Ferrous slag.

Valuable raw material for resource-saving business models.

Valid as of
2025

04

ECONOMY AND ECOLOGY GO HAND IN HAND

Pioneering: Ferrous slag is environmentally friendly, saves natural resources and avoids waste

06

SOUGHT-AFTER CONSTRUCTION MATERIAL AND PROVEN FERTILISER

Safe and reliable: numerous industries put their trust in high-quality slag-based products

08

TOP PERFORMANCE IN CONSTRUCTION

Unconditional confidence: Even for extreme conditions, cement and concrete with ground granulated blast furnace slag and air-cooled blast furnace slag are the first choice

10

SAFE AND LONG-LASTING ROADS

The multi-talent: Exceptional properties of aggregates made from slag ensure safe and sustainable roadways under all weather conditions

12

HIGH-PERFORMANCE AND ENVIRONMENTALLY FRIENDLY FERTILISERS

The best growth forecasts: Converter lime made from slag proves persuasive in agriculture thanks to its effectiveness while simultaneously being gentle on nature

14

FROM INDUSTRIAL BY-PRODUCT TO RAW MATERIAL OF THE FUTURE

Blast furnace and high-tech: Modern methods allow the metallic melt flow at around 1,500 degrees Celsius to produce homogeneous mineral materials for high-quality industrial products

15

THE TRANSFORMATION OF THE STEEL INDUSTRY AND „NEW SLAGS“

Fit for the future: Research is already laying the foundation for the resource-efficient and climate-friendly use of the by-products of a decarbonised steel industry

19

FEHS – BUILDING MATERIALS INSTITUTE

The professionals: Comprehensive expertise, decades of experience and intensive cooperation arrangements with science and businesses have gained the Duisburg-based organisation an international reputation

FERROUS SLAG:
GOOD FOR BUSINESS, GOOD FOR THE ENVIRONMENT!

Economic development, prosperity and quality of life are unthinkable without environmental protection. The consequences of climate change alone are making themselves clearly felt in our everyday lives, and are already costing billions.

However the consumption of raw materials and energy also deserves our particular attention, because (natural) resources are not available indefinitely. We all have to act conscientiously in order to secure a liveable future for ourselves and for the coming generations. The fact that sustainability is right at the top of the political agenda is therefore to be welcomed: for example in the „Resource-Efficiency Roadmap" in the European Union's „Roadmaps 2050" on climate and energy, in the amended German Circular Economy Act, or in the EU's Circular Economy Action Plan, Clean Industrial Deal and planned Circular Economy Act.

This brochure explains the role that ferrous slag plays in economical and ecological business models. This is because using the slag produced during steel manufacturing does more than just guarantee competitive products. The mineral material also saves natural deposits, protects nature, and promotes the circular economy. We at the FEhS – Building Materials Institute have spent decades working to steadily improve this positive balance for businesses and the environment. In intensive collaboration with companies, public authorities, and the scientific sector, we are refining our manufacturing and processing methods, optimising products, verifying suitability for practical application, and working on new fields of application for ferrous slags, e.g. as a tree substrate or as a blasting agent. Furthermore, we are currently researching the new slags of the future, in hydrogen-based steel production. For we are convinced: slags are a raw material of the future!

Further interesting information about slag can be found on the websites www.fehs.de and www.rohstoff-schlacke.de. We look forward to your visit!

Thomas Reiche,
Managing Director at FEhS – Building Materials Institute

If one were to make a heap of all the ferrous slag used in Germany since 1949 – over a billion tonnes – it would be **600 metres in diameter** and **2,900 metres high**, making it the same size as the highest mountain in Germany, the Zugspitze.

ECONOMY AND ECOLOGY GO HAND IN HAND

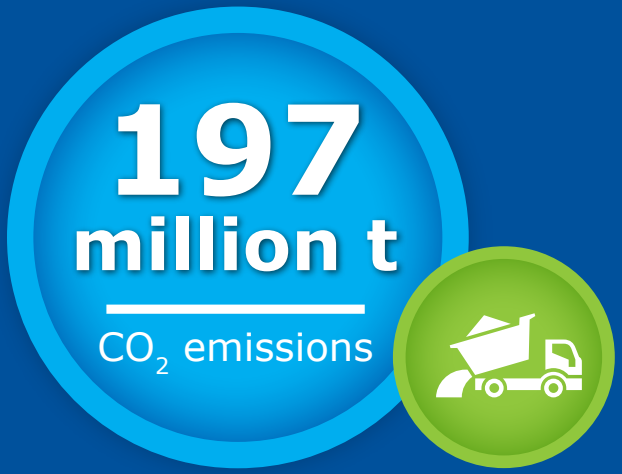
Ferrous slag is a valuable raw material created during the production of pig iron and steel. Depending on the manufacturing method, we talk about blast furnace slag or steel slag. Modern processing methods are used to turn these into ground granulated blast furnace slag (GGBS), aggregates and fertilisers, which for many years now have been benefiting not only the construction industry and agriculture, but also the environment!

SAVING RESOURCES, PROMOTING THE CIRCULAR ECONOMY

Slag-based products like cement, concrete, asphalt and converter lime are versatile, high-quality, and above all environmentally friendly. This has been confirmed by numerous public authorities and ministries in Germany and the EU, such as the estimates of the German Environmental Agency, and directives from the German Federal Ministry of the Environment. Numerous recent studies have demonstrated that ferrous slag is safe and can be used without risk.

Any business that wants to be competitive and cares about environmental protection needs to increase its resource efficiency. Using ferrous slag makes an important contribution to this. Using it reduces emissions of the climate killer CO_2. Furthermore, it makes it possible to avoid excavating large quantities of the primary raw materials natural stone and sand, which also protects landscapes.

Ferrous slag additionally makes a considerable contribution to the circular economy. Almost the entire slag output is used for manufacturing high-quality products – only 4% ends up in landfill. In addition, large quantities of scrap metal are used in the manufacturing of crude steel, which produces steel slag.



Through the use of granulated slag in place of Portland cement clinker in cement, the emission of 197 million tonnes of CO_2 could have been avoided since 1949.


PRODUCTION AND USE
OF FERROUS SLAGS 2024 (IN T)
11.8 million
tonnes of ferrous slag per year in Germany
2.6 million
tonnes of aggregates
0.8 million
tonnes of in-plant recirculation
0.4 million
tonnes of lime/fertiliser
0.5 million
tonnes go to landfill
0.4 million
Other applications
7.1 million
tonnes of ground granulated blast furnace slag (GGBS)

SOUGHT-AFTER CONSTRUCTION MATERIAL AND PROVEN FERTILISER

Blast furnace slag and steel slag are industrially manufactured mineral materials that have what it takes. They make structures stable, ensure safe roads, and allow plants to flourish. This is because the properties of ferrous slag are homogeneous and technologically exceptional. This is ensured by very high temperatures of the production process, just like with magmatic rock, and state-of-the-art processing methods.

PROVEN QUALITY

Architects, engineers and construction clients have been using construction materials containing slag for over 100 years to build anything that needs to satisfy the toughest requirements: bridges, television towers, dams, road surface courses, storm surge defences, office complexes, industrial facilities and drinking water pipelines. Not only for new construction projects, but also for repairs, experts put their trust in the technical, economic and ecological qualities of slag products.

No sustainable success without reliable quality certification: Factory production controls (FPCs) and quality control associations, public authorities and officially recognised testing bodies, scientific investigations and international research have all confirmed the suitability of ferrous slag as a raw material, as well as the viability in practical applications of the products manufactured from it. This is demonstrated by the comprehensive international approvals for different fields of application in a wide variety of industries.

The high quality and versatility of construction materials and corresponding mixtures with ferrous slag can be seen from numerous projects completed in the chemical industry and heavy industrial applications, the energy sector, road construction, and municipal utilities and waste disposal, amongst others.

65

YEARS

***For 65 years**, through a long-term fertiliser trial using Thomas phosphate, which contains slag, scientists in the Black Forest have been demonstrating the fertiliser's effect on the yield and biodiversity of permanent grassland.*

420 million t

The use of GGBS in cement alone has replaced **420 million tonnes of natural stone** since 1949 – this quantity would fill more than 3.5 million of the world's largest shipping containers.

TOP PERFORMANCE IN CONSTRUCTION

Functionality, quality, economic viability, sustainability, and not least safety: If you want to build high-quality structures, you have to be able to trust the properties of the construction materials. Slag-based cement and concrete have proven their effectiveness thousands of times over – not just for everyday construction projects, but above all in buildings and structures that are subject to the highest requirements.

The success of slag products is no accident. Virtually no other construction materials have been so intensively investigated, comprehensively tested, and repeatedly optimised. For unusual fields of application with special requirements, individually manufactured concrete recipes are even used. The high standard of cements and concretes containing slag is guaranteed thanks to the experience of the experts, the effective cooperation of businesses, scientists and public authorities, and through standardised quality requirements.

Legislation not only requires the specific technological suitability of construction materials. Environmental parameters also need to be fulfilled in order to protect nature and people from hazardous substances in the long term. Slag products therefore enjoy the confidence of companies for construction projects throughout Europe. Examples include drinking water plants, water and sewage treatment plants, surfacing for the chemical industry, buildings with extremely high mechanical loading, and silos.

Environmental protection also means saving resources and the climate. In addition to the extraction of vast quantities of natural stone and sand, 197 million tonnes of CO_2 were avoided between 1949 and 2024 through the use of ground granulated blast furnace slag as a cement constituent.

34

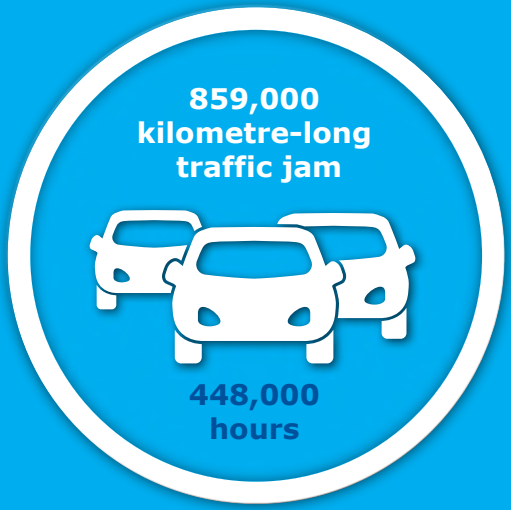
While global fossil fuel consumption increased by a factor of twelve over the course of the 20th century, the extraction of primary raw materials and natural resources increased during the same period ***by a factor of forty-three!***


631
million t
NATURAL STONE
Since 1949, the use of
slag-based construction materials
in road-building has
substituted for over 631 million
tonnes of natural stone!

SAFE AND LONG-LASTING ROADS

Roads should last a long time, withstand truck traffic, ensure safe driving during rain, and generate as little noise as possible. Road construction materials such as asphalt containing steel slag fulfil these requirements. This is because aggregates made from slag are almost immune to weathering, resistant to frost, remain stable for a very long time, have enormous load-bearing capacity, are extremely durable, and are insensitive to heat, which minimises rut formation in summer.

This results in fewer roadworks (and thus less traffic jams), less pollution, and fewer accidents. In addition, construction materials made from slag also fulfil the strict environmental requirements for road-building, such as those regarding water protection.



*According to ADAC, 516,000 traffic jams were recorded in Germany in 2024, with a total length of 859,000 kilometres, robbing road-users of a total of **448,000 hours.** One of the main causes was ongoing busy roadworks.*

Another advantage of slag products is that they are easy to process year-round, regardless of weather conditions. This saves time and money, and roadworks can be completed sooner.

For the construction of waterways and locks, the industry likewise places its trust in concrete with slag. For example, 50,000 m³ of this material was used in the construction of the Kaiserschleuse lock in Bremerhaven, the "Panama Canal of the North".

The exceptional mechanical properties of the construction materials are guaranteed by the specifications of the Ferrous Slag Quality Control Association, whose requirements are even stricter than the statutory regulations.

What's more, ferrous slags are not water-polluting as defined in the German Federal Environment Ministry's Ordinance on the Handling of Substances Hazardous to Water (AwSV).

0.4 million t

Each year, **400,000 tonnes of slag** is turned into lime fertiliser for the agriculture sector.

HIGH-PERFORMANCE AND ENVIRONMENTALLY FRIENDLY FERTILISERS

Slag not only ensures stable buildings and indestructible roads, but also makes delicate plants flourish and keeps the soil healthy. This is because grinding and sieving slag can produce converter lime, which for decades has been valued as fertiliser by the agriculture industry.

The expectations placed on fertiliser within an agricultural context are a good yield and the long-term preservation of the fertility of our soils – as well as faultless products for the consumer. Fertilisers with converter lime more than fulfil these requirements. Alongside the necessary buffering of acid in the soil, they contain numerous elements that are important for plants, such as silicon, magnesium, calcium, and manganese. Converter lime can be used on all soil types and for all crops. The use of converter lime conserves natural resources and makes a significant contribution to food security.

Just like we already saw with construction materials, fertilisers made from slag also need to comply with statutory requirements. Besides the quality of the products, the focus of the inspections here is on environmental protection. "For this purpose, the experts can refer to the experience of long-term field trials that were carried out with slag based fertilisers. In this regard, results are continuously developed within a framework of research projects.

The fact that fertilisers containing slag are completely harmless from an ecological and health perspective has been established in comprehensive studies.

60,000

"Upcycling for the agriculture sector": The recovery potential of phosphates in ash from combustion processes is estimated at 60,000 tonnes. A project subsidised by the German Ministry of Education and Research developed a special method with converter slag for converting the mineral material into an efficient fertiliser.

FROM INDUSTRIAL BY-PRODUCT TO RAW MATERIAL OF THE FUTURE

The production of pig iron and steel generates slag. This is formed like lava by the cooling of a melt flow whose temperature is between 1,500 and 1,600 degrees Celsius. Its composition is primarily of calcium, silicon and magnesium oxide, and is similar to magmatic rock. But unlike in volcanoes, the cooling and hardening processes are not left to chance.

Today these processes are controlled using a variety of methods. Depending on the duration and type of cooling, the grain size, the physical properties, and the chemical composition of the slag can be influenced. Ground granulated blast furnace slag (GGBS) is produced rapidly through the granulation of liquid blast furnace slag using water and air, while air-cooled blast furnace slag is formed by pouring the molten slag into slag pits and allowing it to cool slowly.

And likewise for the further processing of slag, the expertise of specialists and modern plants are required. The results are impressive: homogeneous stone products with consistent properties, precisely tailored to the special fields of application in construction and agriculture. All products comply with the respective national and European standards, and fulfil all environmental requirements.

As a result, slag is a sought-after raw material that contributes to economic and ecological development.

Sophisticated manufacturing methods are used to process 96% of ferrous slag into environmentally friendly, high-quality products such as cement, concrete, asphalt and fertilisers.

THE TRANSFORMATION OF THE STEEL INDUSTRY AND „NEW SLAGS“

The transformation of the steel industry means decarbonisation/defossilisation in the production of steel. The implications: the large-scale refurbishment/new construction of the integrated steelworks and, as a result, slags that have an entirely different composition.

A direct reduction system replaces the CO2-intensive blast furnace and, initially, produces sponge iron in a slag-free process (DRI – Direct Reduced Iron). DRI is melted down in downstream electrical units. New by-products are produced in this process: firstly, in the smelting reduction furnace, ERS (ERS – electrolytic raw iron slag), also known as SAF slag (SAF – Submerged Arc Furnace) is produced; and secondly, in the electric arc furnace, EAF slag (EAF – Electric Arc Furnace) is produced by adding scrap metal and DRI.

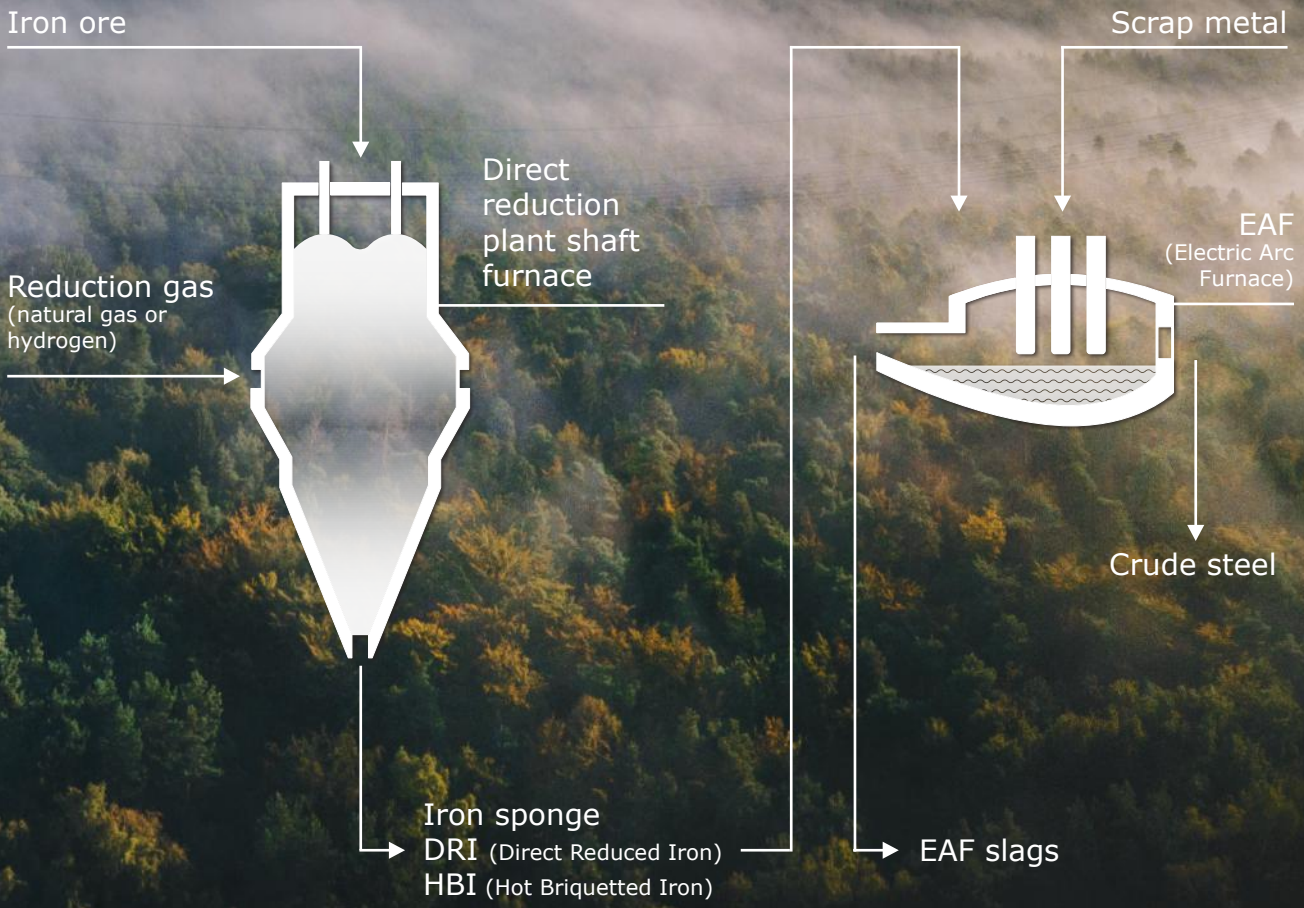
In 2024, 96% of the total of 11.8 million tonnes of ferrous slags generated in Germany could be used in construction materials, in transport engineering, and in agriculture.

The application possibilities for the „new slag“ as a construction material, in road construction, as a fertiliser, or in new fields of use are currently being researched. In addition, experts are also studying whether and how these slags must be conditioned for optimal use.

The FEhS institute has already been working on various research projects focussing on this subject matter since 2013. Since 2021/2022, the „SAVE CO2“ (ERS) and „DRIEOS“ (EAF slags) collaborative projects coordinated by the Duisburg-based institute have been studying how, in future, an alternative Co_2-saving clinker replacement could be manufactured for the cement industry, in place of granulated slag from the blast furnace, as is currently used.

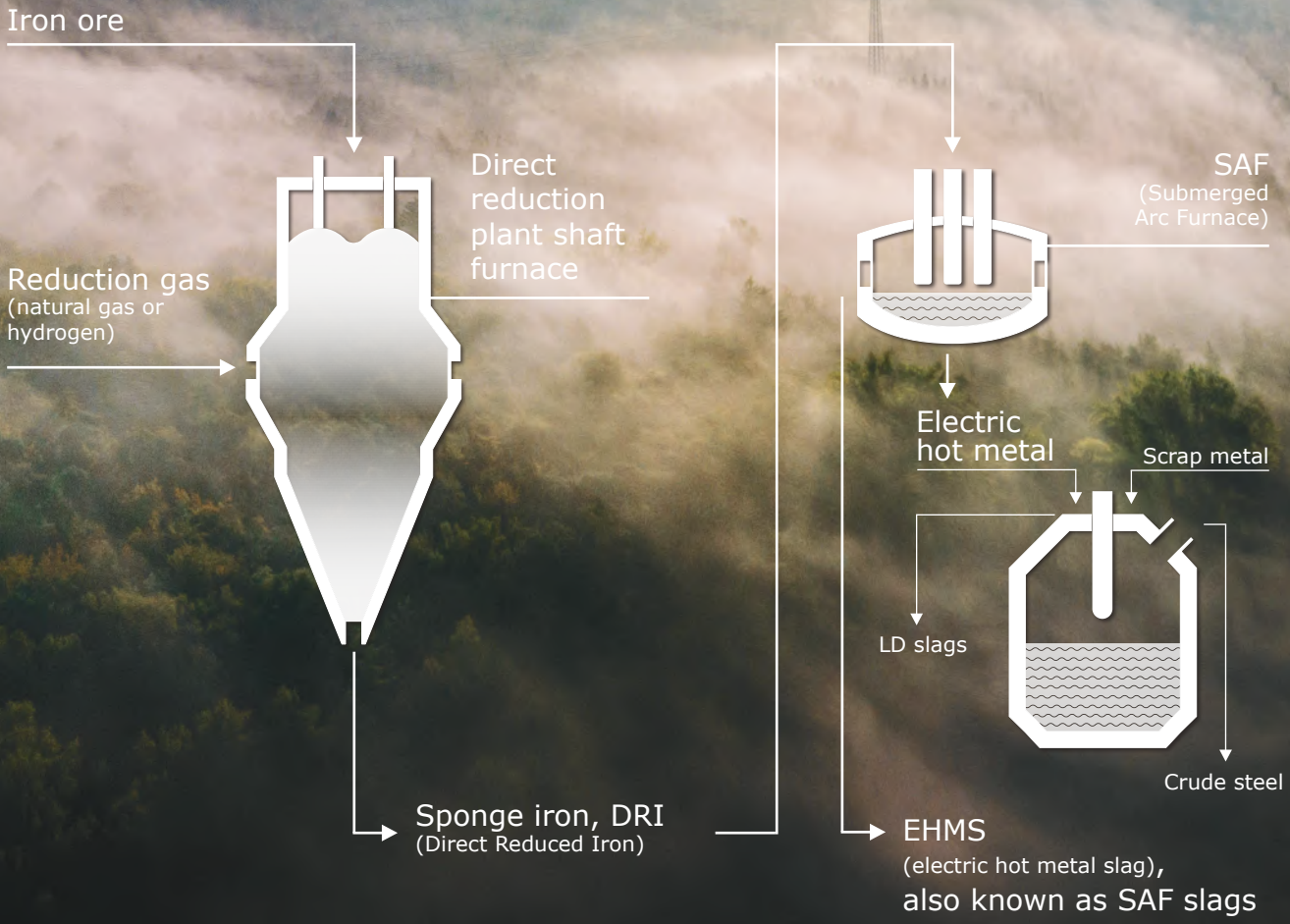
CRUDE STEEL PRODUCTION IN A

1-step process



DECARBONISED STEEL INDUSTRY

2-step process



7,1 million tonnes of

granulated slag

A resource-efficient and climate-friendly construction material: Every year, **more than 7 million tonnes of granulated slag** are used in Germany.

FEHS INSTITUTE FOR CONSTRUCTION MATERIALS RESEARCH

For decades, FEhS – Building Materials Institute in Duisburg has been recognised both within Germany and internationally as a partner for all matters relating to ferrous slag. The slag professionals work closely with a wide network of companies and industrial associations, public authorities and government ministries, quality control associations and universities.

One focus of the work performed by the engineers and scientists is on research and testing. The modern laboratories at the FEhS Institute for cement, concrete, chemistry, mineralogy, slag metallurgy (including a mobile laboratory), transport construction and fertilisers hold numerous permits, more than 70 of which are confirmed by the German Accreditation Body (Deutsche Akkreditierungsstelle, DAkkS), with numerous additional approvals also granted. Specialised quality assurance concepts and involvement in international projects furthermore ensure that they operate at the highest level.

The interdisciplinary team additionally has high levels of consulting skill in all technical and ecological aspects of the use of slag products.

One exceptional example of this is the Construction Competence Forum of the FEhS-Institute. Construction companies, construction clients, construction material manufacturers, planners and plant operators worldwide rely on this knowledge – for example, for new buildings and repair projects, during the planning and monitoring of construction projects, and in matters of environmental

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