Biography

Gustave Magnel: A Global Pioneer and Innovator in Prestressed Concrete

Luc Taerwe

Dept. of Structural Engineering and Building Materials, Ghent University, Ghent 9000, Flanders, Belgium
Correspondence: luc.taerwe@UGent.be

Citation: Taerwe L. Gustave Magnel: A Global Pioneer and Innovator in Prestressed Concrete. *Prestress Technology* **2025**, 2, 69-79. https://doi.org/10.59238/j.pt.2025.02.006

Received: 08/05/2025
Accepted: 12/05/2025
Published: 30/06/2025

Publisher's Note: Prestress technology stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Do not let us make long calculations in order to increase the accuracy. Let us rather concentrate on a good general conception of the structure to be made and see that the prestressing operation is done in the best possible manner.

—— Gustave Magnel

Gustave Magnel (1889–1955)

Autumn 1949, Walnut Lane Bridge construction site, Philadelphia, USA. Rain-soaked mud squelched underfoot as a middle-aged man in a fedora and black overcoat stooped to tap a freshly demolded concrete beam. Frowning, he straightened and surveyed the silent contractors around him. "The porous mess Americans call concrete is soup, not concrete!"

His barbed remark made headlines: *"Belgian Professor Says Americans Make Soup, Not Concrete."* Workers seethed, local experts scoffed—but the Belgian engineer Gustave Magnel (1889–1955) stood firm. He insisted on "zero-slump" concrete, a dry, rock-hard material requiring vigorous vibration for compaction. Despite controversy, the first prestressed concrete bridge in the U.S. was completed, marking a technological revolution.

This revolution began three decades earlier, in a European basement laboratory...

1 From Theoretical Foundations to the Lone Warrior of the Lab

Born in Belgium in 1889, Magnel graduated from Ghent University's civil engineering program in 1912. After five years working in London (1914–1919)—where he mastered English—he returned to Belgium to teach at his alma mater. There, he dedicated himself to reinforced concrete research. In 1923, he published his first monograph, *Practical Calculation of Reinforced Concrete* (*Pratique du calcul du béton armé*), and co-authored Belgium's first design standards for reinforced concrete. Yet he knew passive study was insufficient.

In 1926, backed by Transport Minister E. Anseele, he founded a "Laboratory for Reinforced Concrete " in a former hotel basement (Figure 1). Despite funding shortages, he funded operations by testing industrial projects, gradually acquiring a 300 kN universal testing machine and a 3,000 kN compression testing machine. By 1937, the lab moved to the university's new engineering building, becoming a global hub for concrete research. A full-scale structural testing platform added in 1950 directly advanced engineering practices.

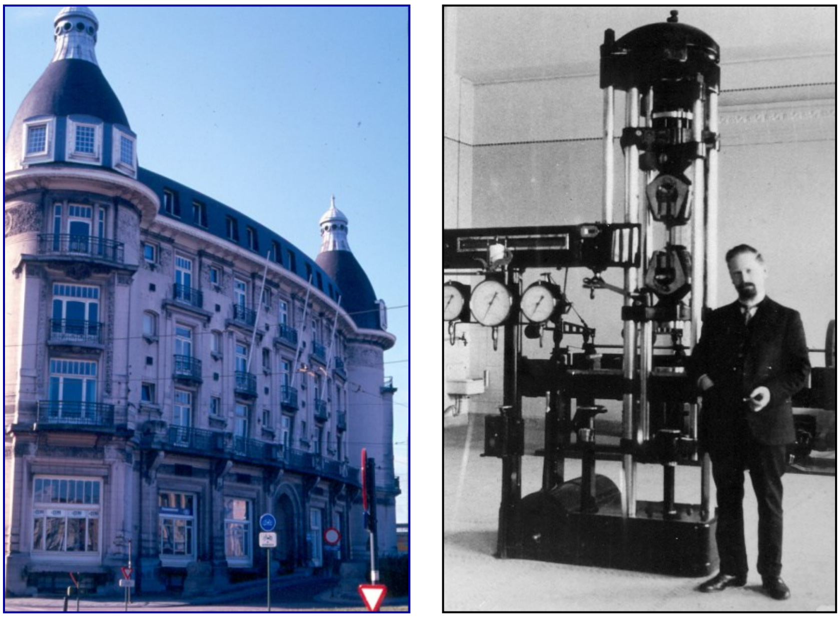


Figure 1 Magnel founded the "Laboratory for Reinforced Concrete" in 1926 (© Archief Universiteit Gent)

"The ultra-rapid evolution of technology, forces university institutes to adapt themselves continuously to the actual requirements at the risk of failing in their task. This adaptation cannot happen on the initiative of the university management which, by definition, is not competent for it and, moreover, rather looks for savings than for new expenditures. Hence, it is the task of the professors to do the impossible to keep their teaching and research at the required level." Magnel wrote in his memoirs: *"It not only goes about having a laboratory: the question is to keep it operational, which requires additional funding. We obtain an extra income from testing we perform for contractors, companies and public authorities, …"* His lab symbolized relentless innovation, not just machinery [1].

2 War's Crucible: Birth of the Blaton–Magnel System

When WWII engulfed Europe in 1940s, teaching bans confined Magnel to his lab. With French engineer Eugène Freyssinet's prestressing systems embargoed by war, Magnel innovated independently.

In dimly lit experiments, he perfected a multi-parallel wedge anchorage system for 5mm high-strength steel wires, encased in corrosion-resistant metal sleeves and

 https://doi.org/10.59238/j.pt.2025.02.006

positioned with spacers (Figure 2). This design balanced stress distribution across wire bundles and required only compact jacks for tensioning. Also external tendons were used.

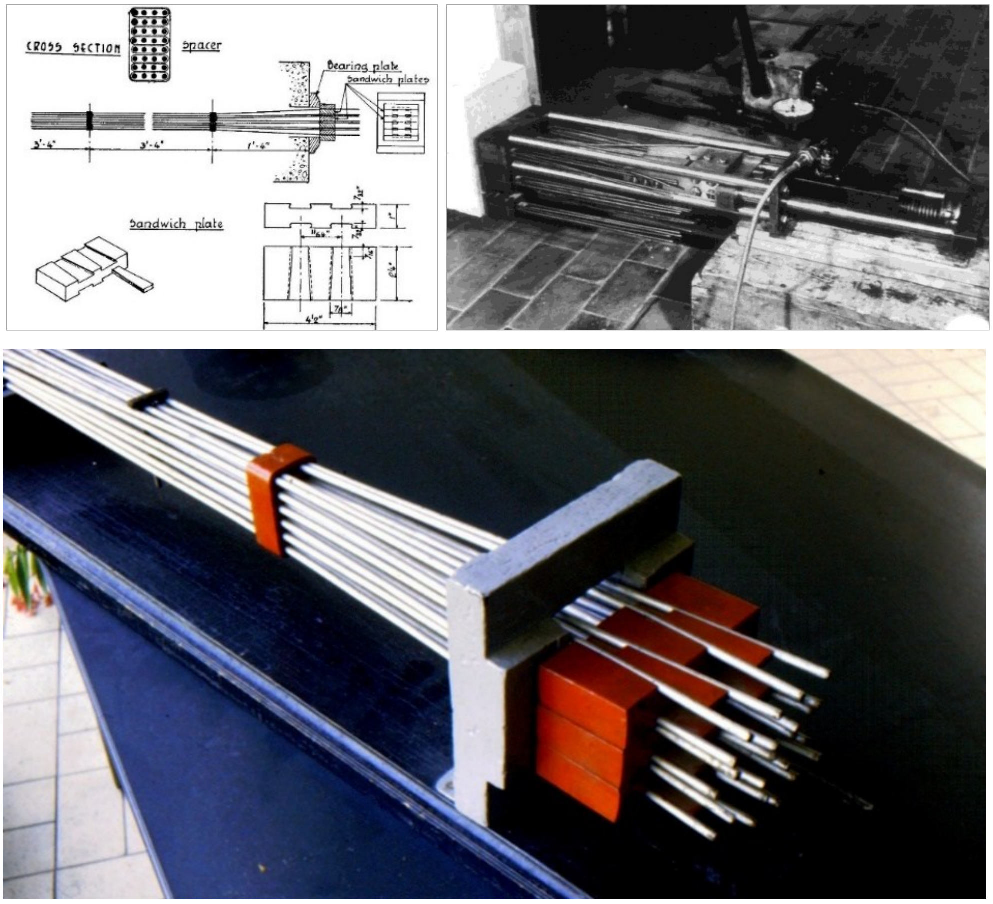


Figure 2 Blaton–Magnel post-tensioning system

In 1944, the railway bridge over the “Rue du Miroir” in Brussel used this technology, with a slab thickness of only 1.15 meters, reducing it by 40% compared to traditional reinforced concrete solutions, making it one of the earliest prestressed concrete railway bridges in Europe (Figure 3).

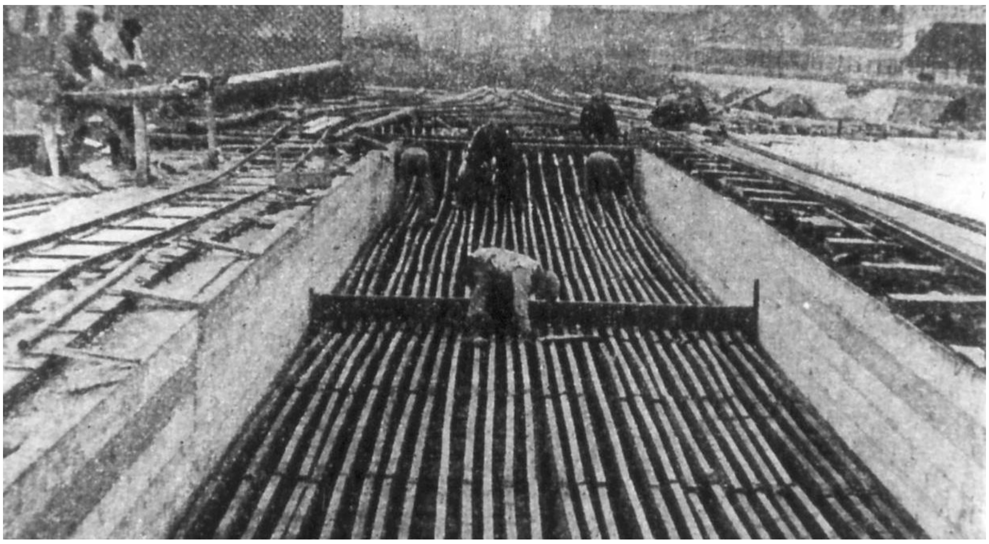


Figure 3 Railway bridge over the “Rue du Miroir” in the North-South connection in Brussels (in 1944)

On this project Magnel concluded the following : "*In our opinion, prestressed concrete is the building material of the future. Over 10 years, very few bridges will still be built in reinforced concrete because everybody will be convinced of the advantages of prestressing. The realization of the pilot project in the Rue du Miroir will have been the catalyst of this evolution and all who were involved in it can be proud of the results obtained*".

In 1947–1948, a new textile factory was built for the UCO company (Union Cotonnière) in Ghent which had, in those days, the largest roof structure worldwide in prestressed concrete, covering a surface of about 35,000 m^2 and which is still largely intact (Figures 4 and 5). One hundred primary beams with a span of 20.5 m and 600 secondary beams with a span of 13.7 m were necessary. All these beams were precast at the site at a rate of 3 primary beams and 18 secondary beams per week which required a perfectly organized casting yard. Magnel writes about this achievement: "*During the last 3 to 4 months, this project attracts numerous architects, engineers and contractors both from Belgium and from abroad. They want to qualify themselves in the field of prestressed concrete, firstly in our lab and secondly at the building site*".

Figure 4 Textile factory with post-tensioned roof beams (1947-1948)

Figure 5 Textile factory in Ghent (UCO)

Following this, the Melsbroek hangar renovation project at Brussels Airport (1948, Figure 6) and the Sclayn continuous beam bridge over the Meuse River (1949, the world's first continuous prestressed concrete bridge) were completed. The latter set a world record with a 63-meter span (Figures 7 to 9).

Figure 6 Heavy beams for plane hangar at Melsbroek airport (1949)

Figure 7 Bridge at Sclayn over the river Meuse (1949)

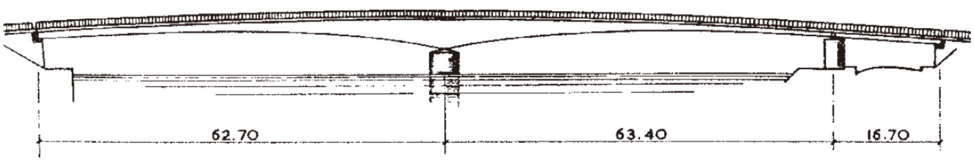


Figure 8 Bridge at Sclayn: lateral view

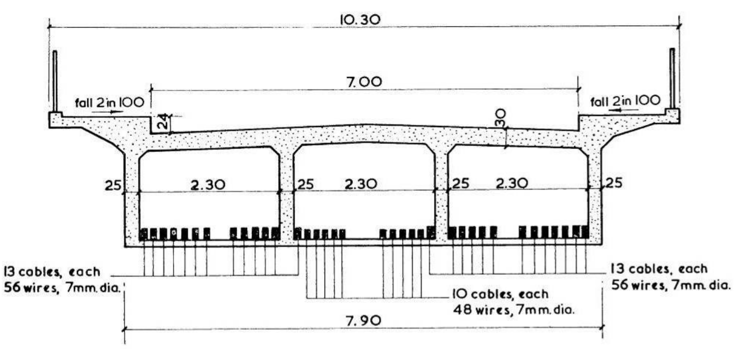


Figure 9 Bridge at Sclayn: cross section

3 Theoretical Breakthroughs: Statically Determinate Beams to Statically Indeterminate Beams

In 1946, Magnel published a statically determinate beam design method, plotting stress conditions under four load scenarios in a $e - 1/P_{\mathrm{i}}$ coordinate system (Figure 10), defining feasible zones for prestress force and eccentricity. Here, P_{i} and e represent the initial prestress force and eccentricity, respectively.

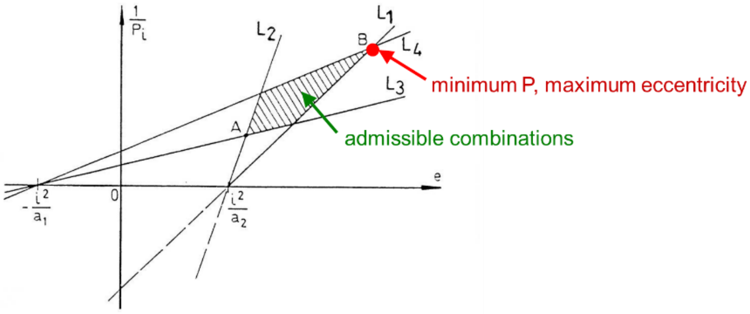


Figure 10 Design method for PC statically determinate beams (1946)

For the design of the end-blocks he proposed to calculate the shear force and bending moment in horizontal sections, which is the so-called deep beam analogy. The resulting shear and normal stresses were combined with the stress components from other sources to calculate the principal tensile stress.

In 1947 he developed a practical solution for the case of statically indeterminate posttensioned beams. He introduced the concept of secondary bending moments $M_{P,sec}$ generated by the prestressing force P, and defined the equivalent eccentricity as

$$e_{eq} = e + M_{P,sec}/P \tag{1}$$

In this way, he could use a similar diagram $1/P_{\mathrm{i}}$, e_{eq} as for statically determinate beams. The relationships between the actual (geometric) eccentricities and the equivalent ones were calculated on the basis of expressions for the secondary moments.

As he had gathered sufficient theoretical knowledge and practical experience about PC, he wrote his first book on the subject [2]. It was first published in French in 1948 and was soon translated in English, Spanish and German (Figure 11).

Figure 11 Several representative works of Magnel

 https://doi.org/10.59238/j.pt.2025.02.006

In 1951, he argued: "*Design beams twice: once for elastic stresses, again for ultimate loads. Current methods lack reliable failure coefficients—stress-based design remains essential*".

In 1951, Magnel stated the following [3]: "*In my opinion, for each beam two calculations have to be made: the first based on stresses using the elastic theory, the other on ultimate load. However, it seems to be impossible at present to make this latter calculation accurately because all known methods require the use of coefficients, the value of which we really ignore. This is mainly true when the failure occurs by crushing of the concrete. I recommend the design based on stresses as the fundamental one, but as it does not always give the same factor of safety against ultimate failure, an attempt must be made in each case to check whether this factor of safety is sufficiently high*".

4 Transatlantic Impact: Walnut Lane Bridge Controversy and Triumph

In 1946, Magnel visited for the first time the United States of America as an "advanced fellow" of the Belgian-American Educational Foundation, founded by Herbert Hoover in 1920. During his first visit to the United States, Magnel lectured on prestressed concrete at several places, a subject almost unknown at that time in that country. Magnel had the rare gift to explain complex theories and difficult problems in a simple way and thus captivated large audiences.

Two significant events occurred during Magnel's first visit to America which had a direct bearing on the development of prestressed concrete in America and which culminated in the realization of Philadelphia's Walnut Lane Bridge, the first prestressed concrete bridge in the USA (Figure 12). The first event was the fact that Magnel was introduced to the Preload Corporation of New York, which eventually became a sub-contractor for the construction of the Walnut Lane Bridge girders. The second event was the fact that Magnel asked Zollman (a former student of Professor Magnel at Ghent University) to translate the French manuscript of his book on prestressed concrete into English.

Figure 12 The Walnut Lane Bridge in Philadelphia, USA

In the late 1940's Ch. Zollman, who had joined the Preload Corporation in the meantime, could convince the Bureau of Engineering of the City of Philadelphia to realize the superstructure of the Walnut Lane Bridge in prestressed concrete on the basis of a proposal elaborated by Magnel. The Preload Corporation was awarded the sub-contract to fabricate the girders in 1949. In October 1949 a loading test was performed on a 49 m long and 2 m deep test girder, identical to the girders forming the center span of the bridge (Figure 13). This test demonstration attracted some 300 engineers from seventeen states and five countries who stood in the rain for the entire day to witness the event. The successful testing to destruction at the job site, far away from the comforts of a laboratory, was a significant achievement which instilled public confidence in prestressed concrete. Ch. Zollman formulated it as follows: "*No single event was more instrumental in launching the prestressed and precast concrete industry in North-America than the construction of the Walnut Lane Bridge in Philadelphia in 1950. More than anything else however, it was the charisma, the dynamism and engineering talent displayed by the man who designed the Walnut Lane Bridge, namely Prof. Gustave Magnel of Belgium, that gave the impetus necessary for the acceptance and development of prestressed concrete in the United States*".

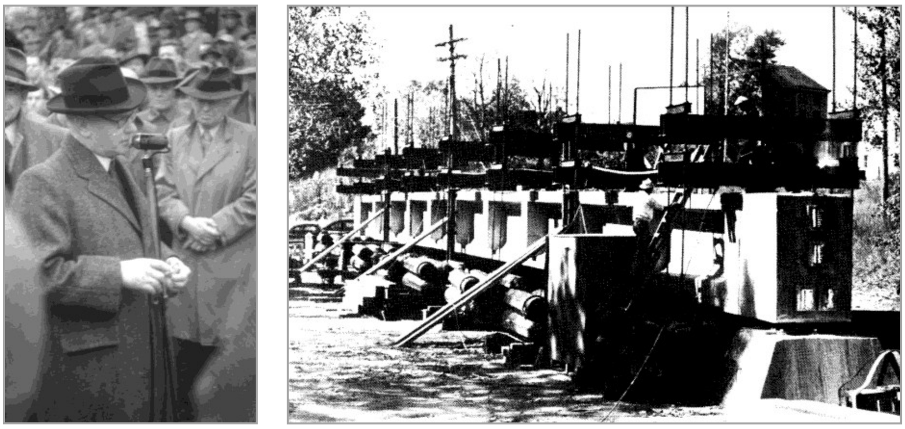


Figure 13 Magnel at the test site (1949)

Prior and during the execution of the bridge, some problems needed to be solved because Magnel required a "zero slump" concrete. According to American practice this was not possible to realize but Magnel had to approve all execution details. Finally, a practical solution was found but several girders showed honeycombs and other imperfections [4] (Figures 14 and 15). The controversary had gone far enough to be published in the influential "Engineering News Record" with the headline [5]: "*Americans make soup, not concrete, says Belgian professor*".

Figure 14 Honeycombs in the first girder cast in 1949

Figure 15 Longitudinal crack on the outer sloping face of the bottom flange (south facia girder)

In October 1950, Prof. Magnel was awarded the Frank P. Brown Medal from the Franklin Institute in Philadelphia for his exceptional contributions to the development of prestressed concrete.

5 Global Legacy: FIP, Writings, and Enduring Honors

Magnel was not only an engineer but also an educator. In 1948, his book 'Prestressed Concrete' was published in English, French, and Spanish, and the first edition of 6,000 copies sold out quickly.

In the early 1950's, several famous American researchers visited Magnel and his laboratory, including T.Y. Lin, David P. Billington (Princeton University) and Robert N. Bruce (Tulane University, New Orleans), which played a significant role in promoting prestressed technology worldwide.

Together with other European pioneers of prestressed concrete, Magnel founded in 1952 the "Fédération internationale de la Précontrainte", abbreviated as FIP, which became a successful international technical organization. In 1996 it merged with CEB (Comité Euro-International du Béton) into fib (International Federation for Structural Concrete).

"*His concrete laboratory was recognized as one of the best in the world. Hundreds of members of staff and research workers from a large number of universities have had the pleasure and privilege of visiting this excellent laboratory. Magnel always warmly welcomed at his laboratory those who wished to improve their knowledge*". Professor R. Evans of Leeds University recalled, "*His gift of friendly intercourse enriched us all by their genial and mellow qualities. Although he often had strong views on technical questions, he was by nature so generous that it was a pleasure even to disagree with him*".

On July 5, 1955, Gustave Magnel passed away suddenly (Figure 16). The University of Ghent established the 'Gustave Magnel Gold Medal' to honor outstanding individuals such as Nicolas Esquillan and Michel Virlogeux, designer of the Millau Viaduct, continuing his legacy of innovation. In 2024, the 14th Gold Medal was awarded to Dr. Liu Zhenyu, who is the Dean of the Bridge Branch of Sichuan Highway Planning Survey and Design Institute.

DONDERDAG
Gent 7 Juli 1955

20 tot 25 graden.

De befaamde professor Magnel plots overleden te Gent

Stichtte met vader Anseele het Belgisch laboratorium voor gewapend beton

Gisterochtend bereikte ons het ontstellend nieuws van de dood van Magnel, die door zijn wetenschappelijk werk en door zijn plannen voor het bouwen van een reusachtige toren te Brussel wereldfaam verwierf. Op dinsdagavond, omstreeks 22 u. overleed

Sedert 1945 was hij lid van de Kon. Belg. Vlaamse Academie. Hij was tevens lid van het American Concrete Institute, van het Institute of Structurial Engineers London.

Zie verder pag. 3, kol. 6

Figure 16 Gustave Magnel Passed away unexpectedly on July 5, 1955

6 Unfinished Vision: Brussels' 1958 Expo Tower

In his later years, Magnel dedicated himself to designing a landmark for the 1958 Brussels World Expo—a 500-meter-high concrete tower with a base diameter of 100 meters and a 135-meter steel mast at the top (Figure 17). This visionary concept, which ultimately fell victim to political controversy, foreshadowed the future of supertall buildings.

Figure 17 Preliminary design of Tower for Telecommunications at World Expo 1958 in Brussels

7 Epilogue: Poetry and Pragmatism in Concrete

Gustave Magnel devoted his life to proving that concrete is not a cold material, but a symphony of strength and beauty. From laboratories to construction sites, he

https://doi.org/10.59238/j.pt.2025.02.006

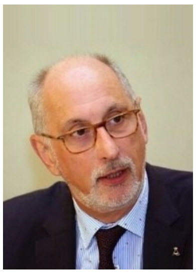
challenged tradition with original concepts, transforming theories into innovative bridges and challenging industrial projects.

Data availability statement: There is no data were generated in this paper.

References

1. Taerwe L R .Contributions of Gustave Magnel to the Development of Prestressed Concrete[C]//Ned H. Burns Symposium on Historic Innovations in Prestressed Concrete.Magnel Laboratory for Concrete Research, 2005.
2. Magnel, G., 1948, "Prestressed Concrete", Concrete Publications Ltd., London, First Edition.
3. Magnel, G., 1951, "Continuity in Prestressed Concrete", In R.P. Andrew and P. Witt (Eds.), Prestressed Concrete Statically Indeterminate Structures, Cement and Concrete Association, pp. 77-86.
4. Zollman, C., Depman, F., Nagle, J., and Hollander, E., 1992, "Building and Rebuilding of Philadelphia's Walnut Lane Memorial Bridge", PCI Journal, May-June, pp. 66-82.
5. Engineering News Record, 1954, February 25.

AUTHOR BIOGRAPHIES

	**Luc Taerwe** D.Eng, Professor, Working at Ghent University (Ghent,Belgium). Emeritus Professor in Structural Concrete at Ghent University Former director of the Magnel Laboratory for Concrete Research Director East Asia Platform Ghent University Academician of the Royal Flemish Academy of Belgium High-end foreign expert at Tongji University, Shanghai EIC of **Structural Concrete** Journal and Co-EIC of **Prestress Technology** Journal. Email: luc.taerwe@UGent.be