INNOVATIVE INFRASTRUCTURE

Create and maintain traffic routes

HEIDELBERGCEMENT

INNOVATIVE INFRASTRUCTURE

Quick and sustainable:

New solutions for traffic route construction

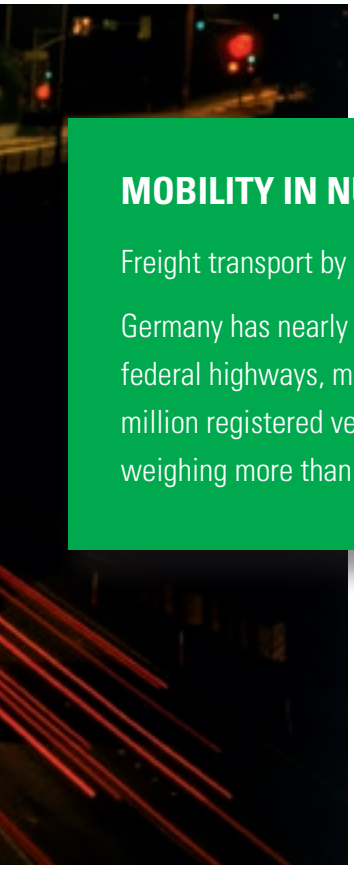
We are more mobile than ever. Our radius of action has expanded radically thanks to modern modes of transport. Workplaces many kilometres from home, shopping centres far outside of town, city breaks on the weekend: this all seems self-evident today and forms part of our quality of life.

However, mobility not only gives us additional freedoms, but also creates problems and new challenges. As a result, the expansion and development of traffic infrastructure is one of the most important tasks of our time. It requires carefully considered solutions. HeidelbergCement meets these challenges and continuously works on complex tasks in all areas of infrastructure.

This brochure aims to provide an overview of the different areas of application in the field of traffic infrastructure and to present HeidelbergCement's corresponding products and services. In addition to our innovative building materials, we can support your construction projects with our expertise in quality assurance, in the selection of suitable building materials and construction methods as well as their development and implementation.

To ensure durability and traffic safety, various standards, regulations and instructions must be observed for the building materials used. An overview of essential standards and regulations of the different fields of application can be found at the end of this brochure. Relevant information on products, further information and contact persons can be found in the green box in the corresponding chapters.

HeidelbergCement and Heidelberger Beton are partners who can provide you with appropriate building materials, services and advice with expertise and know-how as well as assisting you in providing solutions.



MOBILITY IN NUMBERS*

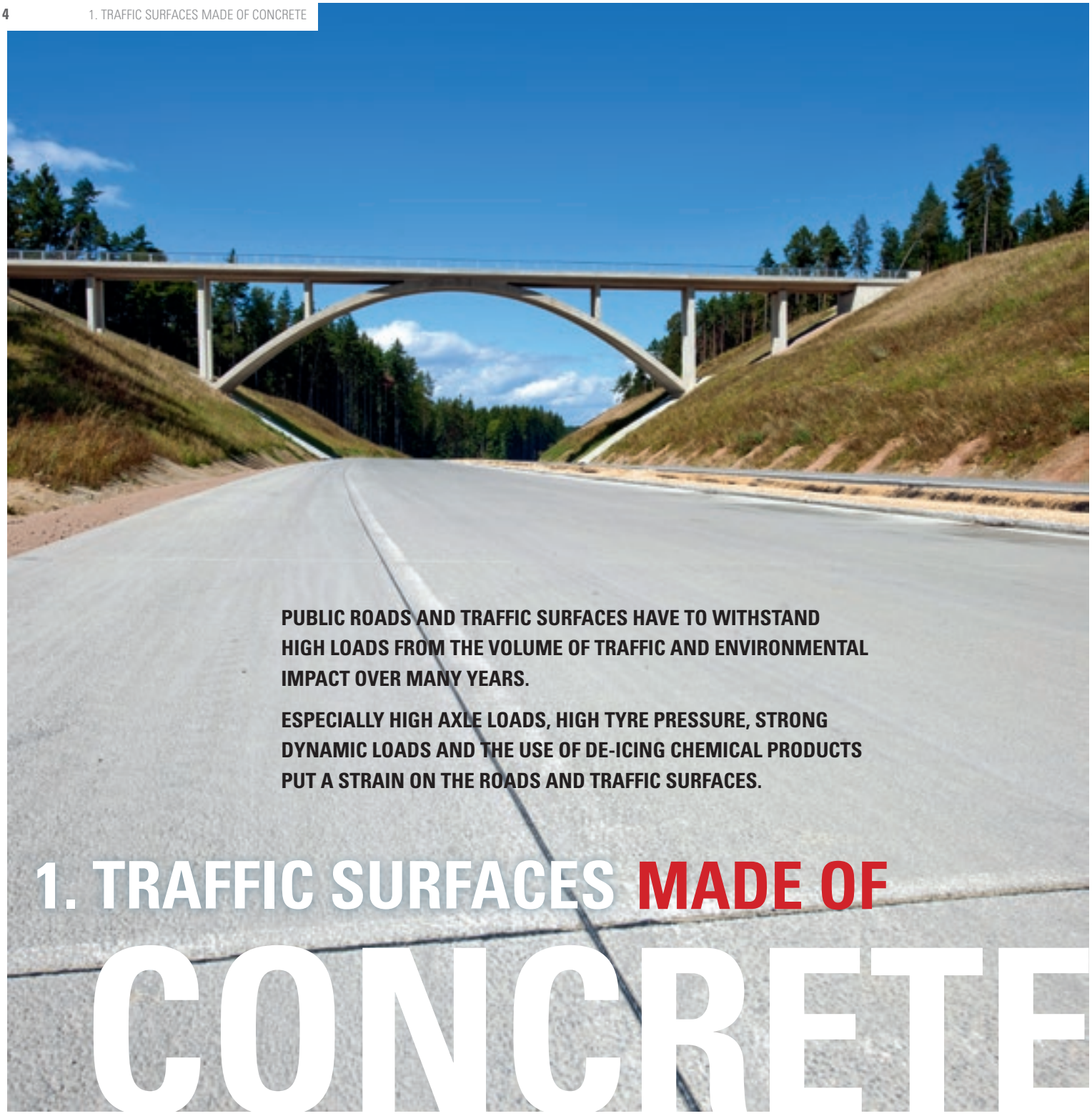
Freight transport by road will increase by more than 80 per cent by 2050.

Germany has nearly 13,000 kilometres of motorways as well as about 40,000 kilometres of federal highways, making it Europe's densest highway network. There are approximately 53 million registered vehicles in Germany, including around 9.1 million trucks and buses weighing more than 3.5 tonnes.

* Sources:

Heinrich Böll-Stiftung, 2012
Statistisches Bundesamt, 2014
(Federal Office for Statistics)

CONTENTS



PUBLIC ROADS AND TRAFFIC SURFACES HAVE TO WITHSTAND HIGH LOADS FROM THE VOLUME OF TRAFFIC AND ENVIRONMENTAL IMPACT OVER MANY YEARS.

ESPECIALLY HIGH AXLE LOADS, HIGH TYRE PRESSURE, STRONG DYNAMIC LOADS AND THE USE OF DE-ICING CHEMICAL PRODUCTS PUT A STRAIN ON THE ROADS AND TRAFFIC SURFACES.

1. TRAFFIC SURFACES MADE OF CONCRETE

Due to its many advantages, concrete has proven to be an ideal building material under these circumstances. Modern installation methods, special types of cements and concretes guarantee a long service life and economic efficiency.

The use of low-CO_2 composite cements or the TioCem special cement makes it possible to produce photocatalytically active traffic surfaces for air pollution control.

There are many advantages to the production of concrete surfaces in the traffic route construction

- Better load distribution across the plates
- High load capacity even with high axle loads
- Permanent resistance to deformation under all weather conditions
- Durable grip across the entire period of use
- Bright surface and thus safe for traffic in dark and wet conditions
- Favourable climatic influence due to the bright surface, particularly in urban settlements. It is possible to lower the temperature by approx. 2 to 3°C
- Significant noise reduction with appropriate surface texturing (e.g. exposed aggregate concrete, grinding)
- 100% recyclable and reusable after the period of use

↓ Repairs to roads, which must be quickly reopened for traffic can be easily carried out with quick-setting concrete.

Aesthetic and sophisticated bridge constructions such as the Oelzetal bridge on the new DB railway line from Ebensfeld to Erfurt can be reliably and durably realised with high-quality transport concretes. →

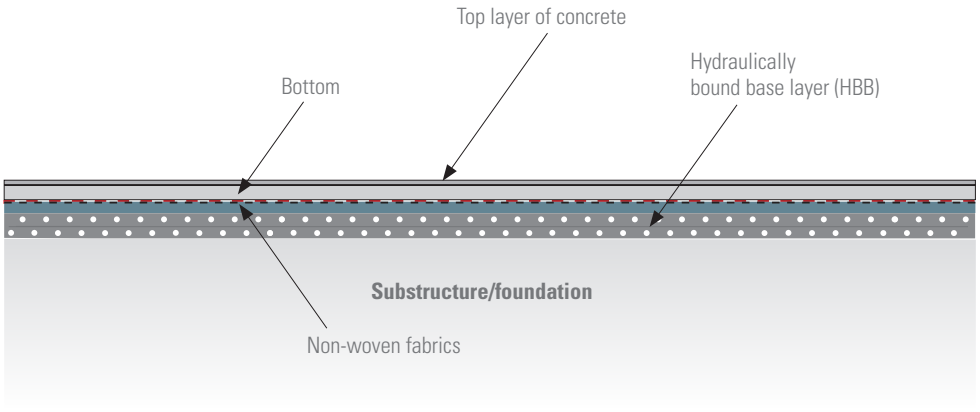
1.1. Roads

The following chapter shows the structure of a road in more detail as well as presenting features of specific traffic surfaces and innovations in this area.

Depending on the features of the road, there are special requirements for the building materials and building material mixtures to be used. HeidelbergCement offers specially developed building materials for each of these areas, decades of experience in this field as well as specialist know-how and is, therefore, the partner you need for the successful realisation of your construction project.

ROAD SURFACES MADE OF CONCRETE

Example cross-section of a concrete road with two-layered construction



The construction of a road or traffic surface is divided into the superstructure, substructure and foundation structure. The superstructure can consist of:

- Concrete surface
- Base layers with hydraulic binding agents
- Layers without binding agents

The thickness of the frost-resistant superstructure for roads both inside and outside closed urban areas is usually dimensioned according to the guidelines for the standardisation of the superstructure of traffic surfaces (RStO).

A concrete road surface rests on the base layer or a suitable surface and completes the superstructure, which is directly affected by traffic. In the standard construction method, a non-woven fabric is placed between the support layer and the concrete surface with hydraulic binding agents to avoid cracks in the concrete surface and the erosion of the base layer. The surface is produced unreinforced, with one or two layers. The top layer is called the top concrete layer, and the bottom layer is the bottom concrete layer. Each layer can be built in one or more layers.

Multi-layer surfaces are made of the same concrete composition, which is installed in several layers.

Two-layered surfaces consist of two layers of concrete made of a different composition (e.g. exposed aggregate concrete construction).

→ For more information, visit www.heidelberger-beton.de

Minimum concrete requirements*

Load class:	Bk100 – Bk3.2
Compression strength class:	C30/37
Bending tensile strength class:	F4.5
Exposure class:	Top layer of concrete XF4, XM2
	Bottom layer of concrete XF4
Humidity class:	WS
Cement composition:	Bottom layer of concrete: ≥ 340 kg/m³ Top layer of concrete: ≥ 420 kg/m³
w/b ratio:	≤ 0.45

* according to TL Beton-StB, DIN EN 206/DIN 1045-2

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

Our product recommendations:

ROAD SURFACE CEMENT AND CONCRETE

See applications and standards pp. 34 – 35

Detailed view of exposed aggregate concrete surface ↓

DEPENDING ON TEXTURING PROCEDURES, GRIP AND DRIVING COMFORT CAN BE INCREASED AND TYRE NOISE REDUCED.

Manufacture of the exposed aggregate concrete surface by brushing ↑

CONCRETE SURFACE

Today, the installation of concrete surfaces is usually done with slip-form concrete finishers, which have achieved a very high degree of automation due to continuous further development. Installation widths of up to 16 m are possible without issue. Vibrating and levelling screeds, which can be mechanically or manually guided, are used for smaller surfaces.

To increase the transverse force transmission and secure the elevation of the plates, the transverse joints are usually dowelled while the longitudinal joints are anchored. This also prevents the plates from moving apart, the opening of joints and the penetration of dirt and water. Vertical forces are transmitted with the anchors, which is particularly important in longitudinal compression joints, in which the crack interlocking is missing.

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Are you looking for a low-noise and non-slip road?

www.heidelberger-beton.de/grinding

Dowelled transverse press joint (day joint) →

Concrete surface with cut transverse and longitudinal joints

Texture and surface

The desired texture is produced (e.g. exposed aggregate concrete, transverse broom finish) immediately upon surface completion. The most commonly performed texture is the exposed aggregate concrete surface. After completing the concrete surface, a surface retarder is sprayed to slow down hardening in the upper peripheral zone of the concrete for a limited time to a defined depth (0.6-1.2 mm).

This allows the subsequent removal of the surface mortar through mechanical brushing. The time of brushing essentially depends on the prevailing weather conditions, the type of cement used and the type of surface retarder used.

Secondary treatment

CONCRETE IS A ROBUST CONSTRUCTION MATERIAL, BUT MUST BE PROTECTED FROM ENVIRONMENTAL INFLUENCES AND EXTERNAL DAMAGE EARLY ON

Immediate, careful and sufficiently long secondary treatment is essential for the concrete to reach the required quality and durability.

The concrete surface is divided into plates by joints. This division prevents the uncontrolled formation of cracks as well as allowing for the natural length change of the concrete through cooling and heating.

Manufacture of the hydraulic binding agents

1.1. Roads

BASE LAYERS WITH HYDRAULIC BINDING AGENTS

Base layers are the lower part of the superstructure. They are between the surface and the foundation or substructure. A distinction is made depending on the type and composition:

- Solidification
- Hydraulically bound base layer (HBB)
- Concrete base layer
- Pervacrete – Drain concrete layers → Only used in special cases

Solidification

According to DIN 18196, almost all soil groups as well as other comparable materials or minerals, such as e.g. pre-screen material, industrial ash and slag are usable for solidification, provided no hardening substances are included.

Hardening can increase the resistance of unbonded base layers, making the surface permanently load-bearing and frost-resistant. For this, the ground and/or building material mixtures types of cements, hydraulic ground and base layer binding agents or Multicrete are mixed with water. The incorporation mixture is subsequently compacted.

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

Our product recommendations:

HYDRAULIC BASE LAYER BINDING AGENT, MULTICRETE, RECYCLING BINDING AGENT®, PERVACRETE

See applications and standards pp. 34 – 35

BASE LAYERS FORM THE FOUNDATION OF LONG SERVICE LIFE ROAD SURFACES BY PROVIDING A TARGETED DISTRIBUTION OF THE STATIC AND DYNAMIC FORCES IN THE SUBSTRUCTURE AND FOUNDATION LAYERS AS WELL AS PERMANENT SURFACE SUPPORT CONDITIONS. FOR THIS, THE LAYERS MUST BE FLAT, LOAD-BEARING, PROFILE-RELATED, FREEZE-RESISTANT AND EROSION RESISTANT.

Hydraulically bound base layer (HBB)

HBBs consist of unbroken or crushed aggregate mixtures and hydraulic binding agents (e.g. cement, base layer binding agents). HBBs can only be produced in a mixing plant. Transport to the construction site takes place on open truck troughs. The HGT is usually built in with a finisher.

↑ Construction of the HBB with a slipform finisher

Concrete base layer

Concrete layers are concrete base layers manufactured according to DIN EN 206 and DIN 1045-2. The requirements for concrete base layers are regulated in ZTV Beton-StB and TL Beton-StB.

Pervacrete – drain concrete base layer (DCB)

Drain concrete base layers are base layers with hydraulic binding agents that deviate from the requirements of TL Beton-StB. They consist of a porous lightweight aggregate mixture, to which only enough mortar is added to completely cover the aggregates and cement them together in a point-shaped manner.

The cavities between the particles must not be filled by the mortar after compaction. The aggregate porosity is achieved by using grading curves with gap grading or low sand content. The manufacture of drain concrete base layers takes place according to the M DCB.

Secondary treatment

In general, all base layers must be treated with hydraulic binding agents. This significantly influences durability. The secondary treatment can be omitted if covering takes place through another layer immediately after manufacture. Base layers with hydraulic binding agents must be kept constantly moist for a period of at least three days. The application of a water-retaining cover (e.g. nonwoven or burlap cloth) is well suited for this.

1.1. Roads

SPECIAL FEATURES – URBAN AND RURAL ROADS

Concrete traffic surfaces have proven themselves over the past few years and are economically convincing. The proportion of federal highways that currently have concrete surfaces is around 30%, with a strong upward trend. But concrete is also becoming increasingly important as a very durable building material in the area of urban and rural roads.

Frequent deformations, ruts and heavy wear in previous construction methods lead to massive problems in traffic safety as well as to high repair costs and traffic problems due to necessary repair measures. Concrete, on the other hand, is resistant to deformation, stable, low-maintenance and therefore ideally suited for heavily used urban and rural roads.

ZOB Detmold (central bus station) ↓

↑ Access road, cement factory Geseke

In addition to the properties described in the previous sections, the following special features must be taken into consideration for urban and rural roads:

- Predominantly closed drainage systems
- Constraint points and the resulting low gradients
- The design aspects of the street space (colour, surface texture)

The following special features must be considered when building rural roads:

- The consideration of the predominantly used open drainage systems
- Dynamic driving routing and the associated different transverse inclinations and transverse tilt changes
- Influence of marking on the joint pattern and therefore on the dimensioning plate geometry

→ SEE APPLICATIONS AND STANDARDS P. 34 – 35

i

More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

Our product recommendations:

TIOCEM® – photocatalytic cement FIBRE CONCRETE

COLOURED CONCRETE

AIRCRETE® – Air-entrained concrete

1.2. Special traffic surfaces

The federal government, the counties, districts, towns and municipalities have a large number of roundabouts, car parks, service stations, bus traffic areas as well as cycle paths and footpaths. These special types of infrastructure are always subject to increasing static and dynamic loads. The focus is increasingly on concrete construction and its advantages in these particular areas. With its high resistance to deformation and its high load-bearing capacity, concrete has great benefits, especially in the field of lane traffic and areas with high shear loads as well as parking areas. Considering the service life and the low maintenance expenditure, concrete construction is an interesting and above all economic alternative for public and private builders.

Concrete surfaces can be easily manufactured with an individually coloured concrete or another texturing for the visual design of various traffic areas.

→ **www.heidelberger-beton.de/farbbeton**

This chapter builds on chapter „1.1. Roads", focusing on the characteristics of these traffic surfaces and the advantages of concrete construction. HeidelbergCement supports you with expert advice in planning and implementing these special traffic surfaces. In addition, the supply and quality assurance of the building materials and remarkable products can be guaranteed for your project.

→ **www.heidelberger-beton.de/beratung**
→ **www.heidelberger-beton/qualitätssicherung**

Fact sheets with working aids for these special areas of application were created by the Road and Transport Research Association (Forschungsgesellschaft für Straßen- und Verkehrswesen e. V. (FGSV)), with the active participation of HeidelbergCement.

CONCRETE ADVICE FOR THE DESIGN AND IMPLEMENTATION OF THESE SPECIAL TRAFFIC SURFACES MADE OF CONCRETE IS PROVIDED IN THE FACT SHEET, BASED ON THE REGULATIONS OF THE ZTV AND TL BETON-STB.

↑ Concrete roundabout, Ulm-Langenau, BAB A8 – AS Ulm-Ost

1.2. Special traffic surfaces

ROUNDABOUTS

Important intersections are increasingly planned or redesigned as roundabouts. They provide higher traffic safety, high performance and durability.

Due to lower vehicle speeds and better visibility in the roundabout compared to signal-controlled intersections, there are a reduced number of traffic accidents. Also, there are no costs for purchasing and maintaining traffic light systems.

Roundabouts are subject to the following demands:

- High thrust and centrifugal forces due to driving in tight bend radii combined with a wheel pressure increase
- Lane traffic with a correspondingly high crossing frequency
- Strong shear load caused by braking and acceleration at the access and exit points

Due to concrete's high stability and abrasion resistance and its temperature-independent load-bearing effect, it is the ideal building material for meeting these demands. For this reason, more and more constructors and planners are choosing to build a modern concrete roundabout.

The construction of a roundabout requires careful planning. The structure and the surface thickness must be sized according to the local conditions and planning specifications (e.g. RStO, Table 2). Due to the unique demands, the next higher RStO load class must be provided for roundabouts per the M VaB, Part 1.

→ **TIP**
he film "Concrete roundabout in Werneck" can be found at:
www.beton.org (in German)
Keyword: Concrete roundabout

THE ELEMENTS OF ROUNDABOUT TRAFFIC:

- **CENTRAL ROUNDABOUT ISLAND**
- **ROUNDABOUT TRAFFIC LANE**
- **INNER RING**
- **ACCESS ROADS AND EXITS**

← Concrete roundabout, Werneck, in the network area of AS BAB A70, A 7 and A 71

← Betonkreisel, Ulm-Langenau, BAB A8 – AS Ulm-Ost

ZOB Detmold (central bus station)

BUS TRAFFIC SURFACES

Bus stops, bus lanes and bus stations face particular stress due to the concentrated traffic in tight bus lanes. The roadways are subject to high static, dynamic and thermal loads, particularly with low-floor vehicles. This is due to the increasing axle loads and tyre contact pressures due to smaller tyre dimensions, in particular during the stopping and acceleration processes, as well as due to the partially slow and stationary traffic.

In addition, bus stops and bus stations are often exposed to pollution from mineral oils, lubricants and fuels from buses.

Detailed view ZOB Detmold →

Concrete's resistance to deformation, durability and its oil and fuel resistance give concrete construction the advantage. Maintenance is significantly reduced, which is an advantage for the public transport operating process as well as saving on operating costs.

ZOB Detmold with photocatalytically active TioCem concrete

For the dimensioning of bus traffic surfaces, information on the corresponding load classes or the required surface thicknesses is given in the RStO and additionally in the M VaB Part 1.

ARE YOU IN A HURRY? The perfect solution – quick concrete Chronocrete from Heidelberger Beton

→ **www.heidelberger-beton.de/chronocrete** or P. 25

→ **SEE APPLICATIONS AND STANDARDS PP. 34 – 35**

1.2. Special traffic surfaces

SERVICE STATIONS

Parking and service station facilities are subject to certain demands such as

- Tight corners
- Frequent braking and accelerating
- Pollution from mineral oils, lubricants and fuels

Due to the heavy traffic and the special demands mentioned, not only the parking areas but also the access roads, passages, driving lanes and exits should be constructed using concrete.

For the dimensioning of service station concrete surfaces, information on the corresponding load classes or the required surface thicknesses to is given in the RStO and additionally in the M VaB Part 1.

Service station Riedener Wald

SERVICE STATIONS

→ TABLE APPLICATIONS AND STANDARDS PP. 34 – 35

TODAY, ROADS CARRY THE MAIN LOAD OF GOODS AND PASSENGER TRANSPORT. ACCORDING TO THE MOST RECENT FORECASTS, ROAD TRANSPORT AND IN PARTICULAR GOODS TRANSPORT WILL CONTINUE TO INCREASE IN THE NEXT YEARS. EFFICIENT TRAFFIC ROUTES ARE REQUIRED FOR THIS. ITS REALISATION REQUIRES DIRECT AND CAREFULLY CONSIDERED SOLUTIONS.

1.3. Innovation and further development

HeidelbergCement took on the task of innovation and development a long time ago and is continually researching the development of future types of cement, concretes and products with its development department. A commitment to innovation makes HeidelbergCement your ideal partner for demanding construction projects in the field of infrastructure. The following pages show innovative solutions that are sustainable and trend-setting from both an ecological and economic point of view.

CONTINUOUSLY REINFORCED CONCRETE ROAD SURFACE

The standard construction of concrete road surfaces does not provide any reinforcement and is divided into plates by transverse and longitudinal joints.

In continuously reinforced concrete surfaces without joints, however, a longitudinal reinforcement made of ribbed reinforcing bars is used. Its purpose is to distribute the transverse cracks which occur in a free formation as evenly as possible in the longitudinal direction of the road and limit the crack width to a maximum of 0.5 mm.

Due to this crack, width seals can be avoided. Together with the dowel effect of the longitudinal reinforcement in the crack, good crack interlocking and a high transverse force transmission can be achieved in the crack edge region. Experience also shows more favourable bearing behaviour than in the unreinforced construction, whereby the thickness of the concrete surface can be reduced by 10 to 20%. The continuously reinforced concrete surface can be used to produce roads which take high-loads, are road-safe, long-lasting and low-maintenance.

In 2009, HeidelbergCement used the construction of a new approx. one-kilometre-long development road between the Elsa and Milke cement plants in Geseke as an opportunity to test the reinforced concrete surface with high-load traffic. This practical example demonstrates the potential of this method of construction and the innovative of HeidelbergCement.

↓ Access road, Geseke

Noise reduction during track construction.
Bebenroth tunnel,
Railway route Göttingen-Eichenberg-Bebra

1.3. Innovation and further development

PERVACRETE – THE OPEN-PORE CONCRETE

Pervacrete is a porous concrete, including drain concrete base layers and surface courses and open-pore concretes, with a cavity volume of 15% to 25%. The aggregate material pores result from the exclusive use of a particle size group, e.g. 5/8 mm with a good, cubic particle shape, whereby the single particles are only cemented together at the contact points by a thin layer of cement paste.

A surface-accessible cavity content results in a reduction of the sound pressure level through absorption and the discharge of air between the road surface and the tyres. As a result, the tyre-on-road noise is greatly reduced, positively lowering the frequency of the rolling noise for human hearing.

Pervacrete is therefore primarily used as a thin functional layer (7-8 cm) for noise reduction on a dense concrete base. Bonding is ensured by a high-quality polymer/cement-based bonding agent.

The cavity-rich concrete is also used for drainage in road, civil and hydraulic engineering. Due to the high cavity content, water is removed from the road very quickly, significantly reducing aquaplaning and spray mist.

Advantages of open-pore concrete construction:

- High sound absorption
- Reduction of the sound pressure level above 5 dB(A)
- High road safety on dry and wet roads
- Minimised aquaplaning
- No spraying
- Increased grip
- Favourable reflection properties due to the bright surface
- Excellent driving dynamics with high driving comfort
- Strain of sewers/sewage treatment plants relieved
- Reduction of flood risk
- Increased groundwater formation
- Improvement of the micro-climate due to natural evaporation

INTERESTED IN PERVACRETE?
→ **www.heidelberger-beton.de/pervacrete**

Verge concrete construction →
with the offset slipform finisher,
BAB A61 AS Gundersheim – AK Alzey.

HEIDELBERGER BANKETTBETON

Verges form the lateral end of the lane on most non-urban roads and thus connect directly to the edge strip or hard shoulder of the road. On narrow streets, it is often impossible to pass oncoming traffic without driving on the verges. An unsurfaced or poorly constructed verge presents a considerable accident and safety risk for the road users in the event of emergency driving. In addition to broadening, a major advantage over other verge surfaces is the high water permeability of the load-bearing layer with a cavity volume of 18% +/- 3%.

The areas of application are narrow local roads, county, state and national roads as well as motorway construction sites with narrow hard shoulders. Rural paths (e.g. agricultural and forestry routes) can also be sustainably surfaced. Due to its water permeability, hard shoulder concrete is also suitable for the surfacing of embankments.

HEIDELBERGER DAS ORIGINAL BANKETTBETON

Overview of the advantages of verge concrete:

- Ecological and economical construction
- Individual construction thickness and width according to traffic requirements
- Good strength properties with high durability even with temporary heavy traffic loads
- Effective protection of road edges against breakages
- High permeability due to good drainage effect
- Maintenance of the speed level as the road is not visually widened
- Reduction of the risk of accidents in verge driving due to evasive manoeuvres on narrow streets and the resulting personal, vehicle and road damage
- Secure construction of reflector posts and fixtures (e.g. drains, manholes) possible in the verge surface
- Sustainable and resource-saving (recyclable)
- Complete revegetation possible
- Safe, faster, long-lasting and economical problem solver for municipalities and road authorities

Heidelberger Beton offers a special open-pore concrete for verges, which has proven itself for years in the Netherlands and elsewhere. This innovative building material can be built in quickly, cleanly and in variable heights, widths and even qualities with a slipform offset finisher or verge finisher.

Minimum concrete requirements*

Compression strength class:	C30/37
Exposure class:	XC4, XD3, XF4
Humidity class:	WA (DAfStb regulation "Alkali reaction in the concrete")
Cement composition:	min. 320 kg/m³
w/b ratio:	≤ 0.45
Concrete monitoring:	Monitoring class 1 1

* according to ZTV FRS, TL BSWF, DIN EN 206/DIN 1045-2

2. CONCRETE PROTECTION WALLS

Restraint systems or so-called concrete protection walls along roads can reliably prevent vehicles from deviating off the road. As a result, they provide all road users with the optimal active and passive protection in the event of accidents and dangerous situations.

Due to their high rigidity, straight concrete protection walls have a very high penetration resistance. Vehicles deviating off the road are stopped and diverted without breaking the wall. Concrete protection walls can be made of in-situ concrete (BSWO) or prefabricated concrete components (BSWF). Heidelberger Beton's Aircrete, the special concrete with micro-hollow balls, is particularly suitable for the purposeful production of robust protection walls with a high freeze-thaw resistance.

→ **www.heidelberger-beton.de/aircrete**

The construction of vehicle restraint systems is regulated in the „Additional Technical Terms of Contract and Vehicle Restraint System Guidelines“ (ZTV FRS).

The basis for the use of vehicle restraint systems is DIN EN 1317 „Road Restraint Systems“ (FRS). In accordance with these regulations, concrete protection walls are manufactured and installed according to performance class requirements in various dimensions and profiles (e.g. New Jersey profile, step profile).

The „Guidelines for passive protection on roads through vehicle restraint systems“ (RPS) regulate the performance characteristics of the FRS required in each case.

The type of concrete protection wall depends on:

- Area of application (roadside, central strip, buildings, danger spots)
- Permissible maximum speed
- Volume of traffic (DTV-SV)
- Likelihood of vehicle deviation

Various tested in-situ concrete systems or prefabricated components are available on the market.

→ Advantages of concrete protection walls:

- Controlled stopping and diverting of approaching vehicles
- High breakthrough security with minimum space requirement
- Long service life
- Low maintenance and repair costs (e.g. no repair in light impact events)
- Low maintenance costs
- Better visibility in the dark due to reflectors
- Optimal glare protection

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

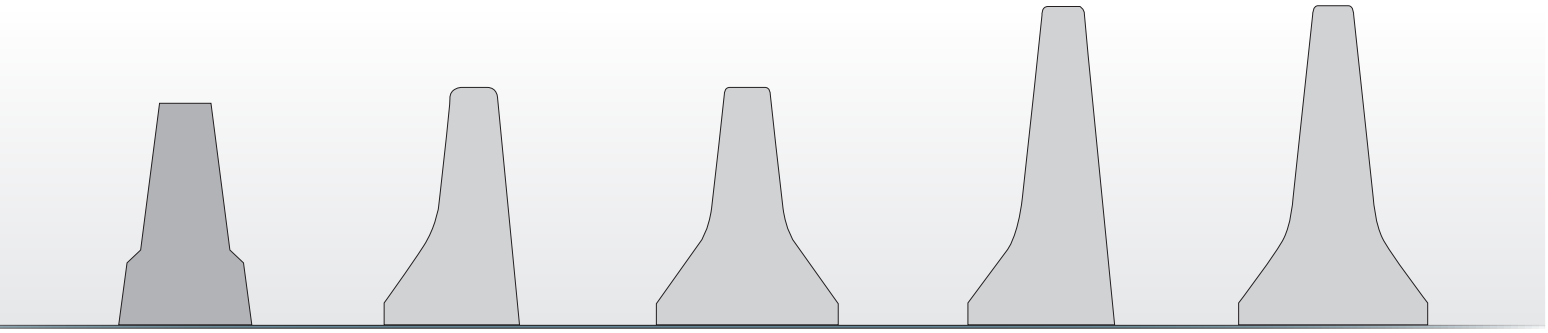
Our product recommendations:

AIRCRETE® – Air-entrained concrete

See applications and standards pp. 34 – 35

Profile overview concrete protection walls

STEP-PROFILE | NEW JERSEY-PROFILE



Double-sided | **One-sided, low** | **Double-sided, low** | **One-sided, high** | **Double-sided, high**

3. STRUCTURAL MAINTENANCE

The extreme demands on infrastructure are increasingly leading to roads, air traffic areas, logistics areas or other traffic areas becoming damaged. As a consequence, there can be considerable traffic hindrances associated with construction sites and traffic jams as well as a heavy burden on public and private funds.

Here, quick and uncomplicated repair is required, which Heidelberger Beton can offer with ideal solutions such as Chronocrete or whitetopping concretes.

Chronocrete construction, Cologne/Bonn Airport ↓

ARE YOU IN A HURRY?
Chronocrete, the quick concrete from Heidelberger Beton, also works in whitetopping construction
→ **www.heidelberger-beton.de/chronocrete**

or do you prefer it to be colourful?
→ **www.heidelberger-beton.de/farbbeton**

3.1. Whitetopping

Whitetopping construction offers the possibility of producing new road surfaces without completely renewing the existing road. Compared to conventional repair measures, the entire superstructure does not have to be removed. The milled off layer is replaced by a low-shrink and modified fibre high-performance concrete. This concrete can also be used to strenghten the tyre load of the traffic area.

Whitetopping can, therefore, utilise the remaining roadway structure as a complete construction layer. This makes this construction method quick, economical and sustainable.

↑↓ Concrete construction with the slipform finisher, B47 Bensheim

Detail of a milled, wet-cleaned asphalt surface →

WHITETOPPING IS A CONSTRUCTION METHOD FOR THE REPAIR STRENGTHENING OF DAMAGED OR UNDERDIMENSIONED ROAD SURFACE MADE OF ASPHALT OR CONCRETE.

Whitetopping can be used in low and high construction as a combination of the construction methods. The milled layer is usually replaced by a low-shrinkage, fibre-modified high-performance concrete or reinforced to increase the carrying capacity of the traffic surface. This creates a new, load-bearing road surface.

Whitetopping construction is particularly suitable if the existing road construction no longer meets the needs of high static and dynamic traffic loads. This is the case, for example, for asphalt surfaces with typical deformations such as ruts, punctual deformations or „washboards“.


Ruts with punctual deformations

3.1. Whitetopping

Areas of application

With whitetopping construction, almost every traffic surface can be sustainably repaired, provided that the substructure or the road construction is still sufficiently stable and intact.

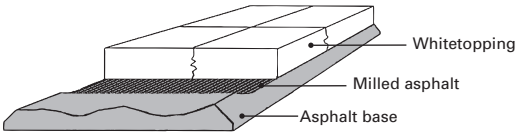
Heavily used traffic surfaces can be built over quickly and sustainably with newly developed high-performance concretes and modern construction methods.

- Motorways
- Federal, state and city roads
- Traffic lights and crossings
- Bus lanes, bus stops and bus stations
- Logistics and parking areas
- Air traffic, industrial and parking areas
- Rail and harbour facilities
- Container terminals

Whitetopping on asphalt

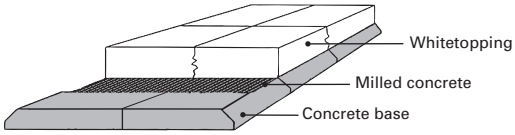
To permanently repair a damaged asphalt surface using the white topping method, a residual asphalt thickness of at least 8 cm is required after milling.

For higher loaded areas such as traffic lights and crossings, bus lanes or stops, the milled asphalt base should have a residual thickness of at least 10 cm. For the waterproof construction method on asphalt, the thickness of the new concrete layer should not be less than 10 cm.



Whitetopping on concrete

When repairing concrete surfaces using white-topping construction, the total thickness of the concrete surface should be determined in accordance with the load classes of the RStO. The new concrete layer should have a thickness of at least 8 cm, which has been proven in practice.



Possible concrete properties and additives:

Compression strength class:	C30/37 or C35/45
Exposure class:	XF4, XM2
Bending tensile strength class:	F4.5
Cement composition:	min. 380 kg/m³
w/b ratio:	≤ 0.40
Additives:	Plasticiser, air-entraining agent, shrinkage reducing additive
Admixtures:	Pigments, polymers, silica fume
Fibres:	Polymer, glass or steel fibres

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

Unsere Produktempfehlungen:

CHRONOCEM® IR – quick cement

CHRONOCRETE® – Quick concrete, early strength cement

FIBRE CONCRETE

COLOURED CONCRETE

AIRCRETE® – Air-entrained concrete

See applications and standards pp. 34 – 35

Non-destructive testing of compressive strength for traffic authorisation →

3.2. ChronoCem® and quick-hardening Chronocrete®

Products for quick traffic authorisation

There are usually only narrow time windows available for the repair of traffic surfaces. This means that repair systems have to achieve the strength required for traffic authorisation within a few hours. This is easily achievable with the special products Chronocrete and ChronoCem IR from HeidelbergCement.

Where are ChronoCem IR and Chronocrete used?

Both products are suitable for all repairs of concrete traffic surfaces that need to be quickly authorised for traffic, as well as for precast concrete components and special applications in structural engineering

- Motorways
- Federal, state and city roads
- Traffic lights and crossings
- Bus lanes, bus stops and bus stations
- Logistics and parking areas
- Air traffic, industrial and parking areas
- Rail and harbour facilities
- Container terminals

Chronocrete construction, Cologne/Bonn Airport

CHRONOCEM IR: Specially developed cement for the production of concrete with very high early strength.

CHRONOCRETE: Concrete with quick strength development and high durability.

ChronoCem IR or. Chronocrete enable every fast strength development in various applications where speed is required.

Supplied directly from the truck mixer, Chronocrete can be processed up to one hour after production. Transport times of 30 to 45 minutes can be realised. The required joints can be made within three to five hours after completion of the concrete surface.

In the case of concrete roads ChronoCem IR or Chronocrete can be used to achieve a concrete compressive strength of more than 20 N/mm2 already 3 to 5 hours after the end of construction, depending on the boundary constraints during the manufacture, processing and secondary treatment of the concrete. As a result, early traffic authorisation is possible just a few hours after construction.

Do you only have little time for your construction project? HeidelbergCement is your ideal partner in terms of speed with its tried-and-tested special products and experienced employees in this field. Your personal contact can be found here:

→ **www.heidelberger-beton.de/beratung**

TIP Chronocrete can also be used in whitetopping construction without completely renewing the existing road structure.

4. BRIDGES

Oelzetal bridge:
New route construction
Ebensfeld-Erfurt

DUE TO ITS EXCELLENT PROPERTIES, CONCRETE WITH STEEL ALLOWS THE PLANNING POSSIBILITIES OF FORMING AND DIMENSIONING IN BRIDGE CONSTRUCTIONS.

Bridges have been used to cross obstacles for many centuries and remain an important part of modern transport infrastructure. In Germany, bridges are mostly constructed using prestressed concrete. Concrete has a high compressive strength and steel has a very large tensile strength. Very slim constructions are possible using a combination of these material properties.

Bridges are designed for a service life of 100 years where traffic loads of more than 100,000 vehicles per day are not uncommon.

HeidelbergCement offers you the correct cement and concrete as well as competent advice for your bridge construction. Bridge projects such as the Oelzetal bridge on the new DB railway line between Ebensfeld and Erfurt can be realised and are made permanently safe using high-quality concrete from Heidelberger Beton.

In short, HeidelbergCement is an experienced all-rounder and partner for your demanding construction project with its building materials, test laboratories and concrete pumps.

→ **Concrete is a durable, low-maintenance building material, thus ideal for bridge construction.**

↑ Road surface and arched bridge, B15 Regensburg to Landshut

← Bridgehead A94

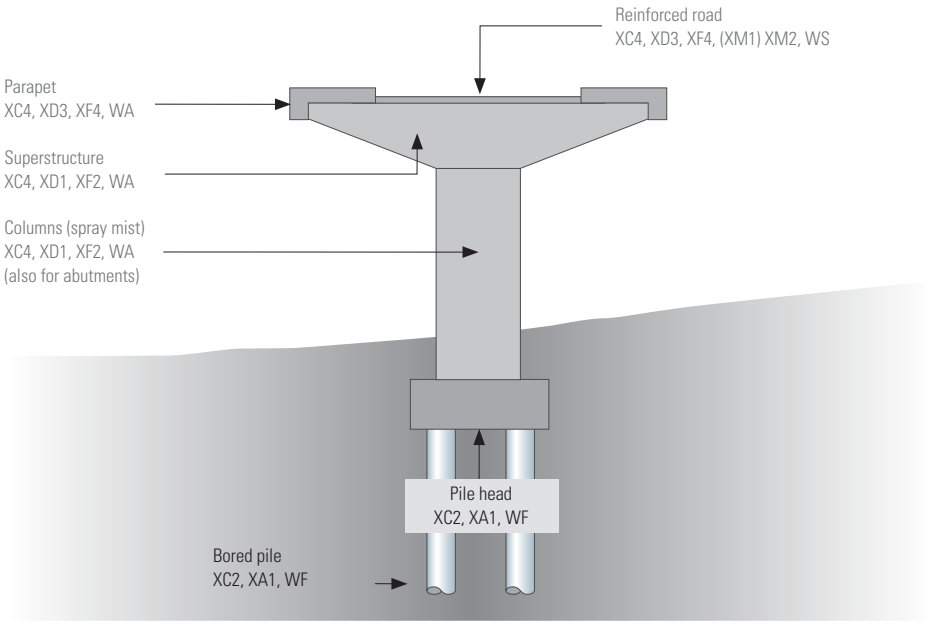
BRIDGE CONSTRUCTION PROCESS

There are a variety of bridge construction methods, including cantilever construction, the incremental launching method or using support scaffolds. The choice of method is dependent on the external framework conditions, e.g. the terrain, the bridge length and the span.

- Small bridges with small spans and low heights are often designed with support scaffolds
- Medium multi-span bridges from approx. eight fields and a span of up to 60 m are often built using the incremental launching method
- Large spans across valleys and rivers or inlets are often constructed using cantilevering

The following figure shows examples of the allocation of exposure classes according to DIN EN 206-1/DIN 1045-2. The exposure classes must be defined by the person specifying the concrete (e.g. architect, design office, engineering office) in accordance with the applicable regulations.

Exposure classes in bridge construction



Soil: chemically slightly corrosive

Further information can be found in the technical data of the concrete at:
→ **www.betontechnische-daten.de**

PARAPETS

Bridge parapets fulfil a wide range of functions, such as protecting the load-bearing bridge construction, anchoring passive protective systems, securing the traffic area as a safety kerb or they can also serve as cycle paths and footpaths. Due to their position, bridge parapets are exposed to particularly severe frost-de-icing salt attacks and dynamic stresses. Nevertheless, concrete bridge parapets are economical and durable. High resistance to freeze-thaw attacks can be achieved through the addition of micro-hollow balls or through the addition of air-entraining agents. Heidelberger Beton offers the ideal product for this, with its special product Aircrete.

→ **www.heidelberger-beton.de/aircrete**

In addition to the ZTV-ING, the DBV leaflet on "Bridge Parapets made of Concrete" also provides information regarding tendering, concrete production, component placement, including secondary treatment and component use.

ABUTMENT

The abutment carries the end of the bridge superstructure and directs the vertical and horizontal forces from the bridge superstructure into the ground. In addition, it secures the embankment in its position by absorbing the earth pressure forces in the transition area to the bridge superstructure. Due to the high loads, only concrete is used for this component.

↓ Gänsebachtal bridge, Thuringia

All formed surfaces with remain exposed are executed according to ZTV-ING at least in the exposed concrete class SB2.

FOUNDATION

The foundations form the basis of the long service life of bridges by providing a purposeful derivation of the static and dynamic forces, such as the weight of the bridge, the weather conditions and the traffic loads. As part of a subsoil survey and foundation report, soil samples are taken, the load-bearing capacity is determined, and foundation variants are considered.

Concrete is load-distributing, load-bearing, durable and resistant to deformation. These advantages make concrete an essential building material in the area of foundation construction. Concrete is used in areas such as:

Surface foundations The bridge stands on a foundation with a shallow depth.

Piled foundations Loads are directed into the ground through concrete piles.

Caisson sinking foundations After sinking, the caisson is filled with concrete.

SUPERSTRUCTURE, SUPPORTS AND COLUMNS

Supports and columns are located between the abutments and bear the loads and absorb deformations in the case of multi-span bridge superstructures. High-strength concretes, in particular, allow for narrower components and higher loads and are at the same time a design material that opens up new architectural avenues.

→ **www.heidelberger-beton.de/hochfesterbeton**

→ **Throughout Germany, Heidelberger Beton's around 130 concrete pumps make it possible to construct using fresh concrete, saving time, money and energy.**

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

Our product recommendations:

AIRCRETE® – Air-entrained concrete

HIGH-STRENGTH CONCRETE

See applications and standards pp. 34 – 35

← Massetal bridge: New route construction from Ebensfeld to Erfurt

5. TUNNEL

MOUNTAIN PRESSURE, PRESSING WATER, DE-ICING SALTS, EXHAUST GASES OR CHEMICAL THREATS FROM THE GROUND OR MOUNTAINS HAVE AN EXTREME IMPACT ON TUNNEL CONSTRUCTION. MODERN TUNNEL CONSTRUCTION WOULD BE UNTHINKABLE WITHOUT CONCRETE.

S-Bahn tunnel U12, Stuttgart ↑

Tunnel construction is an essential component of efficient transport infrastructure. The increasing flow of goods and demands on mobility make road and rail tunnels indispensable. The original reasons for tunnel construction were topographical, with the aim of overcoming natural obstacles such as rivers or mountains.

In recent years, ecological and social reasons such as noise and exhaust pollution or unwanted cutting through landscape and living spaces, have become the decisive factors in tunnel construction.

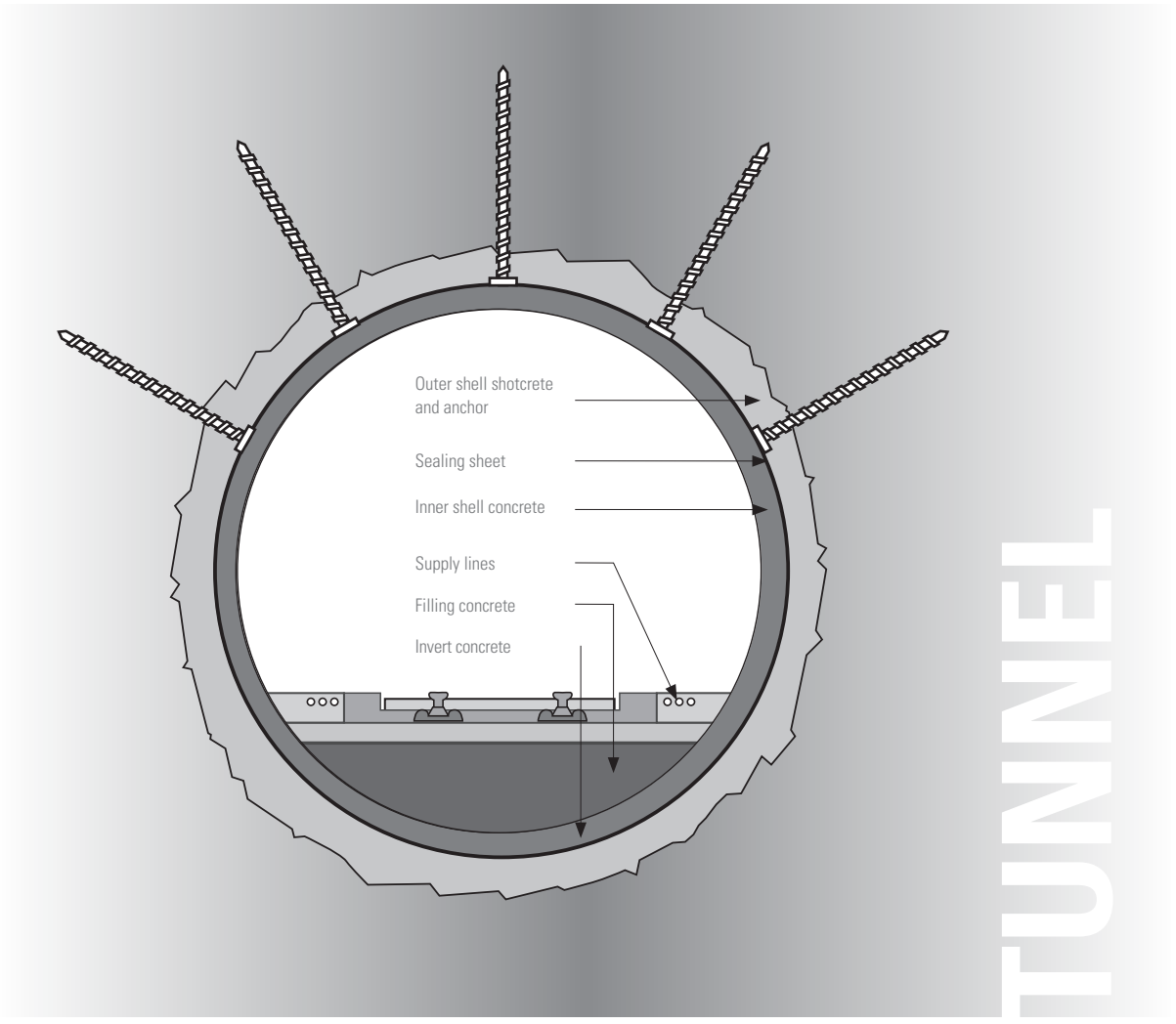
The following arguments speak in favour of using concrete and similar materials:

- Sealing properties against pressing water
- Transmission and derivation of compressive forces
- Concrete is non-flammable, thus offering high fire resistance
- Durability

A precondition for tunnel construction is having exact knowledge of geological conditions and rock strength or existing soil strength, the position of the rock strata and the pressure forces that occur. The tunnel geometry, the shell thickness and the design are determined accordingly. Road and railway tunnels are usually double-shelled. The first shell (outer shell, often shotcrete) secures propulsion, the second shell (inner shell, construction concrete) secures the operation in the tunnel after traffic authorisation. All traffic tunnels are subject to high fire protection requirements. As a result, tunnels are equipped with escape routes, emergency exits, fire detection and sprinkler systems. Heidelberger Beton offers the ideal product for this, with its fibre concrete. The addition of polypropylene fibres reduces spalling and increases the concrete's fire resistance of concrete.

→ **www.heidelberger-beton.de/faserbeton**

Example of tunnel construction



Railway tunnel Eierberge, ICE new route ↑
construction from Ebensfeld to Erfurt

Tunnel construction can be distinguished between open and closed/mining construction methods.

In open construction, the tunnel is excavated from above. The excavation cross-section is laterally secured with bored piles or other retaining walls. After excavation, a concrete cover is placed on top.

In mining construction, excavation is carried out by blasting or with a digger. The excavation depth is ensured by shotcrete, reinforcing mats, steel arches and rock bolts.

Alternatively, the tunnel cross-section can be excavated with a rotating drill head. The cavity is further secured with the installation of steel concrete segments. The cavity between the segments and the rock is again compressed with special mortars.

5.1. Shotcrete

Shotcrete is high-performance concrete produced in ready-mix concrete plants. The formulas have reactive shotcrete cement of strength class 42.5 or 52.5. The shotcrete is adjusted for good processability and pumpability by using high-quality plasticisers. It is possible to work with the concretes for several hours, even under difficult conditions. This is achieved through the appropriate addition of plasticisers and retarding additives.

The shotcrete is applied in a flat manner using a spraying machine. Alkali-free solidification accelerators are added at the spray nozzle. Shotcrete and solidification accelerators are a system and must be well coordinated. Only the combination of the components which was proven in initial tests leads to success **> Low rebound, good early strength, high final strength.**

Steelcrete, the steel fibre concrete from Heidelberger Beton, helps avoid complicated and time-consuming reinforcement construction.

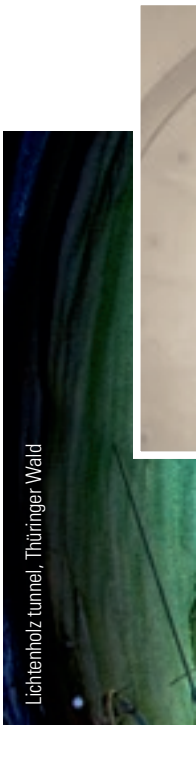
5.2. Inner shell concrete

The types of concrete used for completing tunnel protection (regular operation) are mixed as so-called inner shell concretes in ready-mixed concrete plants, delivered and usually added to the prepared formwork using pumps. Good workability and pumpability of the concrete are important again here. The mixture must be made in such a way that water secretions and separations are avoided.

With its accredited test centres, HeidelbergCement can tailor the concrete mixtures to your requirements (**www.betotech.de**) and incorporate them precisely using their own pumps (**www.heidelberger-beton.de**).

Inner shells are subject to increased demands with regard to the surface (exposed concrete quality). Furthermore, the concretes should remain crack-free when in use. This requires the use of cement with low or limited hydration heat development. CEM II or CEM III cement of strength class 32.5 R or 42.5 N are particularly suitable.

High sulphate levels in the subsoil may require the use of SR cement with high sulphate resistance.



Lichtenholz tunnel, Thüringer Wald

5.3. Segment concrete for tunnelling

To safeguard tunnel excavation during mechanical tunnelling, the tunnelling machines (shield tunnelling) carry prefabricated elements, also referred to as segments.

These segments are erected as a circular ring in advance, anchored and later compressed with filling mortar. After the hardening of the mortar, this results in a frictional bond between segments and the rock.

The segments are manufactured with high precision in precast plants or field factories. Cement which has a high early strength development, e.g. CEM I 52.5 N is used for this.

5.4. Tunnel road surfaces

In longer road tunnels concrete surfaces are being installed as a road surface for safety reasons.

These concrete surfaces are light, have grip and, above all, are safer in the event of a fire as no additional smoke is generated. These surfaces are built in with slipform finishers.

In general, road cement is used according to the TL Beton-StB.

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More information about our products and contact persons near you can be found at:

www.heidelbergcement.de/infrastruktur

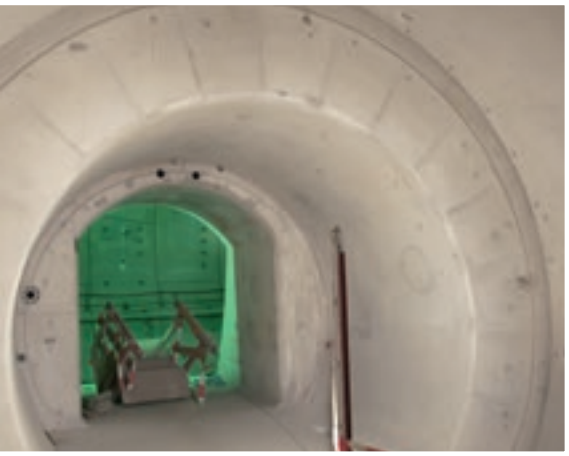
Our product recommendations:

CEMENT FOR SHOTCRETE

FIBER CONCRETE

AND OUR SPECIAL GEOTECHNICAL PRODUCTS

See applications and standards pp. 34 – 35



6. APPLICATIONS and standards

This table provides a general overview of the important regulations and standards for the various areas of application of the corresponding HeidelbergCement special products.

Application
ROAD LANES SUPER- AND SUBSTRUCTURES
Roads
Base layers with hydraulic binding agents
Road verge
SPECIAL TRAFFIC SURFACES
Roundabouts
bus traffic surfaces
service stations
urban & rural roads
parking areas
Logistics areas and freight terminals
cycle and sidewalks
Rural road construction
BRIDGE
Foundation
Abutment
Columns
Superstructure
Parapets
TUNNEL (MINING CONSTRUCTION)
Shotcrete shell
Inner shell
Segments
TUNNEL (OPEN CONSTRUCTION)
Foundations
frameworks / cover
RAILWAY SYSTEMS
Deutsche Bahn / regional traffic (sound absorber, fixed track > trafficability of tunnel and large bridges in case of emergency)
PROTECTION WALLS
Noise protection wall
Concrete protection wall (in-situ concrete, prefabricated component)
STRUCTURAL MAINTENANCE/REPAIR
Whitetopping
Repair of road / rail / air traffic areas

Selection of important rules and standards (No liability, the latest edition applies)	**Construction materials**
ZTV Beton-StB, TL Beton-StB	Road surfaces cement/concrete
ZTV Beton-StB, TL Beton-StB, M DBT	Cement, hydraulic base layer binding agent, recyclable binding agent, Multicrete, Pervacrete, hydraulically bound base layer, concrete base layer
–	Heidelberger Bankettbeton
ZTV Beton-StB, TL Beton-StB, M VaB Part 1	Fibre concrete, Coloured concrete, Aircrete
ZTV Beton-StB, TL Beton-StB, M VaB Part 1	Fibre concrete, Coloured concrete, Aircrete
ZTV Beton-StB, TL Beton-StB, M VaB Part 1	Fibre concrete, Coloured concrete, Aircrete
ZTV Beton-StB, TL Beton-StB, M VaB Part 2 (in process)	Fibre concrete, Coloured concrete, Aircrete
ZTV Beton-StB, TL Beton-StB, M VV, M DBT	Aircrete
ZTV Beton-StB, TL Beton-StB, M VaB Part 3 (in process)	Steelcrete, Aircrete
ZTV Beton-StB, TL Beton-StB, M VV	Coloured concrete , Aircrete
ZTV LW, TL LW	Aircrete
ZTV-ING, DIN EN 1536, ELTB	Bored pile concrete, underwater concrete
ZTV-ING, ELTB	
ZTV-ING, ELTB	
ZTV-ING, ELTB	High-strength concrete
ZTV-ING, VDB / DBV leaflet "Concrete bridge parapets"	Aircrete
ZTV-ING, DIN 18551, DIN EN 14487, ELTB	Shotcrete
ZTV-ING, ELTB	Fibre concrete
ZTV-ING, ELTB	Fibre concrete
ZTV-ING, DIN EN 1536, ELTB	Bored pile concrete
ZTV-ING, ELTB	Fibre concrete
ELTB	Pervacrete
ZTV-Lsw	Aircrete, Coloured concrete, Pervacrete
ZTV FRS, TL BSWF	Aircrete
M WT	Aircrete, Fibre concrete, Coloured concrete
ELTB, M EFB, ZTV BEB-StB, TL BEB-StB, M BEB	Chronocrete, Fibre concrete, Coloured concrete, ChronoCem, TioCem

HEIDELBERGCEMENT

This competence brochure is to be understood as general information about innovative infrastructure without a guarantee of completeness and accuracy. The information, illustrations, notes and recommendations contained in this brochure were prepared with due diligence and carefully researched. Despite this, this brochure will under no circumstances replace individual advice from HeidelbergCement AG. To the extent permitted by law, any warranty and liability are excluded.

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