

## Sustainability Study



## Life-cycle Assessment of Floor Coverings

## Contents

|   |           |
|---|-----------|
| Sustainable Building Using Natural Stone (Foreword DNV) | 4         |
| <b>1 Summary</b>  | <b>5</b>  |
| <b>2 Adopted Methodology</b>                            | <b>8</b>  |
| 2.1 Life-cycle assessment methodology                   | 8         |
| 2.2 Procedure   | 9         |
| 2.3 Study framework                                     | 14        |
| <b>3 Life-cycle Assessment Results</b>                  | <b>15</b> |
| 3.1 General aspects                                     | 15        |
| 3.2 Environmental impacts of the substructure           | 15        |
| 3.3 Service life of the floor coverings                 | 16        |
| 3.4 Environmental impacts of the floor coverings        | 17        |
| 3.5 Benefits of natural stone                           | 18        |
| <b>4 Life-cycle Costs</b>                               | <b>21</b> |
| 4.1 Data collection                                     | 21        |
| 4.2 Procurement costs                                   | 21        |
| 4.3 Cleaning costs                                      | 21        |
| 4.4 Refurbishment costs                                 | 21        |
| 4.5 Disposal costs                                      | 21        |
| 4.6 Results   | 22        |
| <b>5 Bibliography</b>                                   | <b>23</b> |
| Appendix A Description of assessed variables            | 24        |
| Appendix B Life-cycle assessment study data calculation | 26        |

## Sustainable Building Using Natural Stone

Sustainable building has gained in importance in recent years. The meaning of *Sustainable building* is the consideration of ecological, economic and social aspects in planning and construction processes and real estate management. Germany has been working on the fundamentals and guidelines for the *Sustainable Building Round Table*, established by the Federal Ministry of Building, since 2001. One of the results of this work is the *Guide to Sustainable Building* by the Federal Ministry for Environment, Nature, Building and Nuclear Safety, which is used as a planning guideline for public construction projects.

A certification system for sustainably designed and constructed buildings has been developed, in particular thanks to the activities of the German Sustainable Building Council (*Deutsche Gesellschaft für Nachhaltiges Bauen*).

The German *Sustainable Building* seal of quality includes a catalogue of around 50 criteria which quantify numerous aspects for planners, architects, builders, etc.

Internationally, *sustainable building* is often equated with the term *green building*. A similar certification system has existed in Great Britain for many years. The BREEAM system also assesses the buildings environmental performance, including social and health aspects, but does not evaluate economic performance. In the US, the LEED system was developed by the US Green Building Council. The system is now also used outside the United States for planning energy-efficient and green buildings. To date, the LEED system does not use a total building life-cycle assessment to evaluate the ecological performance of a building, but instead bases the ecologically motivated selection of materials on the evaluation of individual properties. For example, in the LEED system, a rating is given for materials and construction products that are transported less than 800 kilometres to the construction site.

Today, the topic of reducing energy demand and CO<sub>2</sub> emissions is becoming increasingly important. Because the construction sector makes a major contribution to global CO<sub>2</sub> emissions and energy consumption, construction products should also have the lowest possible environmental impact in their manufacture and use, right through to disposal, taking economic aspects into account. Each year, more than 350 million square metres of new floor coverings are laid in buildings in Germany alone.

For these reasons, the Deutscher Naturwerkstein-Verband e.V. (*DNV – German Natural Stone Association*) commissioned a study by the Institute of Construction Materials at the University of Stuttgart, which compares the ecological and economic impacts of different floor coverings from the production to the use phase.



Joachim Grüter  
President of the German Natural Stone Association

## 1 Summary

The object of this study is to determine the ecological performance of different floor coverings used in a variety of public and commercial applications. The ecological impact of a load-bearing structure comprising concrete base, insulation layers and screed for the different floor coverings, including the necessary mortar, was also studied in a life-cycle screening procedure. The data was collected from existing environmental product declarations (EPD) issued by the various building material manufacturers.

Natural stone floor coverings predictably achieve very good life-cycle assessment results, due to the low primary energy demand of the stone. According to the German *Bundesverband Baustoffe – Steine und Erden* (Federal Construction Materials Association – Non-metals), the costs of energy consumption for processing natural stone are a mere 3.3% of the production value.



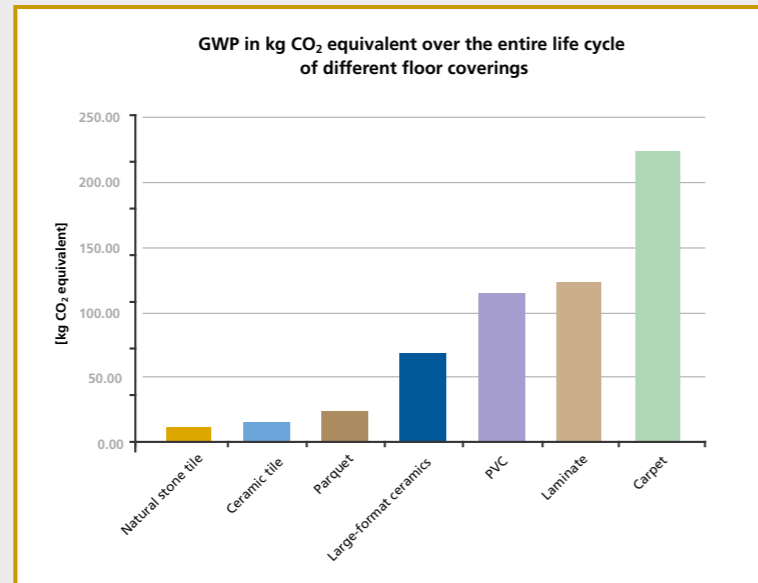
1+2: Art Gallery, Auckland, New Zealand  
Dietfurt Limestone

3: Ludwig-Erhard-Haus, Berlin  
Krystal Marble

A comparison of all floor coverings showed that those produced from natural stone cause a significantly lower environmental impact in their production, installation and use than large-format ceramics, carpets, PVC, laminates and parquet.

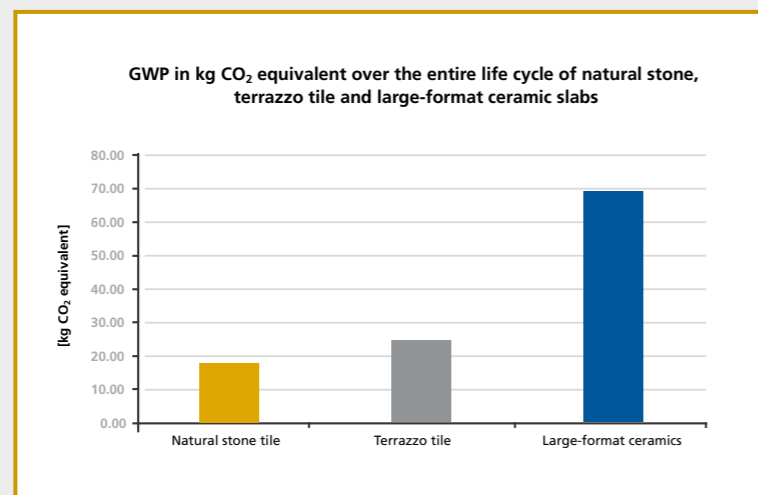
In the especially important category of global warming potential (GWP) impact, the production and utilisation of floor coverings using natural stone tiles display significantly lower CO<sub>2</sub> equivalents than the production and use of other covering materials. At 10.9 kilograms CO<sub>2</sub> equivalent, the lowest emissions are attributed to the GWP of natural stone tiles, together with the associated adhesive mortar. The GWP of a carpet is with a value of approx. 223 kilograms CO<sub>2</sub> equiv. more than 20 times higher than for a natural stone tile (See Figure 1).

Figure 1: GWP for different floor coverings



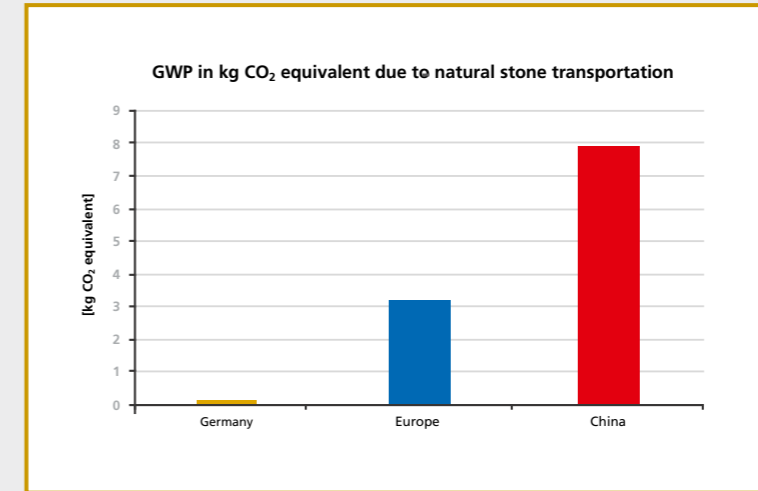
When investigating coverings used for the highest performance floors, it was found that equivalence values for natural stone slabs are lower in all impact categories compared with terrazzo tiles. For example, the GWP of a natural stone slab is about 27% lower than that of a terrazzo tile and about 74% less than that of large-format ceramics.

Figure 2: GWP of slabs of different materials



Another important aspect of using natural stone is the influence of transportation. While only 0.16 kilograms CO<sub>2</sub> equiv. are produced when using local natural stone (100 km lorry transport), this increases to 3.2 kilograms CO<sub>2</sub> equiv. in the case of transport within Europe (2000 km lorry transport) and 7.9 kilograms CO<sub>2</sub> equiv. per square metre of flooring for natural stone from China (18,600 km by ship, 150 km by lorry and 200 km rail transport).

Figure 3: GWP from transportation of dimension stone

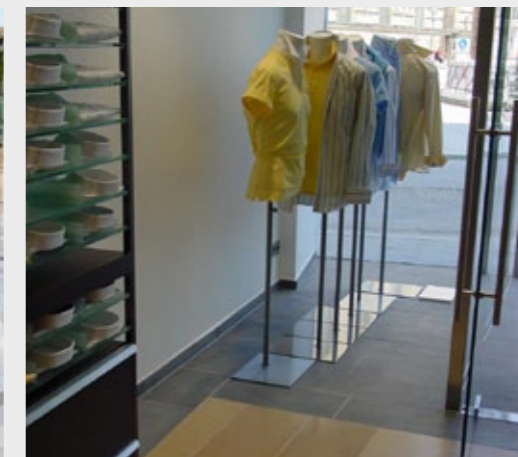


Representative environmental product declarations were selected for all flooring products studied. They contain verified values that may be anticipated for the various environmental impacts. The EPD of a product group with available EPD was selected as being representative of the respective floor covering. Missing information or undeclared modules for individual life-cycle phases were supplemented with appropriate assumptions, employing data from comparable EPDs or available databases such as *Ökobaudat* (eco building database) for the analysis.

An analysis of life-cycle costs, which depend significantly on the level of cleaning costs, is also included in the LCA study (see Section 4).



4



5

4: Shopping Centre Westfield, England Jura Limestone

5: Boutique, Munich Solnhofen Flooring

We would like to thank our **partners** for the generous support for this floor covering sustainability study:



**ZDNW – Zentralverband der deutschen Naturwerksteinwirtschaft**  
Weißkirchener Weg 16  
D-60439 Frankfurt am Main  
[www.zdnw.de](http://www.zdnw.de)



**Sopro Bauchemie GmbH**  
Postfach 42 01 52  
D-65102 Wiesbaden  
[www.sopro.com](http://www.sopro.com)



**Franken-Schotter GmbH & Co. KG**  
Hungerbachtal 1  
D-91757 Treuchtlingen-Dietfurt  
[www.franken-schotter.com](http://www.franken-schotter.com)



**Naturstein-Verband Schweiz**  
Seilerstrasse 22  
CH-3001 Bern  
[www.nvs.ch](http://www.nvs.ch)



**AKEMI chemisch technische Spezialfabrik GmbH**  
Lechstraße 28  
D-90451 Nürnberg  
[www.akemi.de](http://www.akemi.de)

#### Legal information

Published by:  
DNV  
Deutscher Naturwerkstein-  
Verband e.V.  
Sanderstraße 4  
D-97070 Würzburg  
Telefon +49 0931/1 20 61  
Telefax +49 0931/1 45 49  
[www.natursteinverband.de](http://www.natursteinverband.de)

Design:  
allegria design – Oppermann  
Munich  
[www.allegriadesign.de](http://www.allegriadesign.de)

Editors:  
Reiner Krug, Jana Kern

Copyright:  
Printed in Germany 2018

Printed by:  
bonitasprint, Würzburg

Photo credits ©:  
Title: Franken-Schotter, center: Wolf-Dieter Gericke for Lauster Steinbau  
Rear (from left to right): DNV, Johann Stiegler, Frank-Peter Funke fotolia.de

Internal figures:  
P.3 Richard Watzke.  
1+2 Franken-Schotter, 3 Wolf-Dieter Gericke for Lauster Steinbau, 4 Franken-Schotter, 5 Steinger Steinmetz, 6 brizmaker-shutterstock.com, 7 Wittaya Puangkingkaew-123rf.com, 8 Wavebreak Media Ltd-123rf.com, 9 Franken-Schotter, 10 Heinrich Quirrenbach Naturstein, 11+12 Wolf-Dieter Gericke für Lauster Steinbau, 13 Grafik Universität Stuttgart, 14 TRACO, 15 juan\_aunion-stock.adobe.com, 16 Jodie Johnson-stock.adobe.com, 17+18 Katarzyna Bialasiewicz-123rf.com, 19 Christian Hillebrand-stock.adobe.com, 20 Panom Pensawang-123rf.com, 21 fiphoto-123rf.com, 22 lightpoet-123rf.com, 23 dotshock-123rf.com

We thank our member companies for providing the image material.

The publisher reserves all rights, including those of reprinting abstracts, photomechanical reproduction and translation.

#### An additional contribution, to resource conservation:

The DNV Sustainability Study was printed on recycled paper (Enviro Top), which has been awarded the Blue Angel. This paper is produced in a climate-neutral way and without the addition of optical brighteners and chlorine bleach from waste paper. The Blue Angel is considered one of the world's most demanding environmental labels. The CO<sub>2</sub> printing and production emissions created during the manufacture of this study have been neutralised by DNV. To this end, the corresponding quantity of CO<sub>2</sub> emission was balanced by transaction ID DE-204-100815 on November 21, 2018.







Published by  
Deutschen Naturwerkstein-  
Verband e. V. (DNV)  
Sanderstraße 4  
D-97070 Würzburg  
Telefon +49 0931/1 20 61  
Telefax +49 0931/1 45 49  
[www.natursteinverband.de](http://www.natursteinverband.de)

Presented to you by: