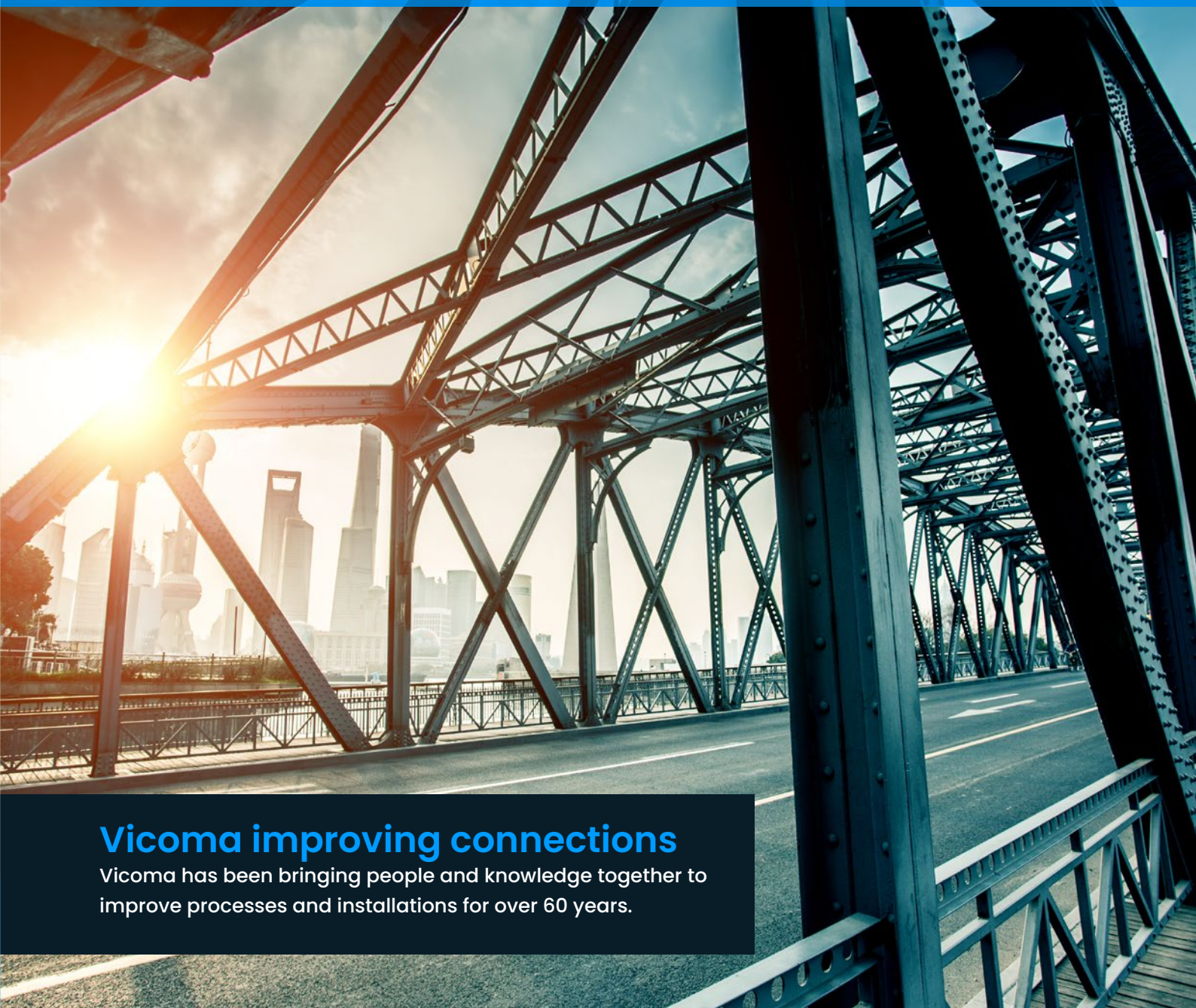
vicoma
Consultancy & Engineering

Service life extension of steel and concrete structures

Asset Management



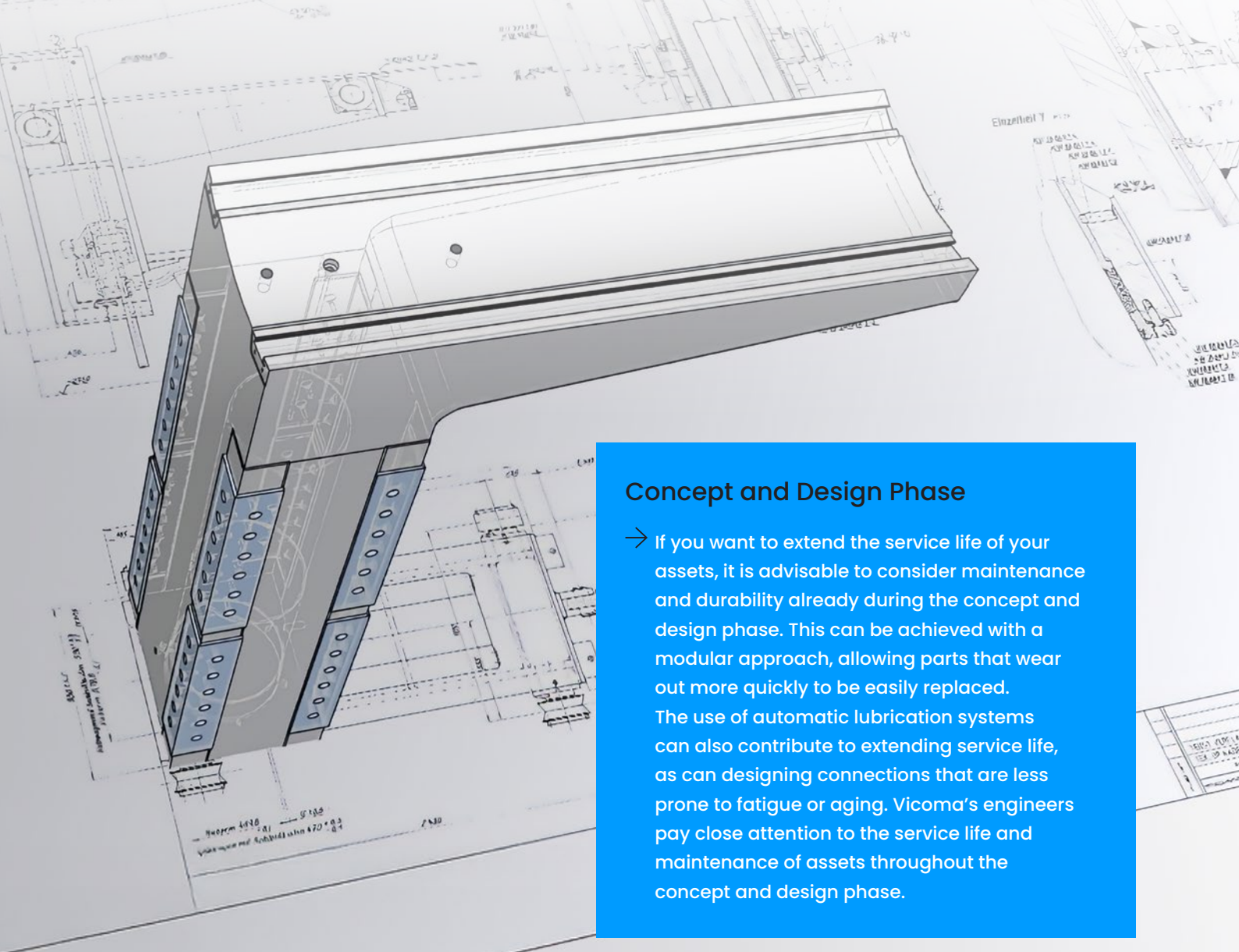
Vicoma improving connections

Vicoma has been bringing people and knowledge together to improve processes and installations for over 60 years.

Asset Management

Many bridges, locks and tunnels are reaching the end of their service life. Similarly, many companies face aging building structures, pipe bridges, pump foundations and installations that urgently require attention. Unfortunately, there is not enough budget for the complete renewal of all these assets. Therefore, maintenance aimed at extending the service life of aging assets is essential.

Sustainability and responsible business practices have become a high priority for many companies. Conserving and reusing raw materials such as steel, along with circularity, are becoming fundamental parts of business operations. Climate change is also playing an increasingly important role, with changing rainfall patterns and progressively drier summers. From the design phase onward, Vicoma collaborates to create sustainable, low-maintenance, and cost-efficient structures where components are easy to replace or recycle. In addition, we offer services to sustainably extend the service life of both steel and concrete structures. In this way, we can make a valuable contribution to the greening of assets.



Concept and Design Phase

→ If you want to extend the service life of your assets, it is advisable to consider maintenance and durability already during the concept and design phase. This can be achieved with a modular approach, allowing parts that wear out more quickly to be easily replaced. The use of automatic lubrication systems can also contribute to extending service life, as can designing connections that are less prone to fatigue or aging. Vicoma's engineers pay close attention to the service life and maintenance of assets throughout the concept and design phase.

Successfully and sustainably extending the service life of steel and concrete structures

Aging assets are assets where, over time and under varying loads, the risk of failure increases. One of the causes is fatigue. At Vicoma, we perform fatigue calculations on steel structures to determine their service life. We have over 25 years of experience in this field. By critically examining a structure and its details, sometimes small adjustments can significantly extend its service life.

Variable Loads

Fatigue in steel structures occurs because they are subjected to varying loads. Examples include traffic crossing a bridge, a crane lifting a heavy load, or a train rumbling over rails. Fatigue cracks often develop in the joints where two structural parts are welded together.

During welding, the material structure in the heat-affected zone (HAZ) changes drastically and uncontrollably. This is due to the brief introduction of heat followed by rapid cooling, which makes the material brittle. While the strength of both the material and the weld remains intact, the material properties have changed, making it more susceptible to issues such as fatigue.

Phases of Fatigue

Fatigue of steel is a process that consists of multiple phases:

- **Phase 1: Initiation of Microcracks**
  These microcracks form at locations where stresses are concentrated.
- **Phase 2: Growth of Cracks**
  In this phase, the cracks increase under a variable load.
- **Phase 3: Crack Propagation**
  When the microcracks and associated stresses reach a certain size, crack propagation occurs. Once the stress exceeds a certain value - known as fracture toughness - irreversible damage will occur, which can lead to catastrophic consequences if not addressed in time.

Determining Service Life

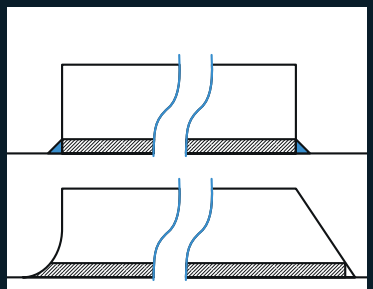
To determine the service life of an asset, Vicoma uses the Ansys (FEM) calculation software. This software supports Vicoma's engineers in identifying the occurring basic and variable stresses at critical points in the structure.

Once the software has mapped these stresses, our engineers perform a code compliance check using the SDC Verifier plugin and can efficiently implement adjustments in the model.

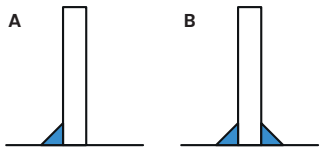
Fatigue Check of the Connection

When performing a fatigue check on a connection, the following three aspects are essential:

- The geometry of the connection·
- The type of weld used (e.g. single or double fillet weld, ½ V-weld, K-weld, ground welds).
- The weld quality (according to ISO 5817:2007).



Geometric modifications.



A double fillet weld (B) is more resistant to fatigue than a single one (A), but even better is a butt weld (½ V-weld or K-weld).

Extending Service Life

It is possible to extend the service life of a component or detail by implementing small modifications. One option is to change the geometry of a part, for example by adding chamfers or rounded edges. In addition, the weld quality or execution can be improved. Both approaches can significantly increase the service life of the component in question.

Circular Steel

The reuse of steel (donor steel) is becoming increasingly popular as an effective approach. It extends the material's service life, reduces CO_2 emissions and helps to limit the extraction of raw materials. Vicoma recognises the importance of this development and aims to actively contribute by applying its expertise to develop innovative solutions focused on the efficient use and reuse of steel. Using donor steel also has a positive impact on nitrogen calculations, as it avoids emissions from steel production, transport and raw material extraction. Vicoma can incorporate these positive effects into nitrogen assessments.

Donor Structure and Donor Structure File

A donor structure is an existing construction from which steel components (donor steel) are dismantled for reuse in new building projects. The dismantled steel is divided into various units based on profile types and lengths.

To ensure quality and suitability for reuse, standard NTA 8713 requires an inspection report to be drawn up for each unit. This document forms part of a donor structure file.

The donor structure file is compiled in collaboration with a third party specialised in conducting inspections, and is prepared according to the prescribed procedure. Vicoma uses this file as input for the required strength and stability calculations in accordance with the applicable standards.

Vicoma's Approach:

- Discussing the client's requirements, being a review partner, and developing a project plan.
- Preparing a donor structure file in collaboration with a third party specialised in inspections.
- Designing and calculating the steel structure made from donor steel, based on the donor structure file.

Asset Management with Vicoma's Expertise

In addition, Vicoma also has expertise in assessing aging assets made of (reinforced) concrete. Our engineers continuously expand their knowledge and closely follow industry trends and developments. With hands-on experience in analyzing the structural condition of stressed concrete elements and determining the necessary repair measures, Vicoma provides solid technical support.

Static Load – Crack Formation

Reinforced concrete is always subject to static loads, such as its own weight, which over time leads to cracking due to shrinkage and creep. Temperature fluctuations, chemical exposure and the addition of extra loads such as solar panels for example can accelerate this process. It is therefore essential to thoroughly assess existing foundations, columns and beams in order to determine their current load-bearing capacity. With a detailed analysis of the cross-section and the acting loads, the structural implications of crack formation can be accurately interpreted and assessed.

Based on a thorough analysis, Vicoma's engineers can provide well-founded advice on repair strategies including structural calculations and technical drawings to support the recommendations.

Dynamic loads

Dynamic loads on concrete elements, such as columns and beams, require a specialised approach. These include dynamic forces acting on the concrete foundations of wind turbines or the varying loads caused by traffic on bridges. In particular, the increasing traffic load on infrastructure is becoming a growing issue in the Netherlands. Today's roads and structures are subject to more frequent and heavier use than they were originally designed for. This leads to accelerated degradation and potential fatigue damage.

Damage over time due to overloading

- In the initial phase, cracks began to form.
- Subsequently, due to excessive loading and possibly external influences, the concrete crumbled, exposing the reinforcement.

What can Vicoma do for you?

Vicoma can play a role in extending the service life of assets. This can be done in various ways:

- Determining an initial service life.
- Providing support to improve the structure in order to extend its lifespan.
- Creating 3D scans, detailed technical drawings, and structural calculations.
- Project management and project supervision.

By combining our specialist knowledge and practical experience, we contribute to the sustainable maintenance and strengthening of Dutch infrastructure.

vicoma
Consultancy & Engineering

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Our consultancy and engineering firm has been working for 60 years with a wide array of clients on single and multidisciplinary projects. What can you expect from us? A pragmatic and flexible approach.

Our engineers are capable of overseeing diverse projects from start to finish, handling the engineering aspect efficiently. We also operate swiftly with flexible teams and streamlined communication channels. Being an independent family-owned business, it's inherent for us to prioritize your interests alone. As such, we are not publicly listed and are not tied to specific contractors.

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