

Research.  
Design.  
Inspire.



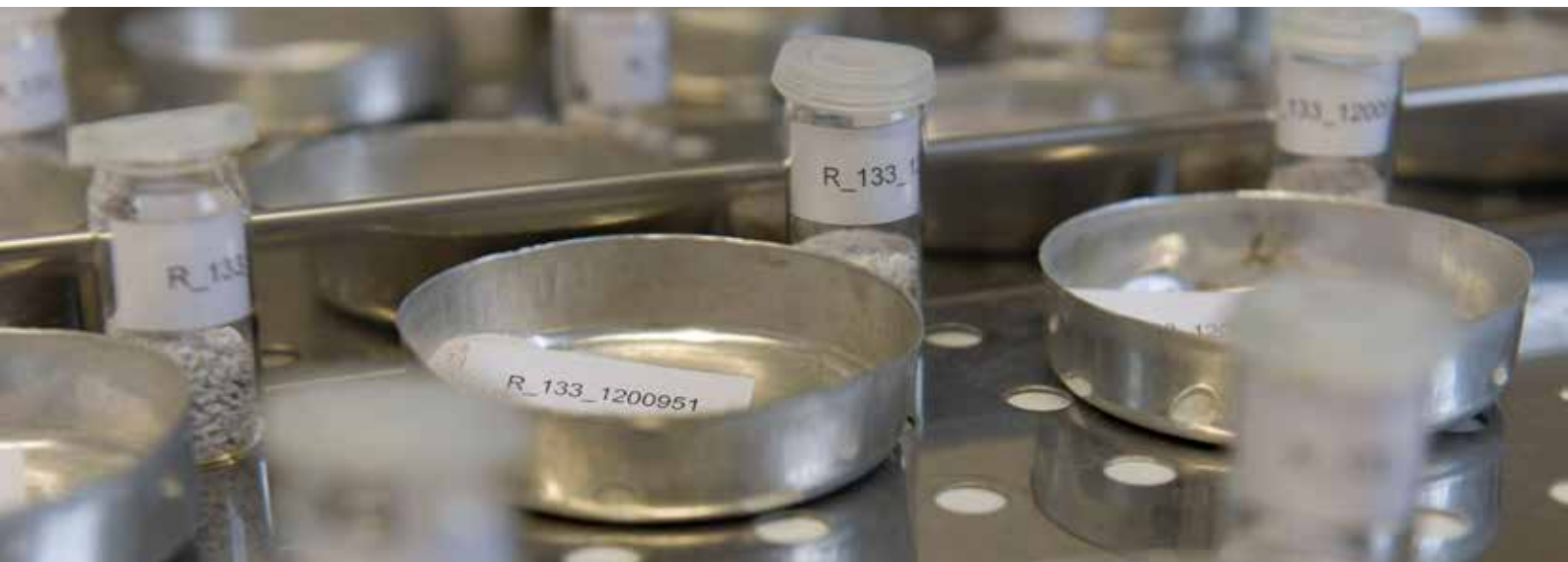
xella

“Research 4.0: highly motivated people, sufficient research funding, courage and the modicum of luck that we need.

Over recent years we have experienced many great moments with all of these requirements at Xella Technology and Research. We can be truly proud of this. Keep it up!”

Torsten Schoch

CEO Xella Technologie- und Forschungsgesellschaft mbH



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# The Right Answers to Key Questions

With its Ytong, Silka, and Hebel brands, the Xella Group is a global leader in autoclaved aerated concrete and calcium silicate products. Its Multipor brand stands for fireproof mineral insulation boards. Ursa, a leading insulation provider, is also part of the group.

The company, which is headquartered in Duisburg, has not only made a name for itself as a manufacturer of high quality building materials, but is also synonymous with innovative and trendsetting products and brands – whether autoclaved aerated concrete (AAC), calcium silicate units or insulating material.

High quality and innovative strength do not come about by chance: if you want to give the right answers to the building challenges that will face us tomorrow, you must ask the right questions today.

This is why Xella operates its own technology and research center near Berlin, which particularly serves its business unit "Building Materials and Mineral Insulation Boards".

At two locations, Emstal and Brück, employees ensure that the company will also be able to meet the growing demand for efficient, modern and environmentally compatible building in future, too. The team of specialists includes experts from the subject areas of mineralogy, building materials testing, civil engineering, building physics and chemistry and they work in close collaboration with each other.

They are working on new materials – from the idea through to the finished product – and are also optimizing proven building materials, thereby improving their characteristics. The work of Xella Technology and Research takes place in constant contact with the production department and also takes practical building applications into consideration, therefore guaranteeing intensive feedback between theory and practice.

The three departments applied research/building physics, product/process research and accredited test center are the central focus here.

Xella's central markets are in Europe. A region with strict requirement profiles for building materials – from the recyclability of building materials to modern solutions to meet the most stringent requirements of customers and building standards alike.

The necessary materials and system solutions of tomorrow are being developed by the experts of Xella Technology and Research today.

"Xella Technology and Research is of incalculable importance to the building industry with its exceptional performance in the areas of research, product development and standardization."

Prof. Oliver Kornadt  
Technical University of Kaiserslautern, Department of Civil Engineering,  
Dean, Department of Building Physics/Building Energy Optimization



# Product and Process Research

A photograph of industrial machinery, likely a large-scale testing facility. A prominent feature is a large, curved, corrugated metal duct on the left side. The background is filled with various pipes, structural beams, and other mechanical components. The entire scene is illuminated with a strong blue light, creating a high-tech, research-oriented atmosphere.

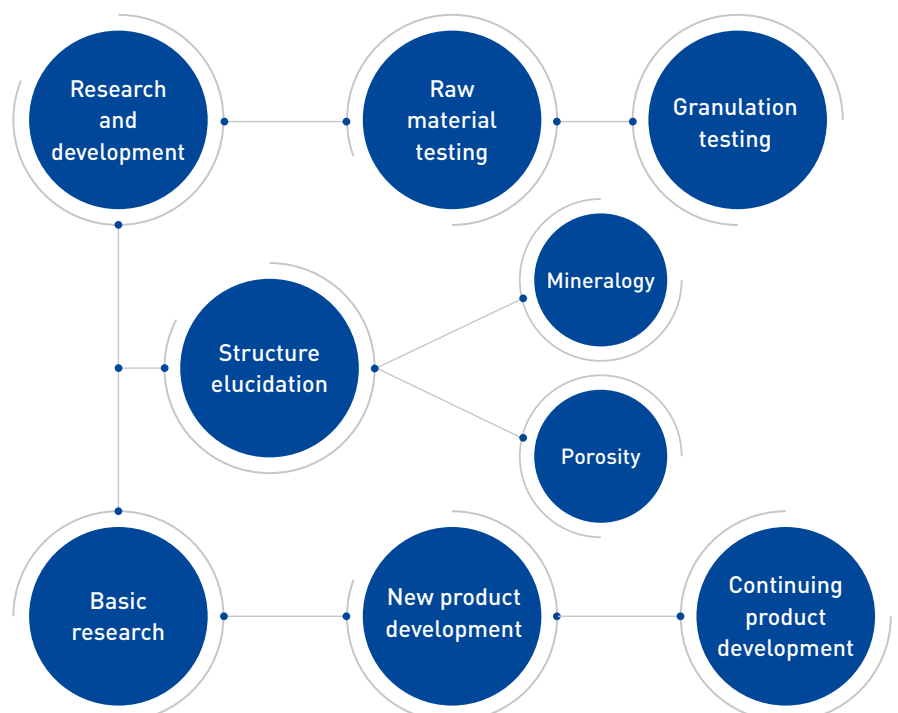
New Products with  
Short Development Times



## Determination of the Physical and Chemical Characteristics of the Raw Materials and Commodities

Basic research is undertaken in the areas of product and process research. This is a subject far removed from plain theory, because the measurement of the physical and chemical characteristic values of raw materials and commodities is ultimately performed with a view to the actual development of innovative products. The research simultaneously focuses on current market requirements. Among others, alternative technologies and processes are developed and tested, which in some cases enable modern products to be manufactured in the first place.

Xella Technology and Research is equipped to allow tests to be performed on an industrial scale, following initial laboratory castings. If these are successful, the new formulations and/or processes can be transferred to production more rapidly. This significantly reduces the development time from the first idea to actual market launch.



“Where would we end up if everyone asked where we’d end up and no one went out to see where we would end up if we started going there?”

Kurt Marti (1921 – 2017)  
Swiss theologian, writer and poet

## Basic Research, Product Development, Pilot Plant

If you want to optimize building materials you have to understand their inner structures. Therefore, it is only possible to develop approaches of improving the characteristics of these materials by carrying out intensive basic research. If, for example, the insulating effect is to be improved, it is essential to take into account compressive strength in the development phase. This makes achieving the one without neglecting the other a continuous balancing act. At the Xella Technology and Research pilot plant, the porosity and crystalline phases – which have a significant effect on the finished building material – are, for instance, selectively controlled.

In the area of product development, innovative approaches to calcium silicate units are developed and tested alongside new formulations for autoclaved aerated concrete (AAC) and mineral insulation boards: In order to produce calcium silicate units with a higher bulk density and, therefore, better noise insulation, the suitability of special filler materials is tested and researched. At the same time, we also investigate the use of lightweight aggregates for improving the insulating properties of kicker courses.

Various characteristics of autoclaved aerated concrete (AAC) granulates are optimized, including water absorption, oil retention capacity, filling volume, dust generation during use, bulk density and capacity for odor generation.

Xella Technology and Research also undertakes research activities when it comes to supplying the market with premium cat litter products.





# 850

## Lab Castings

as part of research projects  
per annum



# 300 m<sup>3</sup>

## Trial AAC

per annum from industrial-scale trial castings to ensure the  
smooth transfer of new products to production

“Research is the transformation of money into knowledge; innovation is the transformation of knowledge into money.”

Hans-Jörg Bullinger  
Former President of the Fraunhofer Society



## Raw Material Testing

The most important requirement for manufacturing high quality building materials is the quality of the raw materials used. To ensure uniform production quality, the raw materials used worldwide are tested to confirm their suitability and exclude fluctuations in their composition. Potential new basic materials are also subjected to strict suitability tests before they are used in production.

## Structure Analysis

In order to gain information about the internal structure of the material, autoclaved aerated concrete (AAC), calcium silicate units and mineral insulation boards undergo qualitative and quantitative phase analyses using X-ray diffraction (XRD). Thermogravimetric analyses on the basis of decomposition reactions allow additional conclusions to be drawn regarding phases contained in the samples investigated.

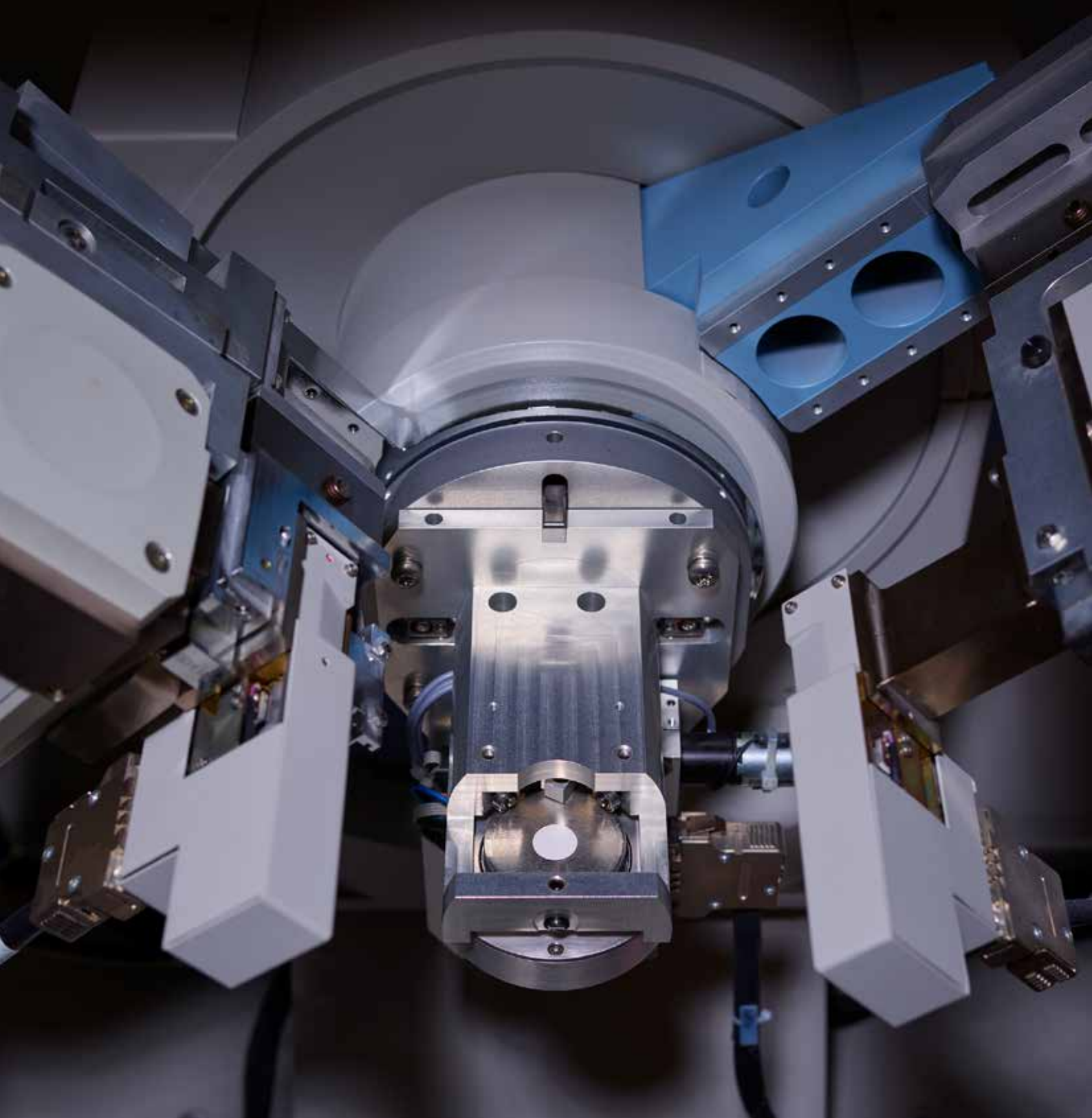
The macropore distribution is investigated using two-dimensional image analysis. Both the micro- and nano-porosity – which have a significant effect on the hygric properties – are researched in cooperation with external institutes.

# 1,200

**Chemical Analyses**

for research projects and quality assurance  
purposes per annum





# 1,600

Quantitative  
XRD Phase Analyses

of which 1,000 analyses for research and  
development per annum

# Applied Research/ Building Physics



## Robustly Withstanding Peak Loads

The Applied Research/Building Physics department is investigating how new building materials by Xella are set to prove their worth in practice in future. At the testing and experimental facilities the building materials are subjected to extreme stresses such as heat, frost, humidity, wind pressure and wind suction. The testing capabilities also include the simulation of stresses such as those arising during earthquakes.

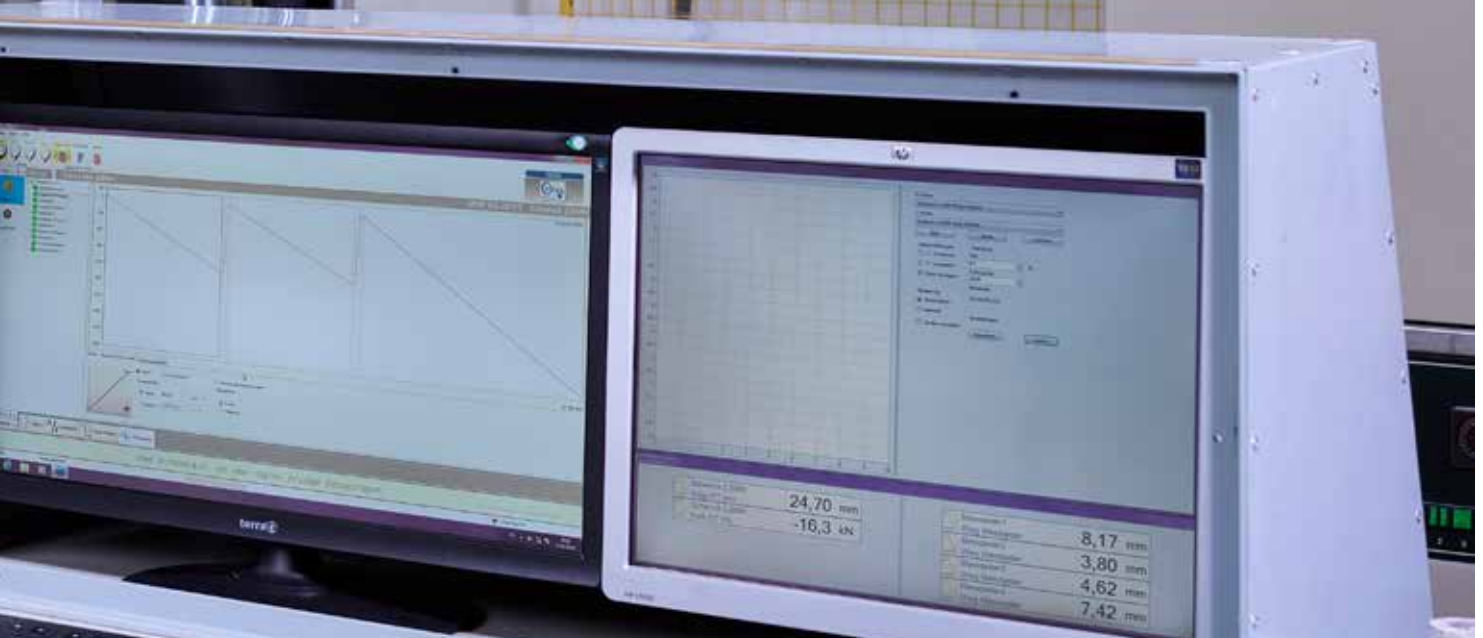
In addition, the department is involved in developing and testing new components and building systems. Alongside building materials, these include the associated assembly and anchoring systems. As soon as new products have demonstrated their suitability during the stringent tests, Xella Technology and Research obtains all of the national and European technical regulations that are required.

“Earthquake safety is one of the greatest challenges facing modern building materials.”

Dr. Lorenzo Miccoli  
Applied Research/Building Physics



## Research that Benefits Living Quality



# 90

### Masonry Tests

per annum

The subject area of building physics addresses both living quality and health as well as safety of use in buildings – including thermal, moisture, sound and fire protection.

A further focus is placed on reducing energy losses via thermal bridges. Measures that improve sound insulation in buildings make an equal contribution to improving the wellbeing of residents.

On the basis of these theoretical and practical investigations we are continuously working on new solutions for modern, healthy and safe living.

Last but not least, planners and clients also receive competent support with the development and use of modern software and measurement technology.



# 100

## Suitability Tests

per annum on renders and plasters, including materials testing

## Suitability Tests on Plasters, Mortars and Thermal Insulation Composite Systems

Building involves so much more than simply first class blocks. Renders, plasters and mortars must also meet high standards of quality and must be matched with the blocks. Xella Technology and Research therefore performs myriad investigations and tests in its climate chamber – and also during long-term observation in the open air.

External manufacturers also utilize these proven test methods and have their rendering and plastering systems tested at Xella Technology and Research. An initial test is carried out on each thin-bed mortar to assure the system quality.

Furthermore, we also develop new products here designed specifically for use with Xella building materials – for example a light-weight thin-bed mortar for highly thermally insulating AAC.

# 800

## Material Tests

on renders, plasters and masonry mortars per annum





## Sound Insulation and Acoustics

# 70

**Acoustic  
Tests**

on wall systems per annum

Since 2004, Xella Technology and Research has been equipped with a test stand for performing acoustic analyses on walls. This test stand also takes into consideration the boundary conditions defined in the ISO 10140 standard which relate to room sizes and reverberation times. In addition to single or double-leaf walls of solid construction, drywall systems, noise protection walls and supplementary products can also be tested here.

As standard, the sound insulation factors are determined in the one-third octave mid-band frequencies of 50 Hz to 5 kHz. Further measurements are made as required, for instance to determine the dissipation factor.

Moreover, the Building Acoustics working group takes care of the development of specific software solutions for noise insulation and is a member in various standardization and association committees.

# Fire Protection

Fire and heat-resistant building systems can save lives in the event of an emergency. Therefore, meeting the fire prevention requirements can also be deemed an explicit quality attribute. Xella has always had an excellent reputation as a manufacturer of non-combustible mineral construction materials. To ensure this reputation is maintained, the fire testing facility – which was opened in 2016 at Xella Technology and Research – is investigating how long components and systems are able to withstand a fire. Autoclaved aerated concrete (AAC)

and mineral insulation boards are characterized by their excellent fire-protection properties and, with their qualities combined, guarantee a high level of safety in terms of fire resistance:

- Excellent thermal insulation, even at high temperatures (fire)
- No smoke or toxic gases are generated
- Low degree of deformation under the effects of heat





# 40

## Climatic Tests

on external thermal insulation  
composite systems per annum



## Thermal and Moisture Protection

The statutory requirements relating to saving energy in buildings are already strict – and will become even stricter with certainty. In order to implement these requirements, the physical relationship between thermal insulation, building materials and moisture transport and accumulation is investigated and evaluated during thermal simulations of components/buildings.

For this purpose, Xella Technology and Research is developing and broadening appropriate software solutions for determining the thermal energy demand of buildings and for minimizing thermal bridges at the detailed planning stage.

The thermal refurbishment of old buildings requires specific technical expertise. Xella Technology and Research performs one- and two-dimensional hygrothermal component simulations and investigates the suitability of complex structures even at the planning stage

Using our own measuring equipment, the airtightness of buildings is checked and thermographic images are used to localize thermal bridges. Finally, the quality of planning and construction work can be examined on finished buildings, any damage traced and defects detected.

# 1,500

## Thermal Bridging Calculations

per annum

“Reflecting the real-life application of building systems in the course of inspections continuously creates new incentives in our day-to-day work!”

Franz Loderer  
Head of the Department  
Applied Research/Building Physics

# Accredited Test Center



“Each test order brings with it diverse and varied work as well as new aspects and challenges every day.”

Henry Hantschick  
Head of the Department  
Accredited Test Center



## Quality Monitoring Building Material Tests Construction Products Regulation

Xella Technology and Research has been an accredited test center since 2011 and is responsible for the areas of quality monitoring, building material tests and compliance with the Construction Products Regulation for the European market. Product testing of autoclaved aerated concrete (AAC), calcium silicate units and mineral insulation boards for Xella Building Materials and for external customers

and monitoring of our factory production control (FPC) assures both the quality of our products and of their associated declared values. The Construction Products Regulation has defined the harmonized conditions for the marketing of construction products since 2013. Within the business unit Building Materials, Xella Technology and Research functions as the representative of the

various countries towards the market supervision authorities. It ensures compliance with this regulation and checks that the requirements are being met at the respective Xella plants during CE assessment inspections with external auditors.

## Quality Monitoring

The test center prepares test plans for the plants and monitors the product characteristics. The in-house production control system at the plants is also accompanied by us.

This ensures that for autoclaved aerated concrete (AAC), calcium silicate units and mineral insulation boards that product characteristics such as compressive strength, bulk density, thermal conductivity and shrinkage meet the approval requirements and product standards.

# 2,760

### Series Tests

of compressive strength, sorption, water absorption, freeze-thaw resistance per annum



# Building Material Tests and Internal Product Release

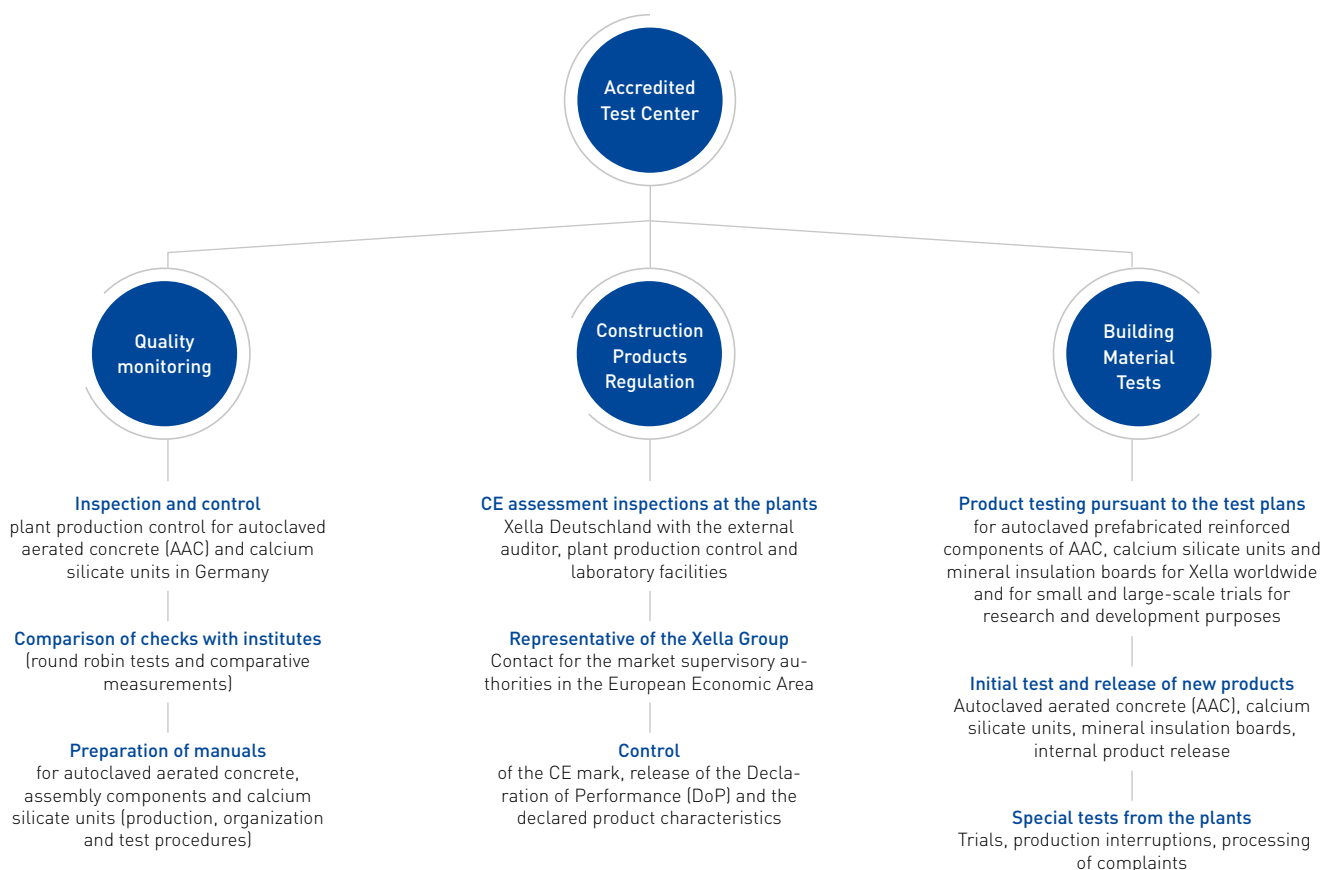
For new products, initial tests are always performed separately for each plant. If all of the target values have been met, the product is released internally. This ensures the quality of our products right from the start.

Only then may the respective product be produced and marketed. In the event of interruptions to production, special tests are performed and analyzed to identify the cause and proposed solutions prepared.

# 30

**Plants Sampled**

Quality monitoring for 30 AAC Xella plants per annum





## Construction Products Regulation

In line with the Construction Products Regulation, which is applicable throughout the EU, Xella Technology and Research is the testing center and thus the representative of the Xella Group as well as contact for the market supervisory authorities in the individual countries.

The testing center checks the marking of products and issues the release of Declarations of Performance in the individual countries. During joint CE assessment inspections with the external auditor, the center checks for compliance with the Construction Products Regulation at the Xella plants.

# 4,500

**Shrinkage Tests**

Quality monitoring, per annum

## Accredited Test Procedures

The accredited test procedures include mechanical-technological and physical tests of building products. These tests enable the test center at Xella Technology and Research to investigate all of the relevant properties of the building materials produced by Xella: autoclaved aerated concrete (AAC), calcium silicate units and mineral insulation boards.

Determination of the dry bulk density and moisture content is equally as important as ascertaining the tensile and compressive strength and the behavior under bending stress.

Thermal conductivity is an important parameter in terms of constructing more energy-efficient buildings. Furthermore, the water absorption

of autoclaved aerated concrete (AAC) and insulating materials is determined and the freeze-thaw resistance of calcium silicate units is tested. Alongside building materials, further products are also subjected to testing. For example, reinforcing steels and their resistance to corrosion.

# On the Trail of the Calcium Silicate Hydrate Phases

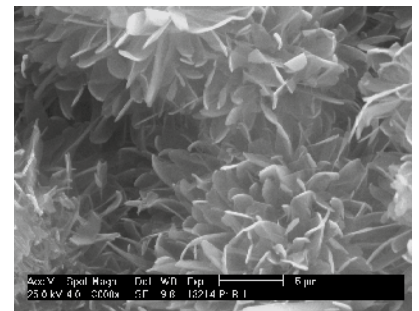
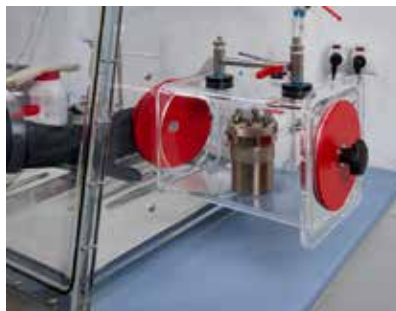
Basic Research and Product Development





“Optimizing the mineral phase composition of our products to ensure that very good thermal insulation goes hand-in-hand with high compressive strength is a focal point of material development.”

Dr. Berit Straube  
Head of the Department  
Product and Process Research



For many tasks in the area of basic research – in the field of calcium silicate hydrate chemistry (CSH chemistry) for instance – the laboratory glovebox offers considerable assistance. It facilitates working under inert gas atmosphere conditions, e.g. high-purity nitrogen. This prevents samples for special CSH phase syntheses from reacting with the carbon dioxide in the air – and consequently from forming carbonates before the reaction takes place. This process simultaneously prevents the trial results from being distorted and, therefore, rendered unusable.

Working in the glovebox allows the CSH phases and their crystallization behavior to be studied and specifically influenced.

The glovebox is divided into three areas: a storage area, a sample preparation area (in which work is performed from the outside using gloves) and an air-lock.

The air-lock allows raw materials and samples to be placed into and removed from the box without the penetration of atmospheric gases.

# Comprehensive Investigation of New Products and Systems

Structural Components and Building Systems – Testing and Release



The Applied Research and Building Physics department undertakes comprehensive investigations of new products on the basis of normative or internally defined trial and test procedures. The aim is to verify durability and load-bearing capacity together with the application safety of components and building systems and their use in practice.

On this basis, releases are issued for the production and use of the products. Corresponding hardware is available for the test methods and processes used (many of which are accredited).

During determination of creep resistance the long-term behavior and long-term durability of the building materials is tested and evaluated. The picture shows a test bench that was especially constructed for this purpose during the stress phase of an analysis. The picture shows the determination of the flexural strength of masonry according to EN 1052-2.



## Examples of These Processes Include:

- Determination of the compressive, bending and initial shear strength of masonry
- Measurement of the heat transmission resistance of wall structures
- Determination of the bending and shear resistance of lintels
- Testing of the creep behavior of autoclaved aerated concrete (AAC) and calcium silicate units





# It's All About the Right Data!

Accreditation of Product Testing



Xella Technology and Research has written assurance from the highest level that work is performed reliably, safely and properly in its laboratories and testing facilities. More precisely, in 2011 the Deutsche Akkreditierungsstelle (German Accreditation Body – DAkkS) issued the center with accreditation, thereby placing Xella Technology and Research on the same level as internationally acclaimed and independent testing institutes.

In line with the quality management system, the test procedures are repeatedly checked internally for up-to-dateness and conformity to the standard – and they are adapted as necessary. Furthermore, the test instruments themselves are monitored and employees correspondingly trained. This “testing of the test” is

regularly checked by DAkkS in co-operation with external technical assessors. Apparatus and test procedures are also assessed, as is the specialist knowledge of the employees. Reaccreditation in 2016 not only confirmed the number of accredited test procedures, but expanded them significantly to 65 versus 19 in 2011.

Today, most of the test procedures for evaluating the material characteristics of blocks and of building acoustics are accredited. Furthermore, the certificate also applies to a large number of tests on mortars, masonry and supplementary components.





“There are two things that are necessary to our work:  
tireless perseverance and the willingness to throw away  
something that you put a lot of time and effort into.”

Albert Einstein (1879 – 1955)  
theoretical physicist, scientist and Nobel Prize winner





# 50

## Standardization and Association Committees

have our specialists on-board

## Representing Interests

Alongside our involvement in specific projects, membership and continuous collaboration in national and international professional associations is important. This is where, among others, issues connected with masonry, environmental protection and building physics, or even specialist subjects relating to the characteristics of the building materials, are dealt with – and much more.

Of particular significance is our presence on standardization committees: Xella Technology and Research is represented on various DIN technical committees and working groups and on the European Committee for Standardization (CEN: Comité Européen de Normalisation).

Especially in the areas of safety, quality standards and standardization it is necessary to chart developments and, where possible, help shape them. Within the business unit Building Materials, Xella Technology and Research is involved when decision-making criteria relating to strategic direction are being formulated.

Within Xella Building Materials, there are myriad links to further national and international initiatives, associations and societies that deal with both technical issues and sustainable aspects.

As the leading player in the building materials sector, Xella is represented by its foreign subsidiaries in all of the relevant national industrial associations. This means that in all of its markets Xella is always in touch with the latest trends, is able to leverage synergies between the countries and can already develop products today that meet the requirements of tomorrow.



# International Collaboration

As part of a company with global operations, the fields of activity of Xella Technology and Research are not tied to national borders. Whether America, Asia or Europe: a new product must frequently also meet specific local/regional requirements. International networks are built up in cooperation with the Xella foreign subsidiaries – and also in partnership with universities, research institutes or other companies.

New products and applications can therefore be developed both at Xella Technology and Research and also in

cooperation with partners. A pool of experienced project engineers forms the key basis for the successful launch of new products in the different countries.

Our project partners include the Karlsruhe Institute of Technology (KIT), the German Federal Institute for Materials Research and Testing (BAM), the Fraunhofer Institute, the Tongji University in Shanghai and the European Centre for Training and Research in Earthquake Engineering in Pavia (Eucentre).

## Joint Research at European Level

Our innovation strategy also involves collaborating in third party funded joint research projects. The route we select in this content depends entirely on the respective requirements and opportunities. Xella is increasingly pursuing an "open innovation" concept that opens up our innovation process to the outside world like a FabLaB (fabrication laboratory). This approach makes it possible to use a broader range of ideas and experience in the development of products and processes. However, it is clear that benefitting from external networks and cooperations while simultaneously making a contribution to the joint project will become an increasingly important aspect.

In 2017, Xella Technology and Research participated in seven joint research projects. For instance, one of these involved the development of structural elements for new and existing buildings. The aim here is to achieve reduced energy and resource consumption for residential buildings.

A further research highlight is a basic investigation on a monolithic and recyclable building block that is manufactured by using a nanoporous filler in a resource-efficient manner. At the end of this research, this block should have excellent insulating properties, even without a separate thermal insulation composite system.



The development of an autoclaved aerated concrete (AAC) granulate for recovering phosphorus from wastewater treatment plants is also among the strategically important joint research projects. Project sponsors include the European Union, the European Regional Development Fund (ERDF) and the German Federal Ministry of Education and Research (BMBF).



“For us, resource efficiency primarily means that we want to close material cycles – at regional, national and European level.”

Dr. Oliver Kreft,  
International Projects

# 100,000

**Euros**

raised in public funds  
for international joint  
projects per annum





# 380

Participants

DEKRA-certified energy consultants pursuant to EnEV since 2009

## Knowledge Management – Technical Seminars and Events

The management, consolidation and promotion of specialist knowledge are the keys to corporate success. With this in mind, Xella Building Materials started to focus many years ago on diverse training initiatives in a range of human resource development programs for employees as well as on external skills. Xella Technology and Research plays an important role as a center of science – where knowledge is literally created. This also makes it a center of teaching and knowledge sharing.

To complement this, a wide range of training programs and lectures take place at the Emstal site. Selected customer groups, such as architects, engineers, specialist planners, self-employed people in the building and related industries, master craftsmen and many others are able to gain an impression of the competencies and facilities of Xella Technology and Research by taking a look behind the scenes. Of course, employees of the Xella sister companies also receive training in the fundamental subjects.



“Each year we welcome hundreds of guests from all over the world, with whom we share our knowledge during qualified technical seminars, conferences and conventions. But it’s not just pure theory – hands-on trials and exciting insights into our research are also part of it.”

Ines Zielke  
Communication/Information



# 760

## Participants

at sound insulation and thermal bridge seminars since 2013

Furthermore, national and international events are held where experienced speakers provide interdisciplinary information on the basis of current topics from their day-to-day work.

Also, a large number of continuing education events take place within the framework of Xella’s own “Ytong Silka Academy”. Those who want to qualify, for instance as an energy consultant or structural damage appraiser, can be trained at our seminars. Participants then sit an official examination for certification by Dekra.

Knowledge management therefore includes a compact and simultaneously comprehensive entry into training and continued training – on a high level and in various subject areas. In other words: the development of Xella Building Materials rests on a modern and secure foundation.



# 40

## Publications

in national and international  
specialist magazines per annum

## Sharing Knowledge

The employees of Xella Technology and Research are in constant international communication with other experts in their specialist fields.

They attend – as speakers or delegates – regular lectures and conferences, such as the International Conference on Autoclaved Aerated Concrete (ICAAC) and the Building Chemistry Convention of the German Chemical Society (GDCh). Specialist conferences, such as the German Masonry Convention and the DAGA Acoustics Conference of the German Society for Acoustics are also firm events on the calendar.

Furthermore, the experts of the Xella Group publish articles in specialist magazines such as “Mauerwerk” (masonry) and “Bauphysik” (building physics). In addition, the reference book “Eurocode 6 – Design of Masonry Structures” was compiled and issued in 2017.



# Intellectual Property Rights

The Patent Management department is a true think tank for Xella and is also housed in Xella Technology and Research. This is where all matters pertaining to the subject of “property rights and patents” are bundled. For this purpose, Xella Technology and Research maintains contact with the external patent attorneys engaged by Xella and also systematically monitors property rights for Xella Building Materials.

Xella Technology and Research is also the point of contact for all of the group's employees who have an innovative idea they would like to patent.

This is where all the contacts to Xella Building Materials inventors are combined, allowing it to optimally use the pool of innovative and manifold ideas streaming from the company.

And: The potential of employees is vast. Within the last decade Xella has filed patent applications for 90 inventions and currently holds 200 industrial property rights.

The Patent Management department also undertakes special research and offers specialist support during applications for registering industrial property rights and for appeal and infringement actions.

# 90

## Inventions

2008 - 2018



# 200

## Property Rights

patents and utility models worldwide

“Patents are the icing on the cake of our research results – granted for new materials, applications or processes.”

Dr. Hartmut Walther  
Quality and Patent Management



## Deposits

# 150

### Assessments

of sand deposits on four continents

As a manufacturer of mineral building materials, Xella must be able to obtain sand of a suitable quality for all of its production sites. The research, examination and assessment of sand deposits in Germany, Europe and throughout the world is an important task of the Quality Management department of Xella Technology and Research. In terms of cement, quicklime and gypsum, it is also necessary to assess potential raw material suppliers.

Between 2012 and 2017 more than 150 sand deposits in Europe, Asia, Australia and Africa were visited to take samples. They were then assessed for their suitability as raw material suppliers for autoclaved aerated concrete (AAC) or calcium silicate units. The tasks furthermore included supporting future licensees (e.g. in India, China, Georgia and South Africa) with initial research.

However, the work of Xella does not end with the use of raw materials. Sand pits, for instance, that are no longer used are being comprehensively recultivated.

## Environment

Products from Xella are ecologically mature and have environmental certificates that meet international standards. Xella Technology and Research performs important work, both during the preparation of new Environmental Product Declarations (EPDs) and in terms of the rules for their preparation (Product Category Rules-PCRs).

Although EPDs and PCRs are still very young tools in the sector of environmentally friendly building, Xella can already look back on important experiences in this field. For instance, the first PCR of the Institut Bauen und Umwelt (IBU) for autoclaved aerated concrete was prepared in 2002. Xella provided important fundamental work for this.

At Xella, the Technology and Research department is responsible for processing issues relevant to health and the environment and sends representatives to key German and European committees and associations – for example to the Board of IBU (Institut Bauen und Umwelt).



# 20,000 m<sup>2</sup>

Outdoor Testing Grounds

at the Emstal site

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**Xella Technologie- und  
Forschungsgesellschaft mbH**

Hohes Steinfeld 1  
D-14797 Kloster Lehnin

**Xella Technologie- und  
Forschungsgesellschaft mbH**

Gregor-von-Brück-Ring 9A  
D-14822 Brück

[forschung@xella.com](mailto:forschung@xella.com)  
[innovation@xella.com](mailto:innovation@xella.com)  
[www.xella.com](http://www.xella.com)

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