

# **PAVEMENT CONDITION DATA INFORMATION SYSTEM BY THE FEDERAL HIGHWAY RESEARCH INSTITUTE ("BAST")**

Börge Wasser

Federal Highway Research Institute ("Bundesanstalt für Straßenwesen")

Brüderstraße 53, D-51427 BERGISCH GLADBACH, Germany

E-mail: [wasser@bast.de](mailto:wasser@bast.de)

## **ABSTRACT**

The pavement condition data of federal highways and motorways, e.g. the longitudinal evenness profile, the profiles of the cross section, the road images and the road surface images for the detection of road damages, have been collected regularly in Germany since 1991 under a uniform standard. The Federal Highway Research Institute (BAST) supports collection of pavement data by setting technical standards and by implementing a comprehensive quality assurance. The assessment of pavement condition, visualization and further analysis of data is also implemented on behalf of BAST. The collection and analysis of pavement data, which are delivered in standardized and fully documented formats, is referred to as "Zustandserfassung und –bewertung" (short "ZEB").

These elementary pavement condition data from the past 20 years provide the basis for the various evaluations and research, for the development of new pavement condition indicators as well as for the prediction of pavement condition.

To use these data effectively and to provide them to the widest possible circle of users for various tasks (including for research), BAST has set up a new online-based information system named "IT-ZEB Server". This system contains elementary and aggregated data of the ZEB and offers different special services to authorized users.

## **1 PAVEMENT CONDITION MONITORING AND ASSESSMENT IN GERMANY**

The pavement condition of German federal motorways and highways has been monitored and subsequently analyzed systematically with high-speed measurement vehicles since 1991. The procedure of Pavement Condition Monitoring and Assessment ("Zustandserfassung und –bewertung" = "ZEB") was developed in a joint project of the Federation of Germany (represented by the Federal Ministry of Transport, Building and Urban Development) and its individual federal states and can now make use of an established organizational and technical structure.

ZEB is realized on all federal motorways and highways at four-year-intervals. Since the introduction of ZEB, approximately 420,000 kilometres of traffic-lane have been monitored and evaluated (see Figure 1). Monitoring is divided into three subprojects: unevenness, skid resistance and pavement structure damages (surface). Moreover, geometrical data such as longitudinal- and transversal slopes are collected. Since 2006, road images and since 2009 also road surface images are included in standardized files and archived.

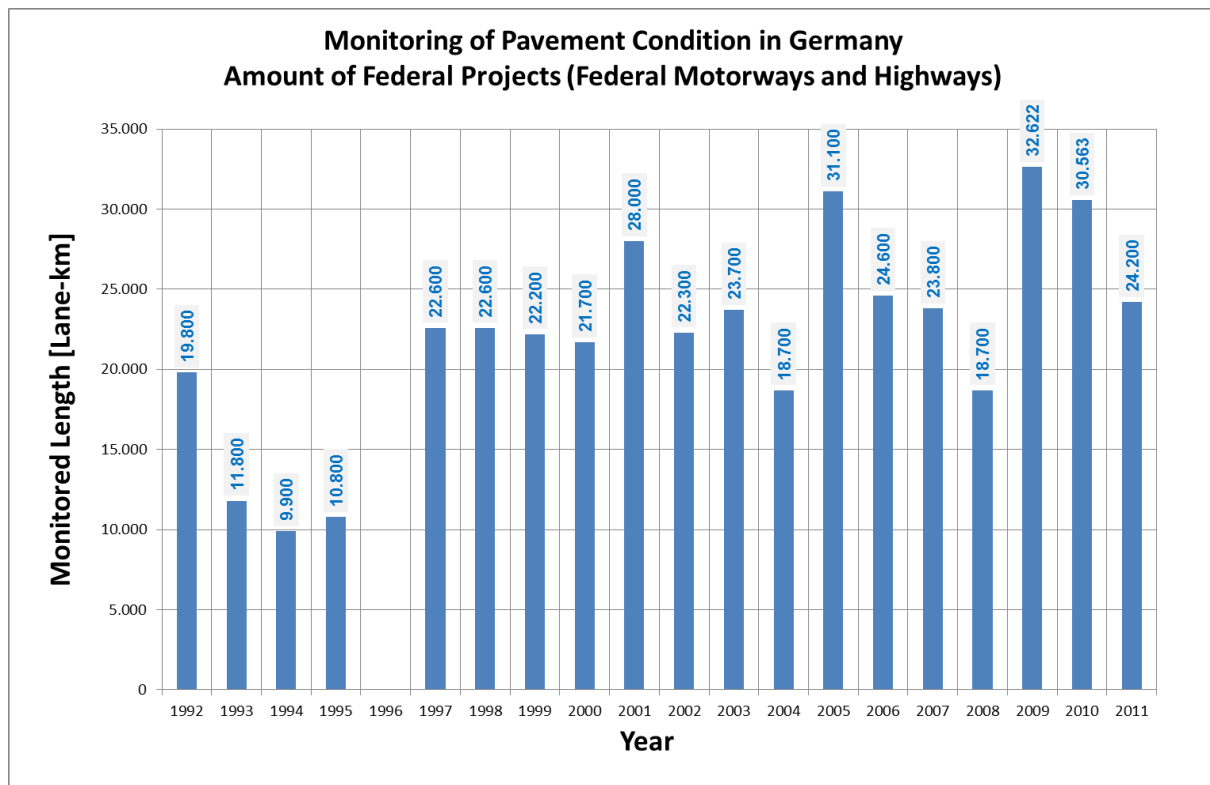


Figure 1: Monitored length on federal motorways and highways in Germany since 1992

In the course of the years, the application scope of ZEB results has been expanding. Meanwhile, data are not only used in maintenance management but also in the conduction of complex analyses based on individual, problem-related criteria.

## 2 IT-SUPPORT OF THE ZEB

Such complex project as the ZEB cannot be realized without the respective supporting tools and technologies of data processing. Within the scope of several Research & Development projects, the BASt has defined standards, procedures and technologies, which support the ZEB as a specialist discipline and all processes during the ZEB measurement campaigns. Both software and databases developed in this process are continuously maintained, extended and updated. The software products supporting the respective federal states and companies participating in the ZEB are provided by the BASt for free. The entire system of software and databases provided by the BASt since 2002 is known as the "IT-ZEB".

## 3 THE IT-ZEB SERVER – AN INFORMATION SYSTEM ON THE FEDERAL MOTORWAYS' AND HIGHWAYS' CONDITION

A consequence of the growing number of users of ZEB-data is the increasing complexity involved in making the ZEB-results available to the Federation and its federal states. In order to satisfy all demands for timeliness of the ZEB-data and for the unified, state-of-the-art method of assessment and visualization of results, a comprehensive and modern online information system was developed in 2008. Current and historical ZEB-data, including network data, geometrical data as well as road images and surface images are provided to users by a BASt server. Besides the provision of data and assessment results, a comfortable and interactive visualization of all relevant pavement condition data and images is available as well. This guarantees quick and intuitive access to the desired information.

In order to use the services provided by the IT-ZEB Server, only an internet browser is required, the client does not need to have any specific software.

- Direct access by ZEB-users to current data and assessment results at all times.
- Efficient use of pavement condition data in maintenance management.
- Visualization of pavement condition data, assessment results and of images is possible without installing additional software on the client computer, which helps to minimize costs of the widespread use of the system.
- The standardization of data interfaces and the use of online services (Web Map Service, Web Feature Service) allow for data export to and import from other federal and regional systems.

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All current and historical pavement condition data, results and documents since 1997 are located on the IT-ZEB Server, including elementary pavement condition data (so-called "raw data") with a very high data density (e.g. the longitudinal evenness profile in a 10 cm grid). Historical data have been transformed to the current, standardized data format (see example of visualization of elementary pavement condition data in Figure 2).

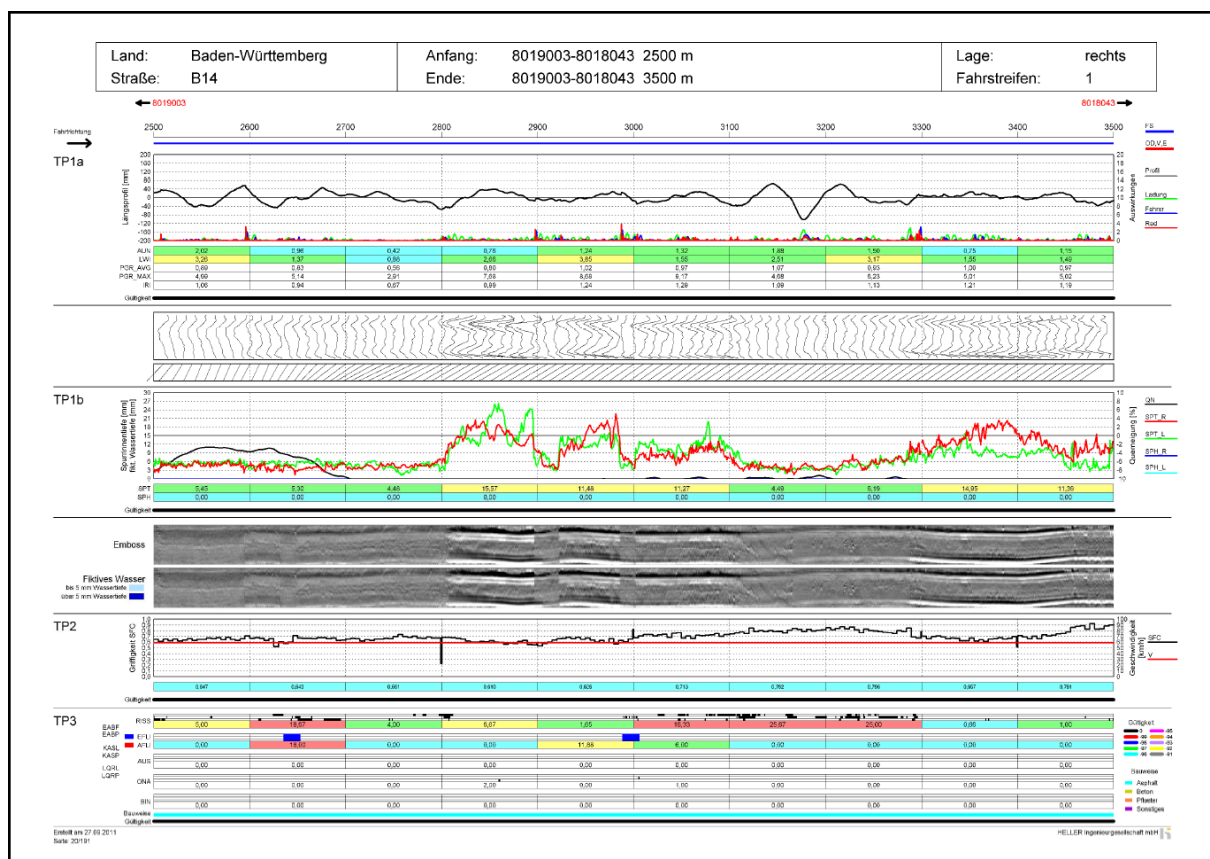


Figure 2: Elementary pavement condition data, visualized on a road plot

The IT-ZEB Server also hosts files with all road images (every 10 metres) as well as with all surface images (one image covers 10 lane metres), see examples in Figure 3. Currently (last update: 2011), the data volume hosted on the IT-ZEB Server corresponds to

approximately 30 Terabytes. Due to the continuously increasing volume of the administered pavement condition data and results, data quantity is likely to increase by 10-20 Terabyte per year – a fact that has been taken into account in the current database concept already.

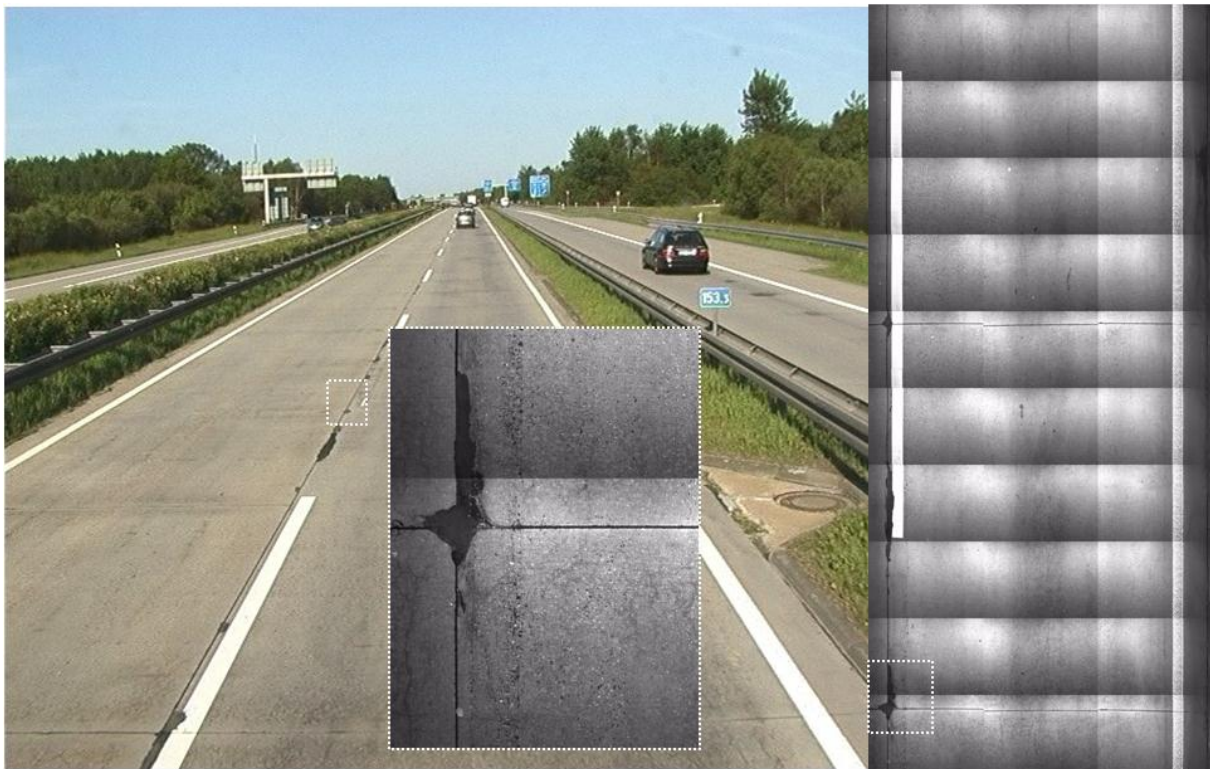


Figure 3: Example of a road image and a surface image

In order to ensure uninterrupted operation and for reasons of protection against server breakdowns or bottlenecks during data transmission, two almost identical servers are operated: one by the BAST and another one by HELLER Ingenieurgesellschaft mbH in Darmstadt – the company responsible for the development of the IT-ZEB Server.

Online services of the IT-ZEB Server are accessible only to authorized, registered users. The potential users of the IT-ZEB Server can be divided into the following three groups:

- Federation (the Federal Ministry of Transport, Building and Urban Development and the BAST)
  - Special departments of the Federal Ministry
  - Special departments of the BAST
- Federal states
  - ZEB-representatives of the federal states
  - Persons in charge of maintenance management
  - Operators of road data banks
- Third parties
  - Universities and other research institutes
  - Participants of ZEB-campaigns



## 4 FUNCTIONS OF THE IT-ZEB SERVER

The IT-ZEB Portal, which can be accessed via an internet browser, is a starting point for the user to select from the available functions. The most important functions are described below.

### 4.1 Interactive and Synchronized Visualization of Pavement Condition Data

The user is provided with an interactive and synchronized view of the pavement condition data on thematic maps (so-called pavement condition maps), on pavement condition profiles as well as on profiles containing elementary pavement condition data (raw data profiles) and the simultaneous view of road images and surface images. The desired position can be selected directly over one of the map windows or the profile windows. Furthermore, a separate navigation window is available for a selection of localization to the matter of metres (see Figure 4).

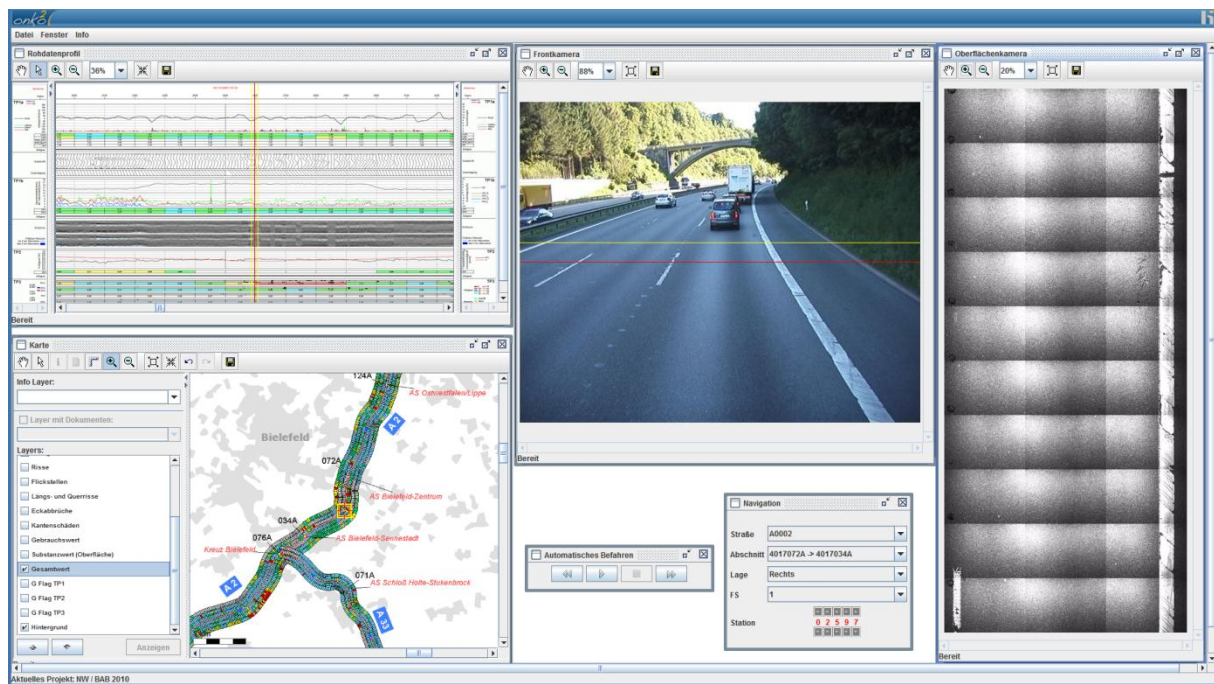


Figure 4: Interactive and Synchronized Visualization of Pavement Condition Data

Interactive visualization also allows for the "virtual inspection" of the network along the desired route, with simultaneous demonstration of the road images, the surface images (road damages) and other pavement condition data.

This interactive and synchronized visualization of pavement condition data can thus replace time-consuming inspections of road damages on the spot.

For this kind of interactive presentation (synchronized visualization of elementary road condition data as well as the aggregated data on profiles in close connection to thematic maps) a unique technology, which has been developed by an external company, has been adapted. This technology has been applied in many European countries so far, for example in Poland, Austria, France, Switzerland, Czech Republic and even in Morocco, and can be used for an interactive visualization of all kind of road data.

### 4.2 Federal Statistics of Pavement Condition Data

In order to conduct statistical comparative analyses of construction methods, administrative units or for dynamic pavement condition assessment (comparison of campaigns), an online software solution has been implemented on the IT-ZEB Server for the generation of

assessments in a standardized manner. The software allows for e.g. answering questions regarding maintenance management that are important from a strategic and federal point of view (see Figure 5).

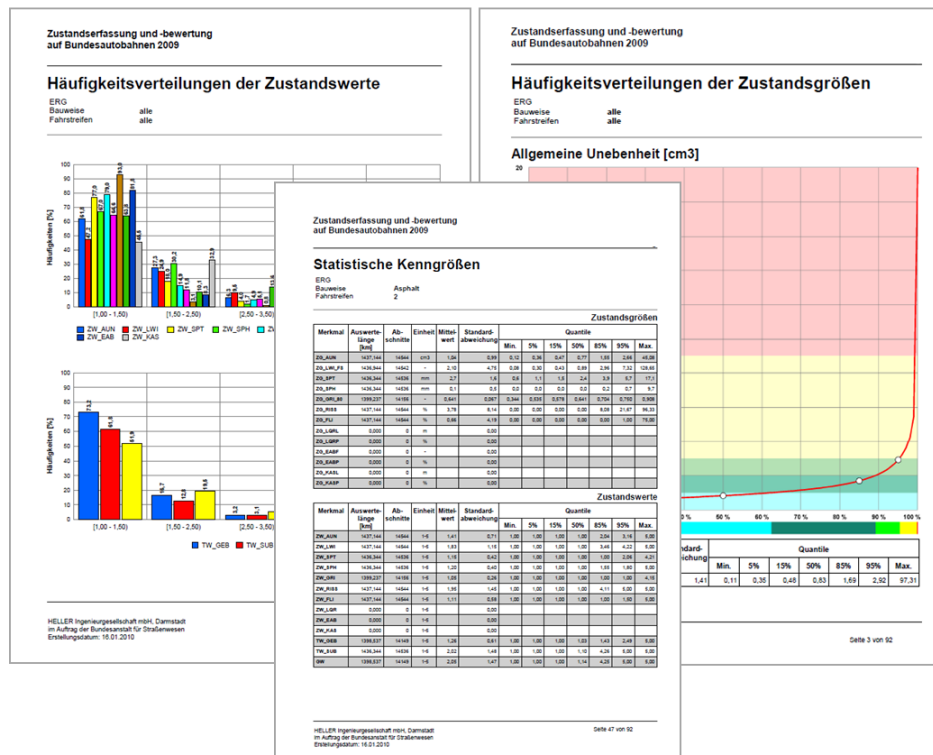
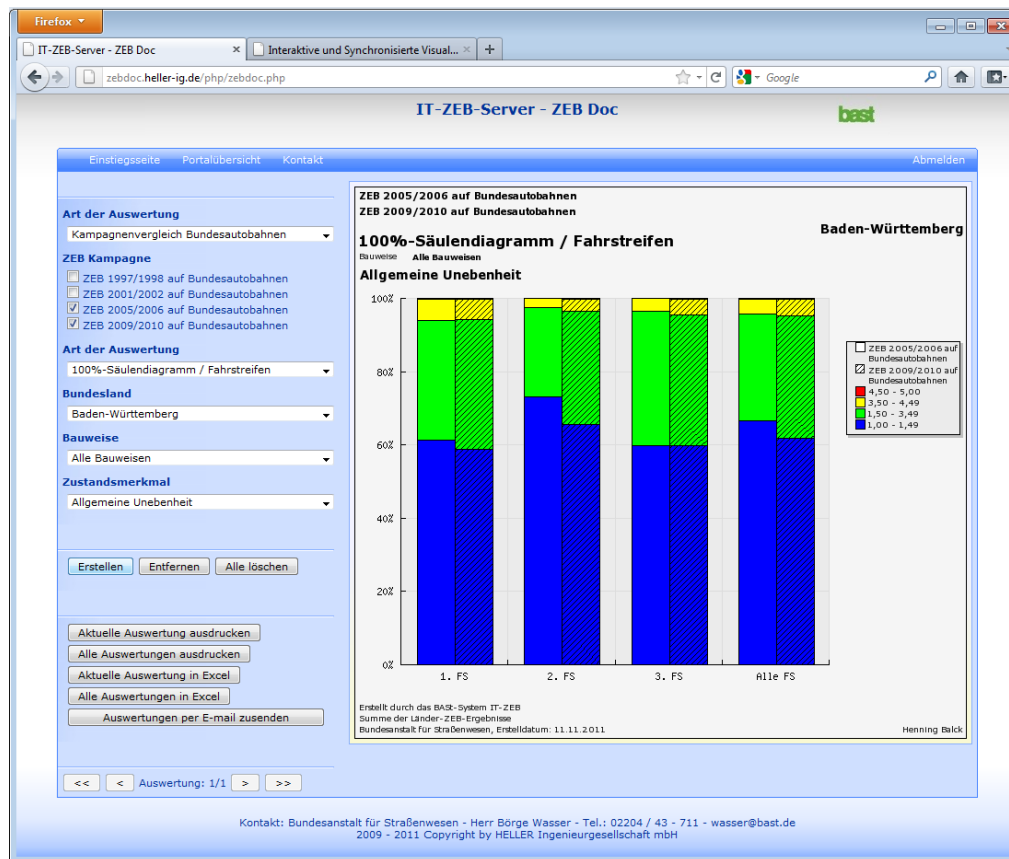


Figure 5: Federal Statistics of Pavement Condition Data

### 4.3 Pavement Condition Data and Assessment Results Download

All pavement condition data, both in their elementary form ("raw data") and aggregated to sections of 100 metres, assessment results, graphics, road images and surface images can be downloaded to the user's computer from the server's download portal.

Current versions of the ZEB standard software and documentation reports from previous ZEB campaigns are available from the download portal as well.

### 4.4 Web Map Service (WMS)

Map elements, especially the so-called condition layers, can be integrated into other Geographical Information Systems (GIS) via the Web Map Service. By doing so, the federal states' road data banks are always provided with the latest pavement condition layers online from the IT-ZEB Server.

### 4.5 Web Feature Service (WFS)

By means of the Web Feature Services, individual pavement condition data and geometrical data, but also images that correspond to the German federal standard OKSTRA® can be downloaded in order to provide them to other external client applications directly in a simple way (e.g. road information systems such as the NWSib).

Figure 6 shows the general structure of the IT-ZEB Server and Figure 7 the Internet-Portal.

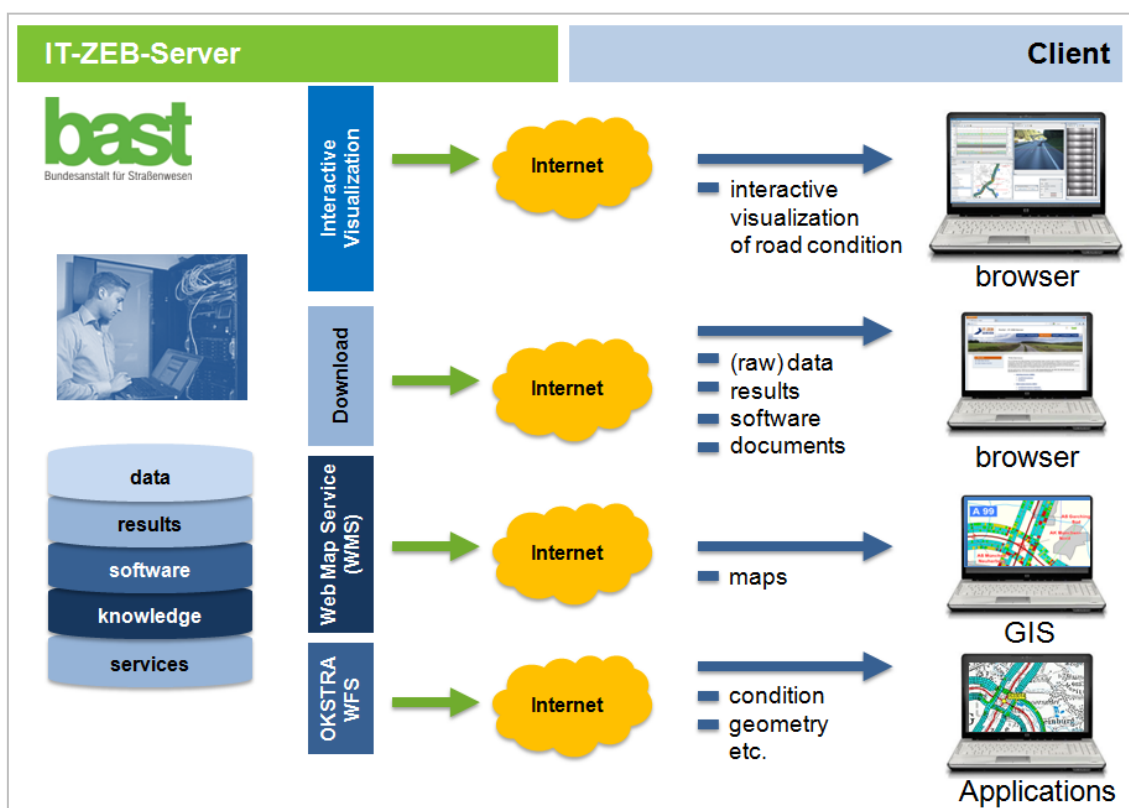


Figure 6: Structure of the IT-ZEB Server

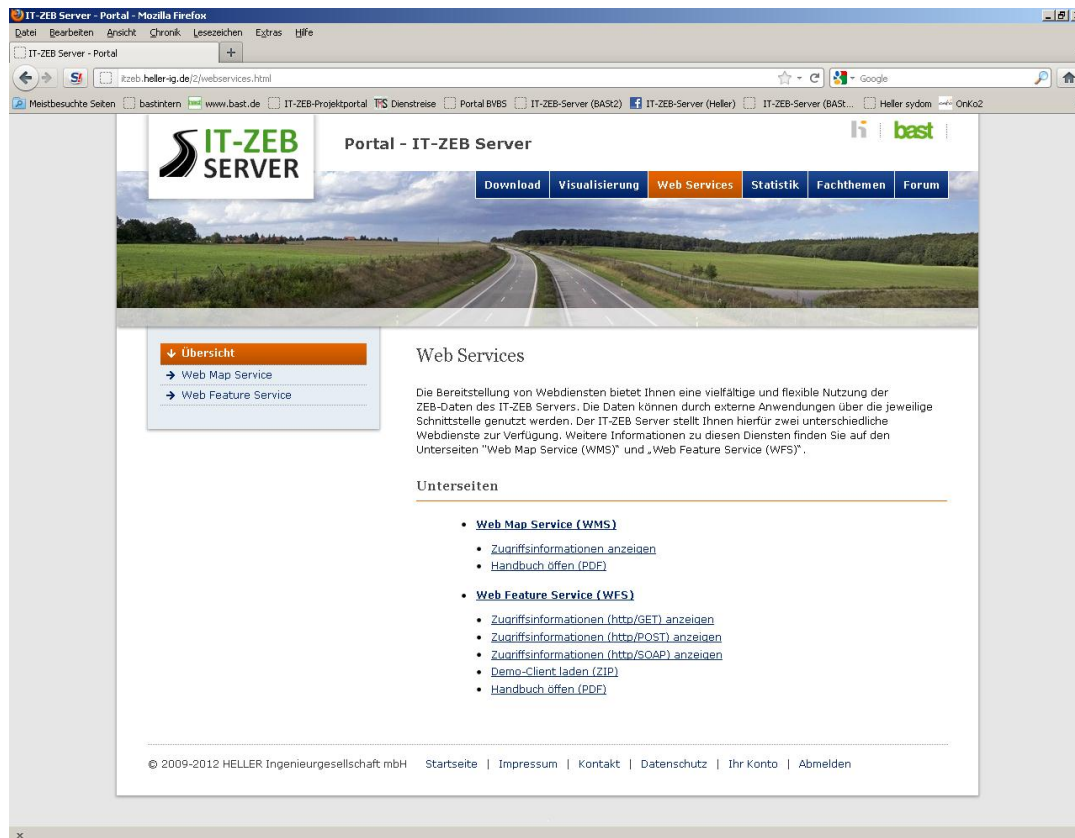


Figure 7: Internet-Portal of the IT-ZEB Server

## 5 SUMMARY AND PROSPECTS

With the introduction of the IT-ZEB Server, a well-structured, stable and expandable online information system has been developed for the provision of federal motorways' and highways' pavement condition data.

This system represents a unique solution. It has not only the already mentioned super-fast and interactive visualization that can be used by any road authority involved in monitoring the pavement condition. The IT-ZEB Server also enables those road authorities to access the most recent, as well as the archived, pavement condition data as files. The evaluation results are available as PDFs via the IT-ZEB Server. The data of the IT-ZEB Server can also be accessed in a simple way by legitimate users using Web Feature Services (WFS) and Web Map Services (WMS).

In order for the system to be used as a support tool along with management tasks, the necessary contracts have been signed to provide permanent operation. They guarantee the successive takeover and provision of ZEB-data directly after completion of the annual ZEB measurements. Trainings as well as a telephone hotline support for users have also been taken into account.

The state-of-the-art architecture of the IT-ZEB Server has proven its expandability already in its first three years of operation by the integration of new data groups and services. It can be expected that thanks to its flexibility and openness, the IT-ZEB Server will be able to integrate further databases from other systems of the Federation and that in doing so, considerable synergy effects can be achieved.