SUSTAINABLE INFRASTRUCTURE PARTNERSHIP

INTERNATIONAL UNION OF RAILWAYS

ÖBB INFRA

VIEW OF A TRAIN TRAVELING IN AUSTRIA © AARONPLAYSTATION / ADOBE STOCK

AUSTRIA

PLANNING RAILWAY INFRASTRUCTURE AND CONSTRUCTING A LOW-CARBON INNOVATIVE GREEN BRIDGE IN AUSTRIA

2024

The International Good Practice Principles for Sustainable Infrastructure

set out ten guiding principles that policymakers can follow to help integrate sustainability into infrastructure planning and delivery. They are focused on integrated approaches and systems-level interventions that governments can make to create an enabling environment for sustainable infrastructure. This case study illustrates specific aspects of one principle in a country context, showing good practices and challenges, and considering potential for advancement or replicability.

GUIDING PRINCIPLE 4: AVOIDING ENVIRONMENTAL IMPACTS AND INVESTING IN NATURE

Adverse environmental impacts from infrastructure should be minimized, and natural capital enhanced to the greatest degree possible. Construction should be avoided in areas important for the persistence of biodiversity or having high ecosystem service value. The development of physical infrastructure should seek to complement or strengthen, rather than replace, nature's ability to provide services such as water supply and purification, flood control and carbon sequestration. Nature-based solutions should be prioritized.

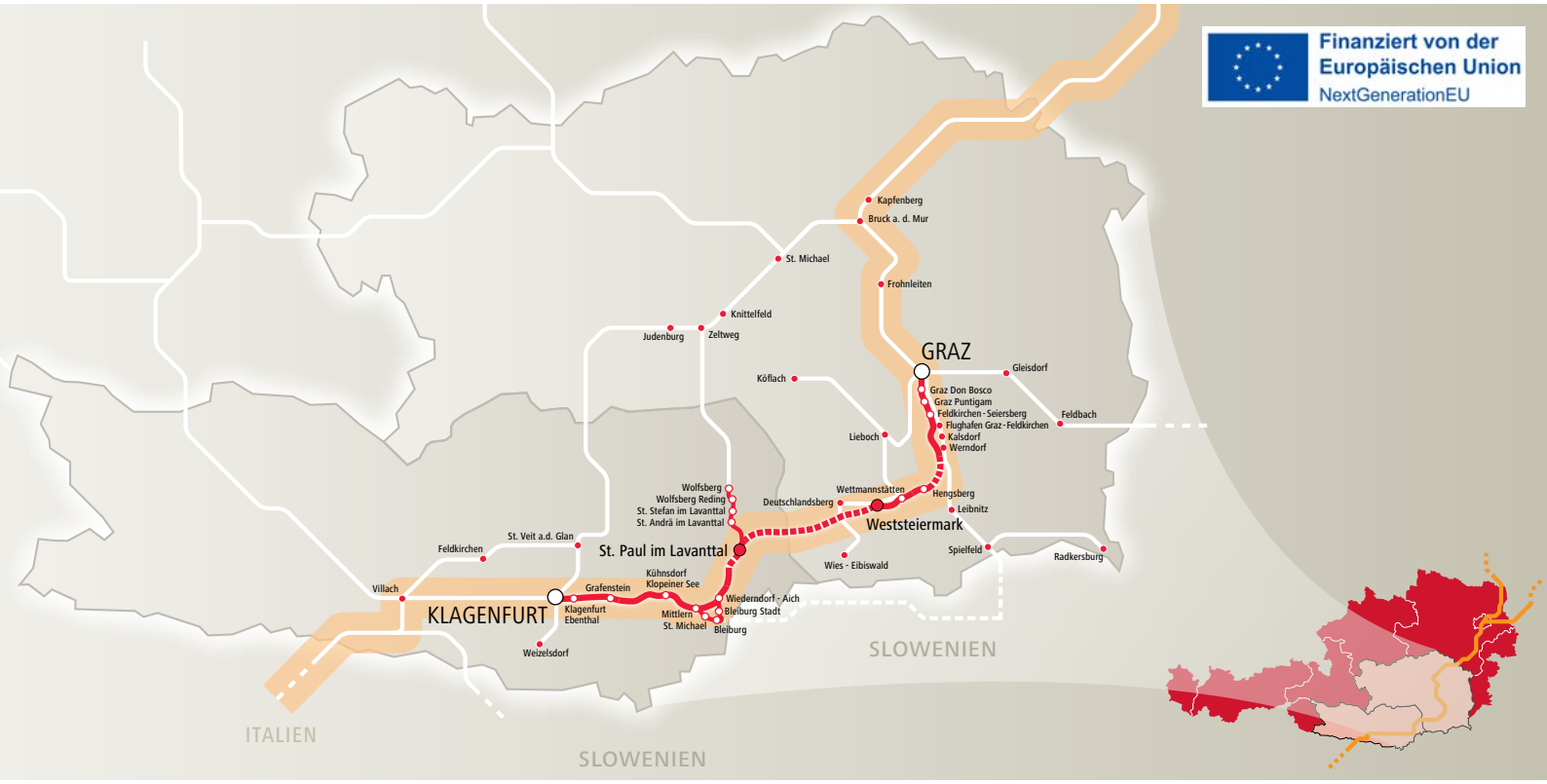
BACKGROUND

The Austrian government is investing historically high budgets into the improvement of the railway infrastructure of the country. These investments are triggered by a framework plan which covers six years and must be approved by the Austrian government. The actual framework plan (2024-2029) includes numerous railway infrastructure projects all over Austria and provides a budget of EUR 21.1 billion (Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology 2023).

The framework plan constitutes the political commitment to improve and expand national railway infrastructure as a means for sustainable development of the country. It is commonly agreed that, overall, railways are the most sustainable mode of mass transport of passengers and goods currently available. The use of railways is also considered to be an effective way of reducing energy and resource demand for transport, representing an important part of the solution to contemporary crises. In this context, large-scale railway infrastructure construction projects are planned and executed in Austria, as well as in many other European and non-European countries. However, the construction of new lines in an already highly fragmented landscape brings significant environmental challenges, due to the barrier effect of linear transport infrastructure. High-capacity lines in Austria, so-called high-performance lines, serving the transport of people and goods, are constructed for a maximum speed of 250 kilometres per hour but do not need to be fenced by law as a safety prerequisite. Nevertheless, the railway lines constitute a new, "artificial" linear object in the landscape, which can cut through traditional migration routes of wildlife.

PASSENGER TRAIN IN THE AUSTRIAN ALPS

FIGURE 1 RED LINE INDICATING THE NEWLY BUILT RAILWAY LINE, *KORALMBAHN*, CONNECTING THE TWO FEDERAL STATES OF STYRIA AND CARINTHIA IN AUSTRIA AND CREATING AN IMPORTANT ELEMENT OF THE BALTIC-ADRIATIC TEN-T CORRIDOR



Source: ÖBB-Infrastruktur AG

For one particular project, the new railway line called *Koralmbahn* between the cities of Graz and Klagenfurt in the federal state of Carinthia, a green bridge[1] was demanded following an Environmental Impact Assessment (EIA) in order to reduce the barrier effect of the railway-line running through the Dobrowa forest. The *Koralmbahn* is part of the Baltic-Adriatic Corridor, which represents one of the European Union's (EU) Trans-European Transport Network (TEN-T) railway-corridors and is co-funded by the European Commission. Railway infrastructure projects of this size are routinely subject to an EIA and, as a result, mitigation measures are defined to minimize the adverse effects of a new railway line.

CONCRETE SHELL GREEN BRIDGE IN THE DOBROWA FOREST

1 A green bridge is defined as a wildlife overpass with strips of vegetation (Borda-de-Água *et al.* 2017).

FIGURE 2 CONSTRUCTION PROCESS OF *KORALMBAHN* GREEN BRIDGE

Source: Benjamin Kromoser & ÖBB-Infrastruktur AG

INNOVATIVE CONSTRUCTION METHODS: A NEW TYPE OF BRIDGE IS BORN

In designing a green bridge for *Koralmbahn* to reduce environmental impacts, a new shell construction method called Pneumatic Forming of Hardened Concrete (PFHC) was developed at the Institute for Structural Engineering at Vienna University of Technology (TU Wien). This construction method is a very resource-efficient way of building a concrete bridge, where a plain concrete plate is blown up with a huge pneumatic tyre into the form of a shell, directly at the place of installation (Kromoser *et al.* 2018). Concrete shells are aesthetic and low-cost supporting structures, which can absorb high loads and span large areas with little material.

Since this construction method can be applied to building infrastructure assets such as bridges in the open countryside, but not for crossings of existing streets or railway lines, the Austrian Federal Railways (ÖBB-Infrastruktur AG) used it to build a green bridge as a fauna passage, in the form of a concrete shell bridge over the two rail-track *Koralmbahn*.

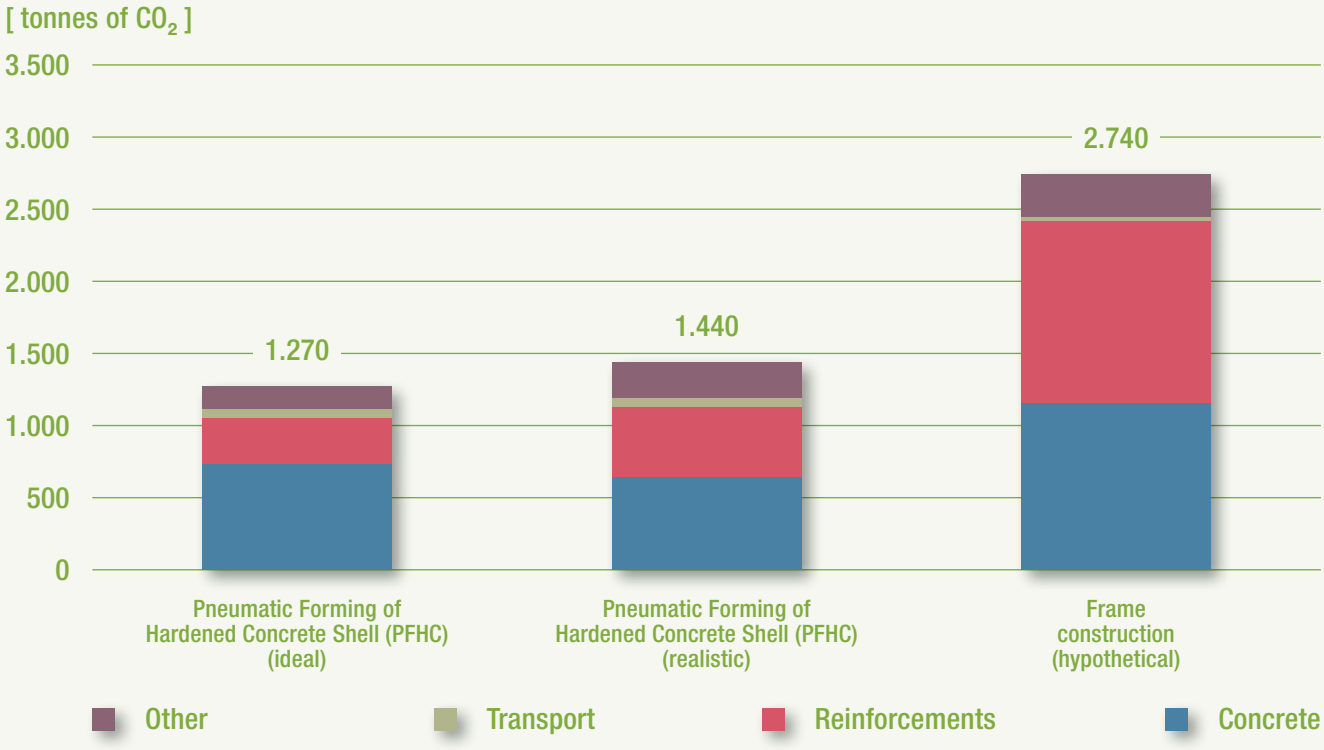
The green bridge represents the first of its kind, since it is the first time that this construction method has been executed at such large dimensions, subsequent to a series of preliminary experiments that were undertaken by Vienna University of Technology. Indeed, before the actual construction work of the green bridge started, ÖBB-Infrastruktur AG decided to build a mock-up first at the scale of 1:2 (ÖBB-Infrastruktur AG 2016). This mock-up served as a test construction and is now used as an event location by the local communities, thus providing additional co-benefits through efficient repurposing.

In comparison to a conventional frame construction with a large amount of armouring steel, the carbon footprint of the green bridge is significantly lower. With this innovative construction method, a carbon dioxide reduction of about 1,300 tons has been calculated (ÖKOPLUS 2018). This reduction of greenhouse gas (GHG) emissions represents the average annual emissions of more than 130 Austrians (Austria, Federal Environment Agency 2023). The concrete shell needs about 65 per cent less armouring steel and about 50 per cent less concrete, which leads to significant reductions of GHG emissions that are connected to the production process of steel and concrete (ÖBB-Infrastruktur AG 2016). Additionally, other emissions such as acidifying and eutrophic emissions are substantially reduced.[2]

An additional benefit of this construction method is that it is even more cost-efficient than the conventional construction method using a frame structure. The high-performance line started its operation at the end of 2023 in the Carinthian part. A monitoring programme, to verify if the green bridge is used as a wildlife crossing by the surrounding animal populations (as per below), is not foreseen currently but may be installed later on.

The green bridge's accomplishments in sustainability have led it to win the Infrastructure and Ecology Network Europe (IENE) project award at the IENE conference in Cluj, Romania, in September 2022 (IENE 2022).

FIGURE 3 GHG REDUCTION OF PFHC CONSTRUCTION METHOD COMPARED TO CONVENTIONAL FRAME CONSTRUCTION



Source: ÖKOPLUS 2018

2 See also United Nations Environment Programme (UNEP) (2022b) for linkages with Principle 5: Resource Efficiency and Circularity.

FIGURE 4 ARIEL VIEW OF THE *KORALMBAHN* GREEN BRIDGE, READY TO TAKE ON ITS ECOLOGICAL FUNCTION

Source: EVMedia

REDUCING LANDSCAPE FRAGMENTATION

Building a green bridge, especially at known hot spots like regional, national or international wildlife corridors, represents an important mitigation measure to reduce landscape fragmentation.

In this part of the federal state of Carinthia, the Dobrowa forest represents a relatively large forest complex that fulfils an important ecosystem function in this area. Dobrowa is a migratory corridor and stepping stone for the forest fauna from the southern alpine ridge of the Karawanken to the central woodlands of Carinthia. The PFHC green bridge ensures habitat connectivity and therefore reduces the risk of train–wildlife collisions, especially with large mammals, like roe deer, wild boar and red deer. Occasionally the Karawanken mountain-ridge is also used as a temporary habitat for brown bears. The population of brown bear is growing in the neighbouring country Slovenia, and there is a possibility that brown bears may start to forage in this area.[3]

Overall, this innovative type of green bridge therefore addresses two urgent ecological problems connected to the construction of transport infrastructure: GHG emissions caused by massive buildings made of steel and concrete, and landscape fragmentation, which is one of the most significant adverse effects of linear transport infrastructure.

3 According to the World Wide Fund for Nature (WWF), the brown bear population of the Balkans is the third largest in Europe (WWF Austria 2014). Most of the animals are living in the Dinaric area of Slovenia and only a few in the Slovenian Alps, but all of these populations are connected and exchanging by migration.

ENABLING PLANS AND STRATEGIES FOR SUSTAINABLE TRANSPORT INFRASTRUCTURE

As indicated, in a broader sense, the construction of *Koralmbahn* green bridge feeds into Austria's wider plans and strategies for infrastructure investment. Indeed, Austria's framework plan provides ÖBB-Infrastruktur AG, as well as the Austrian railway industry, with a projectable, stable and reliable instrument to work on all the infrastructure projects listed in the plan. Specific budgets are needed, because the projects do not depend on an actual federal budget of a current government. To a large extent, the Republic of Austria guarantees provision of the financing for the railway infrastructure investments by issuing bonds on the international market. In May 2022, Austria even launched its first green bond to obtain funds from sustainable investors for railway infrastructure investments (Austrian Treasury 2022).

A detailed treaty between the Republic of Austria and ÖBB-Infrastruktur AG also regulates the railway infrastructure financing process on the basis of specific acts. This is advantageous compared to other contexts, where railway infrastructure investments can be subject to short-term budgets and potential modifications following changes in political circumstances. The Austrian approach to investing in railway infrastructure was informed by economic studies which suggest that railway infrastructure investments generate a reasonable value-added to the national economy, meaning that the return on investment along the value-chain is very high (Berrer *et al.* 2018 and Ecorys 2014).

Austria's general policy and plans for sustainable transport infrastructure are laid out in Austria's Mobility Master Plan 2030 (Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology 2021). The Master Plan's overall goal is to achieve climate–neutral transport by 2040 by following the three underlying principles of avoiding, shifting and improving traffic. Additionally the same Ministry has published Austria's National Biodiversity Strategy 2030+, which also addresses the conflicts between traffic and biodiversity (Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology 2022). Traffic infrastructure providers are required to contribute to the targets, for example by building green bridges and taking such measures of landscape defragmentation.

REPLICABILITY

A substantial amount of new transport infrastructure is planned in Europe and in other regions around the world,[4] including in areas where habitats are not as heavily fragmented as in Europe.

The *Koralmbahn* green bridge project in Austria is the first in the world to apply the PFHC method. This new technology would also be applicable elsewhere in the world, because it does not require any specific local prerequisites. Detailed know-how for this particular technology would be available in Austria. It is much easier to build a bridge with this method for new transport infrastructure, so that the design can be incorporated early and effectively. It is less feasible to use the method for already-existing transport infrastructure, because this would require clearing the area from all infrastructure first.

Awareness around wildlife–vehicle collisions and landscape fragmentation is rising worldwide. There is an urgent need to promote innovative and sustainable technologies and methods, such as those detailed for the *Koralmbahn* green bridge, to avoid or mitigate the negative environmental impacts of transport infrastructure.

4 Worldwide, almost half a million kilometres (489,730 km) of road and rail development is planned or currently being built (UNEP 2022b).

KEY INSIGHTS

- The green bridge over *Koralmbahn* in Austria highlights how GHG emissions and landscape fragmentation should be reduced as much as possible for massive concrete constructions.
- The case demonstrates that even brand-new methods and technologies for infrastructure construction are not necessarily more expensive than conventional methods and technologies.
- Austria's overarching plans and strategies have helped enable the development of sustainable transport infrastructure solutions. Railway infrastructure projects provide a perfect environment for "field-proofing" new, innovative and sustainable construction methods and materials.

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