittel

Prüfebene:

Proben-Nr.: **PDV 1**
ausgeführt am: 26.05.2011
Übersetzung: 1 : 2
Plattenunterlage: Sand
Bodenart:

Prüfer: H. Stapff

| Nr. | Normal spannung [MN/m²] | Messuhr ablesung [mm] | Setzung der Lastplatte [mm] |
|---|---|---|---|
| *** Erstbelastung *** | | | |
| 1 | 0,0000 | 0,00 | 0,00 |
| 2 | 0,0824 | 0,08 | 0,12 |
| 3 | 0,1631 | 0,16 | 0,22 |
| 4 | 0,2406 | 0,25 | 0,32 |
| 5 | 0,3232 | 0,33 | 0,42 |
| 6 | 0,4033 | 0,40 | 0,52 |
| 7 | 0,4521 | 0,45 | 0,60 |
| 8 | 0,5012 | 0,50 | 0,66 |
| *** Entlastung *** | | | |
| 9 | 0,2504 | 0,25 | 0,58 |
| 10 | 0,1201 | 0,12 | 0,48 |
| 11 | 0,0000 | 0,00 | 0,30 |
| *** Zweitbelastung *** | | | |
| 12 | 0,0847 | 0,08 | 0,36 |
| 13 | 0,1622 | 0,16 | 0,44 |
| 14 | 0,2410 | 0,24 | 0,48 |
| 15 | 0,3231 | 0,32 | 0,54 |
| 16 | 0,4034 | 0,41 | 0,62 |
| 17 | 0,4521 | 0,45 | 0,64 |




| Belastung | $S_1$ max [MN/m²] | $a_1$ [mm/(MN/m²)] | $a_2$ [mm/(MN/m²)] | Ev [MN/m²] | $Ev_2 / Ev_1$ |
|---|---|---|---|---|---|
| 1 | 0,50 | 1,155 | 0,228 | 177,32 | 1,67 |
| 2 | 0,45 | 0,789 | -0,059 | 296,12 | |

| *Sollwerte* | | |
|---|---|---|

Bemerkungen:

Dokument: H:\BBBV\Mitarbeiter\Geotechniklabor\Aufträge 2011\1113096_Probefeld LGA\Felduntersuchungen\11-07-04_PDV1_Probefeld.xls

Test report explanatory notes
TÜV Rheinland LGA Bautechnik GmbH

Date 25/08/2011;
Test report no.: BBV113096 / SAP 69627373

# Explanatory notes

## to "4. Laboratory investigations“ of the TÜV Rheinland LGA Bautechnik GmbH test report: Section 4.2 "CBR experiments"

The CBR experiment, being another load bearing test, provides a suitable method for investigating binder-bonded base layers.
Comparative values determined for the bearing capacities match the bearing capacities of hydraulically bonded base layers with higher single axial compressive strengths.

A complete envelopment of the soil grains with **UNDERBOLD®** dispersion makes it possible for the binder matrix to fill out the voids between the grains more effectively and consequently, for the same amount of binder, produce a significantly higher bearing capacity compared to that of a conventional layer with hydraulic binders.

The integrated system flexibility of a soil or mineral mixture coated with **UNDERBOLD®** provides complete crack-free safety.

# 4 Laboratory investigations

## 4.1 Sample preparation and drill core removal

### 4.1.1 Laboratory samples

In order to determine the properties of the cement-Underbold-soil mixture, mixed material was removed in situ from the test field while the test field was being made and 3 test pieces were prepared for CBR testing.

**Table 3:** Sample made in laboratory

| Area | Binder | Designation | Date made - | Comment |
|---|---|---|---|---|
| 1 | 3% cement + Underbold | Sample L1 | 25.05.2011 | for CBR testing |

### 4.1.2 Drill core removal in test field

Three drill cores were also removed from a total depth of 40cm, in order to carry out additional testing of the in situ reacted cement-Underbold-soil mixture.
The drill cores removed for CBR testing are complied in the following table:

**Table 4:** Drill cores from test field

| Area | Binder | Designation | Removal date | Comment |
|---|---|---|---|---|
| 1 | 3% cement + Underbold | Sample 1.1 | 28.07.2011 | |
| | | Sample 1.2 | 28.07.2011 | |
| | | Sample 1.3 | 28.07.2011 | |

## 4.2 CBR tests

CBR - testing is used to determine the relationship between force and depth of penetration when a cylindrical plunger is pressed at a specified penetration speed into a test piece inside a mould.

Testing is carried out according to DIN EN 13286-47 standard on the following laboratory samples and drill cores.
The drill cores were adjusted to fit the CBR test pots and cast in so that a force of adhesion with the test pot existed.

The test pieces that were made in the laboratory were left until testing was carried out and stored in a climatically controlled cabinet.

The CBR test results are complied in the following table:

**Table 6:** CBR test results

| Area | Binder | Designation | Test date | CBR value [%] | | Comment |
|---|---|---|---|---|---|---|
| | | | | 2.5 mm | 5 mm | |
| 1 | 3% cement + Underbold | Sample 1.1 | 28.07.11 | 241.4 | 208.6 | |
| | | Sample 1.2 | 28.07.11 | 285.7 | 360.8 | |
| | | Sample 1.3 | 28.07.11 | 187.1 | 221.1 | |
| Laboratory | 3% cement + Underbold | Sample L1 | 18.08.11 | 1201 | 1137 | |

Records of CBR test results are given in **Appendix 2**.

# 5 Conclusions

## 5.1 Soil compaction

A medium density was attained as follows, for the test field with 3% binder-Underbold-soil mixture, prevalent incorporation conditions and in situ water contents:

| | |
|---|---|
| 3% binder + Underbold | 102.1 % of the simple Proctor density |

Compaction rate requirements are defined for road construction according to each type of section incorporated (e.g. underground, embankment etc) and the grain size distribution of the soil at the start (e.g. clay, sand, etc.).
The Proctor density attainable depends upon the incorporated water content, the amount of binder introduced and other factors.
The compaction rate has an effect on other soil-mechanical properties of the binder-Underbold-soil mixture. In principle, better bearing capacities and compressive strengths are achieved for otherwise similar limiting conditions.

TÜV Rheinland
**LGA Bautechnik GmbH**
Verkehrswegebau

# CBR-Versuch
nach DIN EN 13286-47

TÜVRheinland®
LGA

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Auftrags-Nr.: | 69627373 | |

| | |
|---|---|
| Labor-Nr.: | Probe 1.1 |
| Proben-Bez.: | 3% Bindemittel, Probe 1.1 |
| Prüfer: | H. Gepard |
| Probeneingang: | |
| Prüfdatum: | 28.07.2011 |
| Bemerkung: | Prüfung an Bohrkern aus Probefeld |

## Probendaten

| | | | |
|---|---|---|---|
| Geometrie | Durchmesser ø | [mm] | 151,3 |
| | Höhe | [mm] | 125,4 |
| | Fläche A | [cm²] | 179,79 |
| | Volumen V | [cm³] | 2254,6 |
| | Höhe / Durchmesser H/ø | [-] | 0,8 |
| Wassergehalt | Masse vor Versuch | [g] | 4493,1 |
| | Masse feucht + Tara | [g] | 4354,7 |
| | Masse trocken + Tara | [g] | 4197,4 |
| | Tara | [g] | 186,2 |
| | Masse, feucht | [g] | 4168,5 |
| | Masse, trocken | [g] | 4011,2 |
| | Wassergehalt | [%] | 3,9 |
| | Dichte, feucht | [g/cm³] | 1,993 |
| | Dichte, trocken | [g/cm³] | 1,918 |

## Versuchsdurchführung

| | | |
|---|---|---|
| Versuchsgerät | | |
| Geräte-Nr. | | |
| Vorlast | [N] | 10 |
| Vorschubgeschwindigkeit | [mm/min] | 1,27 |

## Versuchsergebnisse

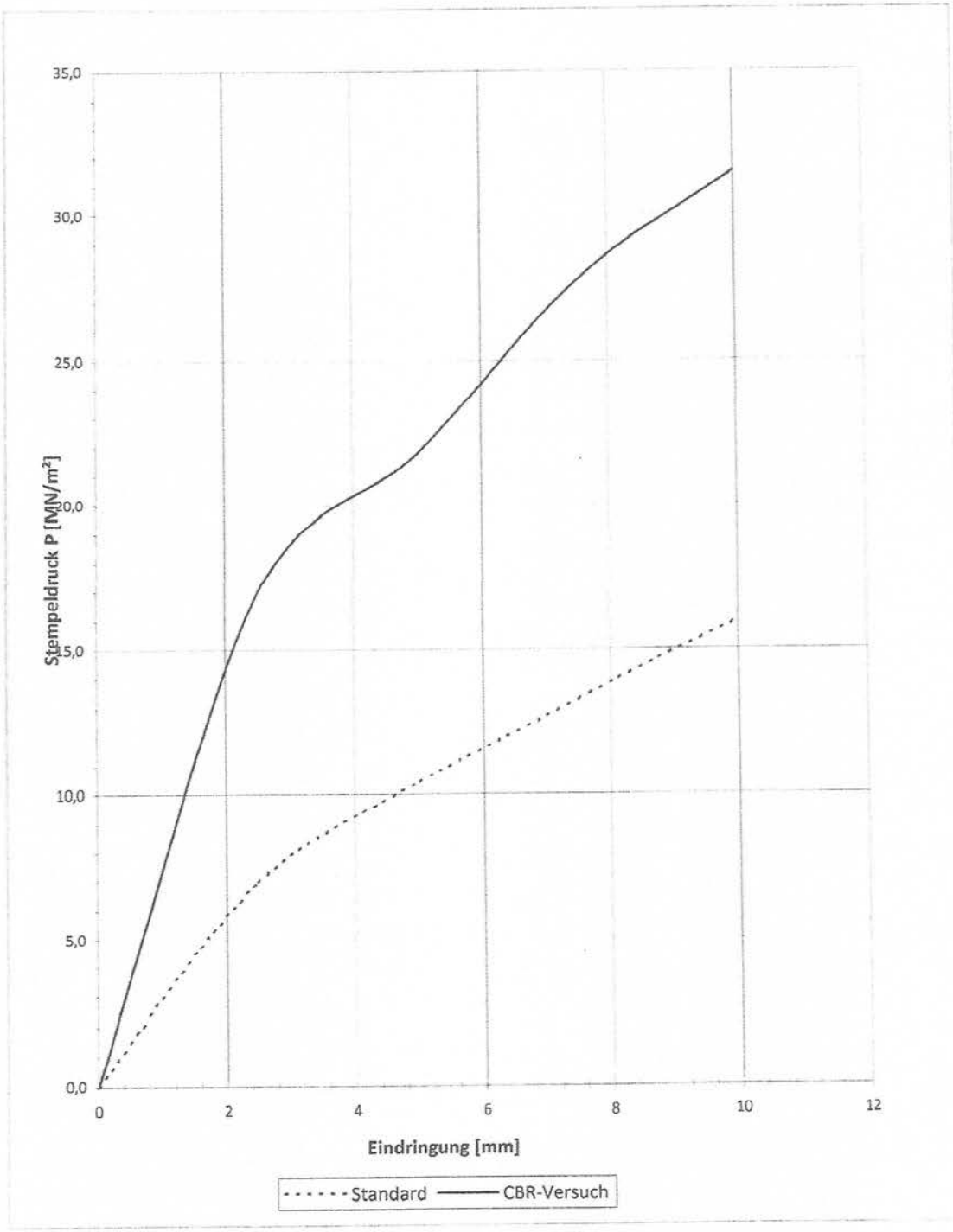
| Versuchs-auswertung | | Standard | CBR-Versuch | |
|---|---|---|---|---|
| | Eindringtiefe | Ps | P | P/Ps*100 |
| | mm | [MN/m²] | [MN/m²] | % |
| | 2,5 | 7,00 | 16,90 | **241,4** |
| | 5 | 10,45 | 21,80 | **208,6** |
| | 7,5 | 13,30 | 27,70 | 208,3 |
| | 10 | 16,00 | 31,50 | 196,9 |
| | | | | |

Bemerkung:

| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach DIN EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Probe.: | Probe 1.1 | |

## Stempeldruck - Eindringung



| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach NF EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Auftrags-Nr.: | 69627373 | |

| | |
|---|---|
| Labor-Nr.: | Probe 1.2 |
| Proben-Bez.: | 3% Bindemittel, Probe 1.2 |
| Prüfer: | H. Gepard |
| Probeneingang: | |
| Prüfdatum: | 28.07.2011 |
| Bemerkung: | Prüfung an Bohrkern aus Probefeld |

## Probendaten

| | | | |
|---|---|---|---|
| Geometrie | Durchmesser ø | [mm] | 151,4 |
| | Höhe | [mm] | 124,5 |
| | Fläche A | [cm²] | 180,03 |
| | Volumen V | [cm³] | 2241,4 |
| | Höhe / Durchmesser H/ø | [-] | 0,8 |

| | | | |
|---|---|---|---|
| Wassergehalt | Masse vor Versuch | [g] | 4593,7 |
| | Masse feucht + Tara | [g] | 4494,7 |
| | Masse trocken + Tara | [g] | 4348,4 |
| | Tara | [g] | 185,7 |
| | Masse, feucht | [g] | 4309,0 |
| | Masse, trocken | [g] | 4162,7 |
| | Wassergehalt | [%] | 3,5 |
| | Dichte, feucht | [g/cm³] | 2,050 |
| | Dichte, trocken | [g/cm³] | 1,980 |

## Versuchsdurchführung

| | | |
|---|---|---|
| Versuchsgerät | | |
| Geräte-Nr. | | |
| Vorlast | [N] | 10 |
| Vorschubgeschwindigkeit | [mm/min] | 1,27 |

## Versuchsergebnisse

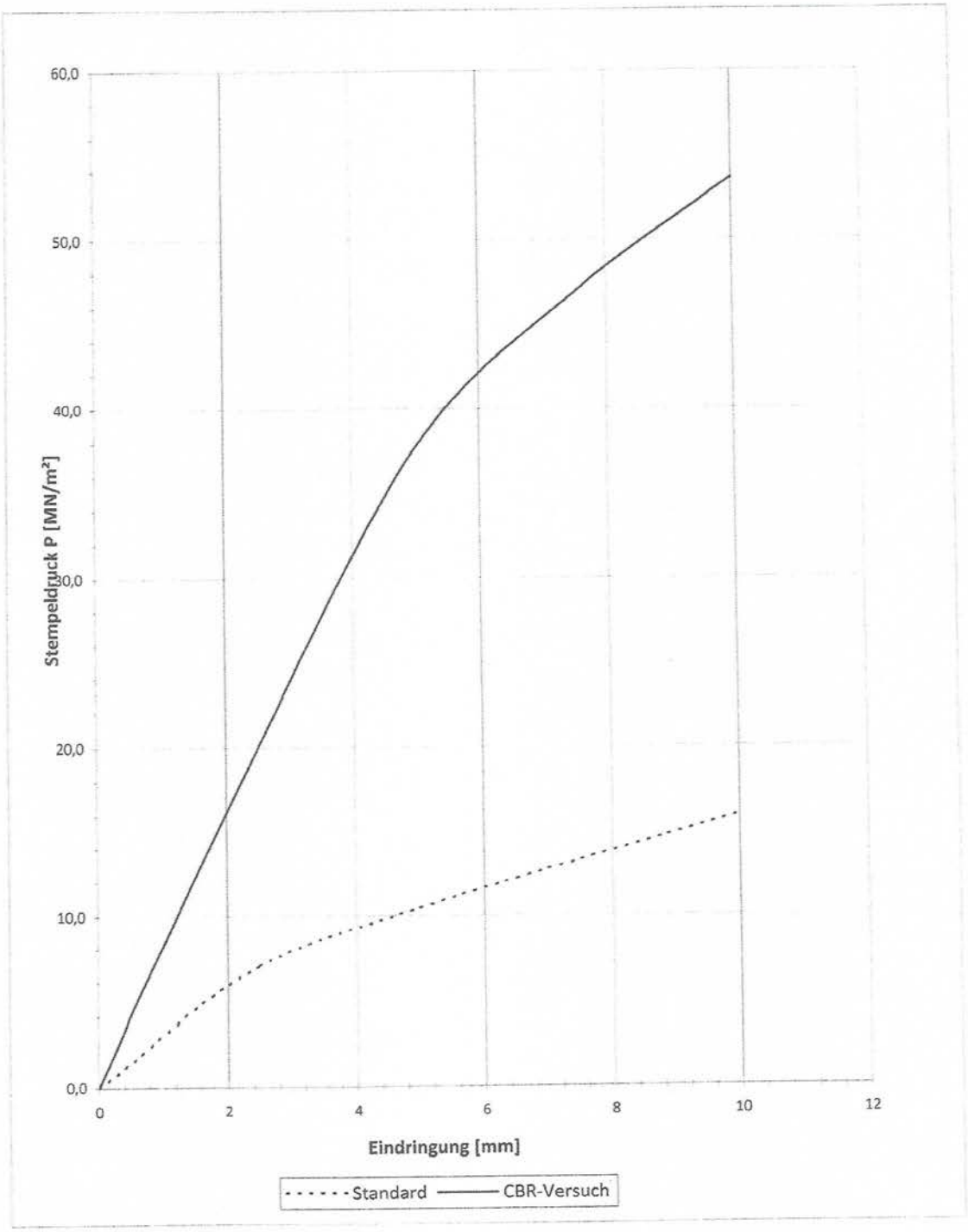
| Versuchs-auswertung | | Standard | CBR-Versuch | |
|---|---|---|---|---|
| | Eindringtiefe | Ps | P | P/Ps*100 |
| | mm | [MN/m²] | [MN/m²] | % |
| | 2,5 | 7,00 | 20,00 | **285,7** |
| | 5 | 10,45 | 37,70 | **360,8** |
| | 7,5 | 13,30 | 46,90 | 352,6 |
| | 10 | 16,00 | 53,60 | 335,0 |
| | | | | |

Bemerkung:

| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach NF EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Probe.: | Probe 1.2 | |

3% Binde Stempeldruck - Eindringung



| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach NF EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Auftrags-Nr.: | 69627373 | |

| | |
|---|---|
| Labor-Nr.: | Probe 1.3 |
| Proben-Bez.: | 3% Bindemittel, Probe 1.3 |
| Prüfer: | H. Gepard |
| Probeneingang: | |
| Prüfdatum: | 28.07.2011 |
| Bemerkung: | Prüfung an Bohrkern aus Probefeld |

## Probendaten

| | | | |
|---|---|---|---|
| Geometrie | Durchmesser ø | [mm] | 151,5 |
| | Höhe | [mm] | 125,4 |
| | Fläche A | [cm²] | 180,27 |
| | Volumen V | [cm³] | 2260,5 |
| | Höhe / Durchmesser H/ø | [-] | 0,8 |
| Wassergehalt | Masse vor Versuch | [g] | 4519,6 |
| | Masse feucht + Tara | [g] | 4395,2 |
| | Masse trocken + Tara | [g] | 4215,8 |
| | Tara | [g] | 185,1 |
| | Masse, feucht | [g] | 4210,1 |
| | Masse, trocken | [g] | 4030,7 |
| | Wassergehalt | [%] | 4,5 |
| | Dichte, feucht | [g/cm³] | 1,999 |
| | Dichte, trocken | [g/cm³] | 1,914 |

## Versuchsdurchführung

| | | |
|---|---|---|
| Versuchsgerät | | |
| Geräte-Nr. | | |
| Vorlast | [N] | 10 |
| Vorschubgeschwindigkeit | [mm/min] | 1,27 |

## Versuchsergebnisse

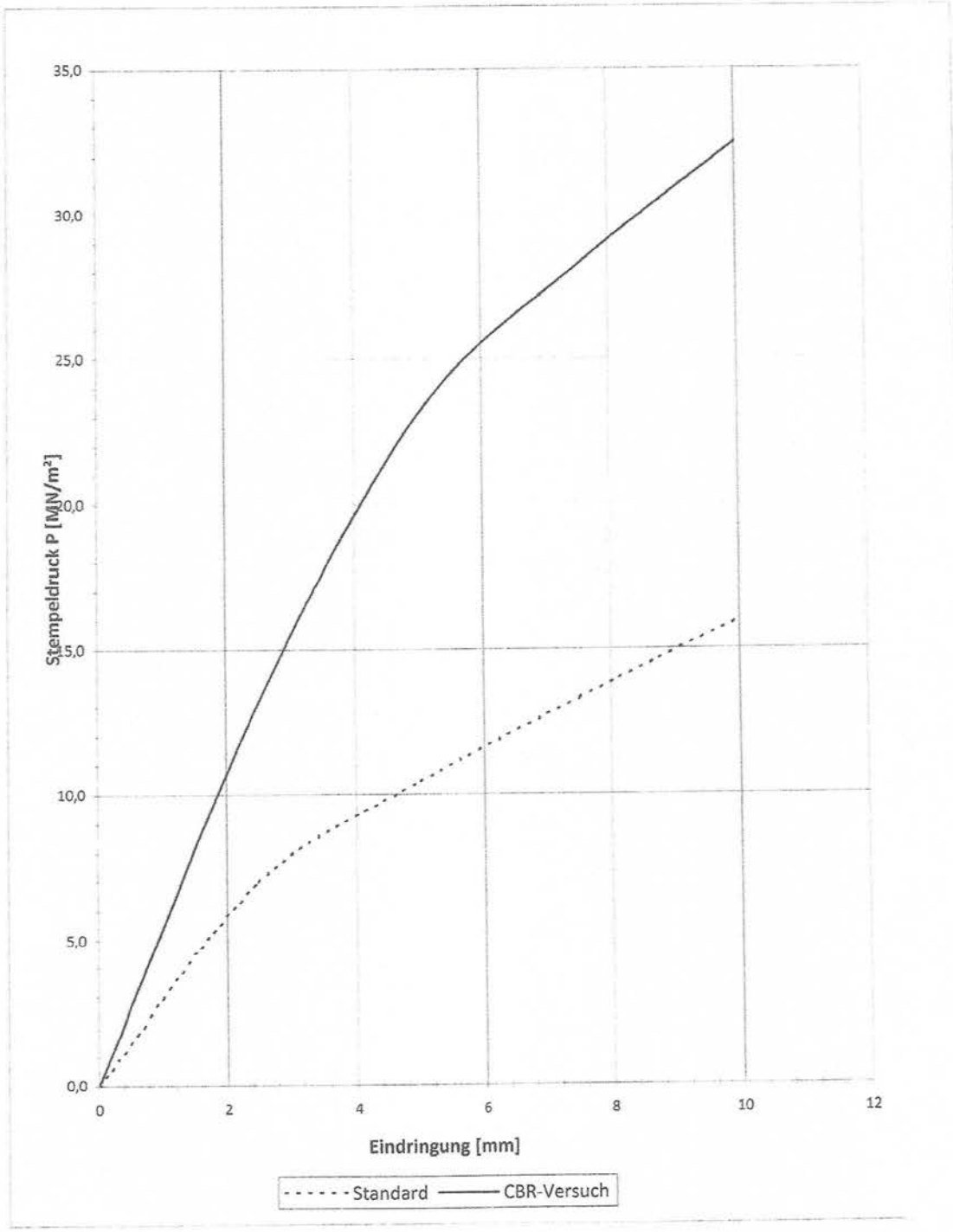
| Versuchs-auswertung | | Standard | CBR-Versuch | |
|---|---|---|---|---|
| | Eindringtiefe | Ps | P | P/Ps*100 |
| | mm | [MN/m²] | [MN/m²] | % |
| | 2,5 | 7,00 | 13,10 | **187,1** |
| | 5 | 10,45 | 23,10 | **221,1** |
| | 7,5 | 13,30 | 28,20 | 212,0 |
| | 10 | 16,00 | 32,50 | 203,1 |
| | | | | |

Bemerkung:

| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach NF EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Probe.: | Probe 1.3 | |

3% Binde Stempeldruck - Eindringung



| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach DIN EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Auftrags-Nr.: | 69627373 | |

| | |
|---|---|
| Labor-Nr.: | Probe L1 |
| Proben-Bez.: | 3% Bindemittel,<br>Laborprobe 1 |
| Prüfer: | H. Gepard |
| Probeneingang: | |
| Prüfdatum: | 18.08.2011 |
| Bemerkung: | Herstellung in Labor |

## Probendaten

| | | | |
|---|---|---|---|
| Geometrie | Durchmesser ø | [mm] | 149,8 |
| | Höhe | [mm] | 125,6 |
| | Fläche A | [cm²] | 176,24 |
| | Volumen V | [cm³] | 2213,6 |
| | Höhe / Durchmesser H/ø | [-] | 0,8 |

| | | | |
|---|---|---|---|
| Wassergehalt | Masse vor Versuch | [g] | 4634,3 |
| | Masse feucht + Tara | [g] | 11768,3 |
| | Masse trocken + Tara | [g] | 11768,3 |
| | Tara | [g] | 7134,0 |
| | Masse, feucht | [g] | 4634,3 |
| | Masse, trocken | [g] | 4634,3 |
| | Wassergehalt | [%] | 0,0 |
| | Dichte, feucht | [g/cm³] | 2,094 |
| | Dichte, trocken | [g/cm³] | 2,094 |

## Versuchsdurchführung

| | | |
|---|---|---|
| Versuchsgerät | | |
| Geräte-Nr. | | |
| Vorlast | [N] | 10 |
| Vorschubgeschwindigkeit | [mm/min] | 1,27 |

## Versuchsergebnisse

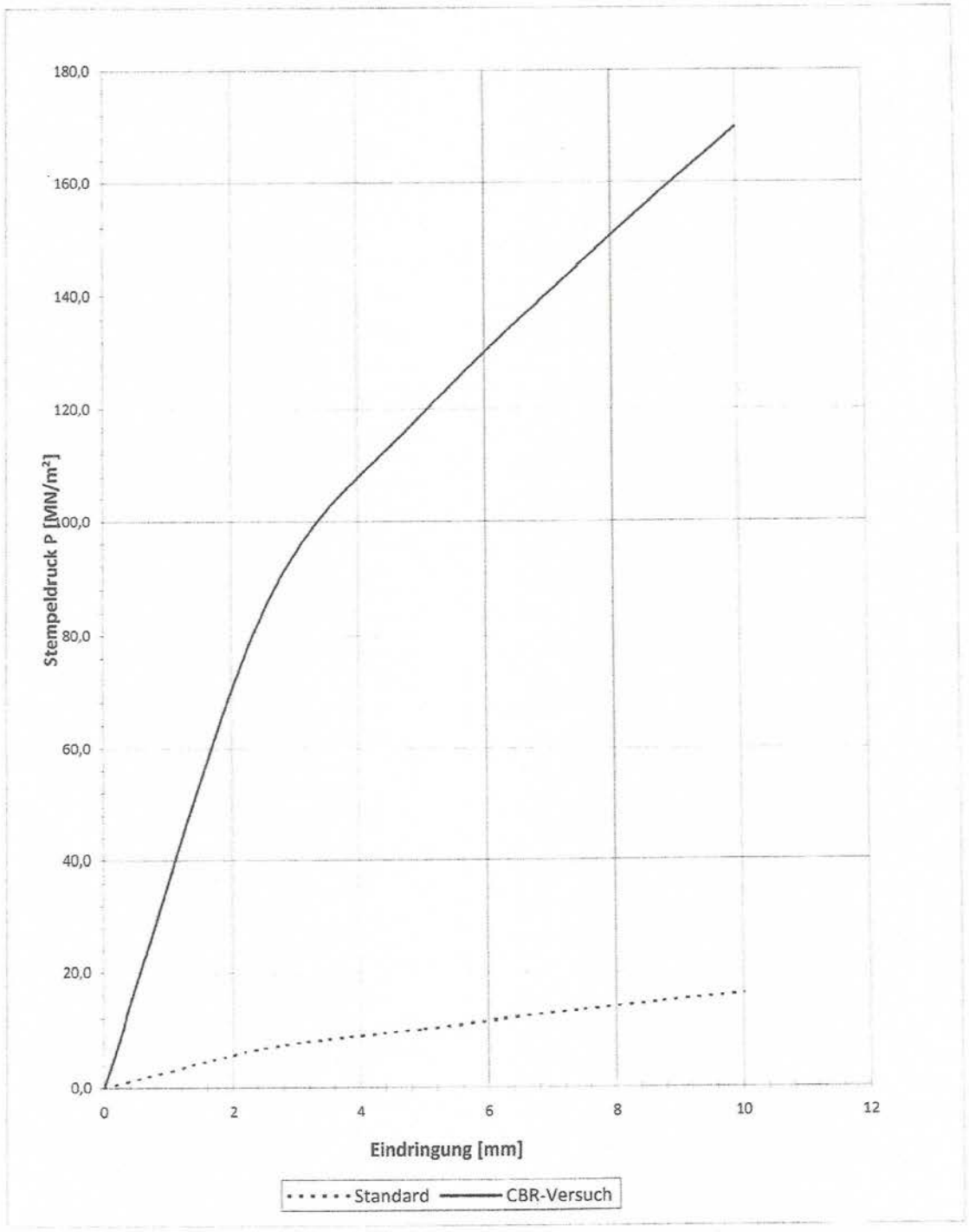
| Versuchs-auswertung | | Standard | CBR-Versuch | |
|---|---|---|---|---|
| | Eindringtiefe | Ps | P | P/Ps*100 |
| | mm | [MN/m²] | [MN/m²] | % |
| | 2,5 | 7,00 | 84,10 | **1201,4** |
| | 5 | 10,45 | 118,80 | **1136,8** |
| | 7,5 | 13,30 | 145,60 | 1094,7 |
| | 10 | 16,00 | 169,80 | 1061,3 |
| | | | | |

Bemerkung:

| TÜV Rheinland<br>**LGA Bautechnik GmbH**<br>Verkehrswegebau | CBR-Versuch<br>nach DIN EN 13286-47 | TÜVRheinland®<br>LGA |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| Projekt: | LGA-Prüffeld | BBVN: | 1113096 | Anlage: |
| Auftraggeber: | Global Underbold System GmbH | Probe.: | Probe L1 | |

3% Binde Stempeldruck - Eindringung



## 5.2 Bearing capacity

The bearing capacity was determined on the test field using the static plate-bearing method. The test was carried out about 1 day after the test field had been constructed. The following bearing capacity was ascertained:

| | |
|---|---|
| 3% binder + Underbold | 296.1 MN/m² |

The higher bearing capacity was due to the effects of the consolidated layer on the plate.

The bearing capacities are much greater than the specifications for unbound layers in road construction. In which case the bearing capacities are up to 180 MN/m² according to RSTO StB 01, e.g. required for roads with heavy traffic.

## 5.3 CBR tests

CBR tests are used to determine an empirical measurement of the soil's strength, the so-called CBR value. The CBR value defines the relationship between the force required to press a plunger into the sample compared to the force needed to achieve the same penetration depth in standard soil.

CBR tests on the drill cores from the test field took place after 64 days. The following average value was obtained for 2.5mm penetration:

| | |
|---|---|
| 3% binder + Underbold | 238% |

The CBR value of the sample made in the laboratory was determined after 85 days. The following CBR value was obtained:

| | |
|---|---|
| 3% binder + Underbold | 1201% |

All CBR values of tests carried out on test field drill cores were much higher than those of the soil standard.

Even higher CBR values were achieved for the sample made in the laboratory. These gave CBR values 1201% of the standard soil for a 2.5mm penetration and a 3% binder + Underbold mixture.

# 6 Concluding remarks

The test report refers to investigations carried out on test field samples having a 3% binder-Underbold-soil mixture; taking place on TÜV Rheinland LGA Bautechnik GmbH's site.

Please do not hesitate to contact us if you have any questions concerning the factual content.

TÜV Rheinland LGA Bautechnik GmbH
Verkehrswegebau (traffic route construction)

Dipl.-Ing.(FH) Dieter Straußberger
Head of department "Verkehrswegebau"

Dipl.-Ing.(FH) Ernst Stapff
Expert