# Hofplein Railway Viaduct (1900-1908): A Pioneering Concrete Structure that Challenges Conservation

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## Summary

The Hofplein railway viaduct (1900-1908) in Rotterdam was once the longest Dutch reinforced concrete structure. Its underlying design is remarkable for its period, as alternatives to then common patented reinforcement systems were sought. Experience with reinforced concrete was still limited. During construction, the design was adapted, leading to a variety of reinforcement systems. Special attention was given to the surface finish, using a combination of natural stone plinth and a tooled artificial sandstone render. The structure is listed as a national monument. Degradation is present, affecting the unique reinforcement and surface finish. As a monument, additional conceptual conservation requirements would have to be fulfilled during an intervention. In this paper, the relationship between the heritage values, historic fabric, and state of conservation is explored, and the resulting case specific criteria for a possible conservation.

**Keywords:** historic concrete; concrete conservation; construction history; historic render; rigid reinforcement; The Netherlands;

## 1. Introduction

The conservation of historic concrete structures is receiving increasing interest in recent decades. A critical review of the architectural and engineering achievements of the last century has resulted in listing many significant structures as monuments. Historic concrete plays an important role in this context, as it enabled most innovative structures. While the historical review of famous structures and key figures is already known, our interaction with historic concrete structures during repair or conservation is less understood. Little attention is given to the additional conceptual demands of conservation, and too easily conservation is deemed equivalent to repair or retrofitting.

To improve current conservation practice, a better understanding of the relationship between heritage values, the construction history, the state of conservation and the impact of different repair techniques is necessary. By this, risks and benefits of proposed conservation strategies can be evaluated case specifically. In this paper, the procedure to identify a dedicated conservation strategy will be illustrated by means of one of the earliest and formerly largest reinforced concrete structures in the Netherlands, the Hofplein railway viaduct (1900-1908).

When the nearly 2 km long Hofplein railway viaduct in Rotterdam was built, little experience with the use of reinforced concrete for bridges in the Netherlands existed. The *Maison Hennebique* office, the design office for the then leading Hennebique system, was asked to make a design and tender for a reinforced concrete viaduct. As no calculations circulated, the client had doubts and wanted a verification of the design. The military engineer and teacher for mechanics Van Hemert (1857-1926) was retained to evaluate Hennebique's design. Van Hemert rejected the design as he doubted the quality. However, Van Hemert did not exclude the possibility of a successful design in reinforced concrete and was commissioned to design and analyse the viaduct himself.



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A practical obstacle was that neither generally accepted theories on the calculation of reinforced concrete nor codes of practice existed. Van Hemert carried out tests to obtain material strengths of the concrete for the calculation. He was also concerned about the execution, particularly about the possible dislocation of the reinforcement during construction. Therefore, Van Hemert chose a rigid reinforcement, where the individual reinforcement members were connected with bolts and rivets (Figure 1). The partially prefabricated reinforcement was a combination of L-sections, single T-sections, and strips.

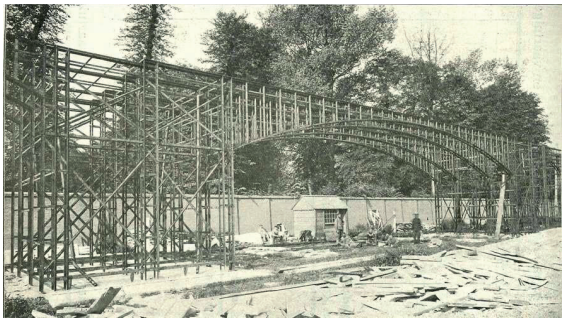

*Figure 1. Left: Overview of the placed rigid reinforcement*

*Figure 2. Examples of reinforcement bars used*

*Figure 3. Details of the facade*

A drawback was that this system could not follow the curvature of the viaduct. Therefore, then normal round reinforcement bars were used for the second construction phase. The Hofplein viaduct was described as a catalogue of viaduct reinforcement systems. The technological evolution can be seen in the different reinforcement systems adopted (Figure 2).

A second, equally important aspect was the appearance of the viaduct. An artificial sandstone render made with Portland cement, lime, and ground sandstone was applied, resulting in a beige colour. Blue Belgian limestone was used for the plinth. Together, the material choice, colour combination and texture are representative of the period, although not many examples have survived.

Since then, the viaduct underwent several changes, either to adapt the function, improve the design or alter the appearance. Historic events such as a major fire during the Second World War bombardment of Rotterdam in in May 1940 can be seen locally in the discoloration of the aggregates in both concrete and render. Over the years, the appearance has been altered by painting the surface white (and many other colours) and by local repairs without adapting to the texture or colour to the original surface (Figure 3). The Hofplein railway viaduct was listed as a *Rijksmonument* (the highest Dutch category of historic structures) in 2002. The railway function of the viaduct ceased recently, and a new use of the structure is being sought. Due to degradation, conservation is recommended to preserve both the historic structure and the heritage values ascribed. As a monument, different criteria apply now for any intervention. A challenge is therefore how to implement these often abstract, intangible demands during technical discussions related to degradation and repair.