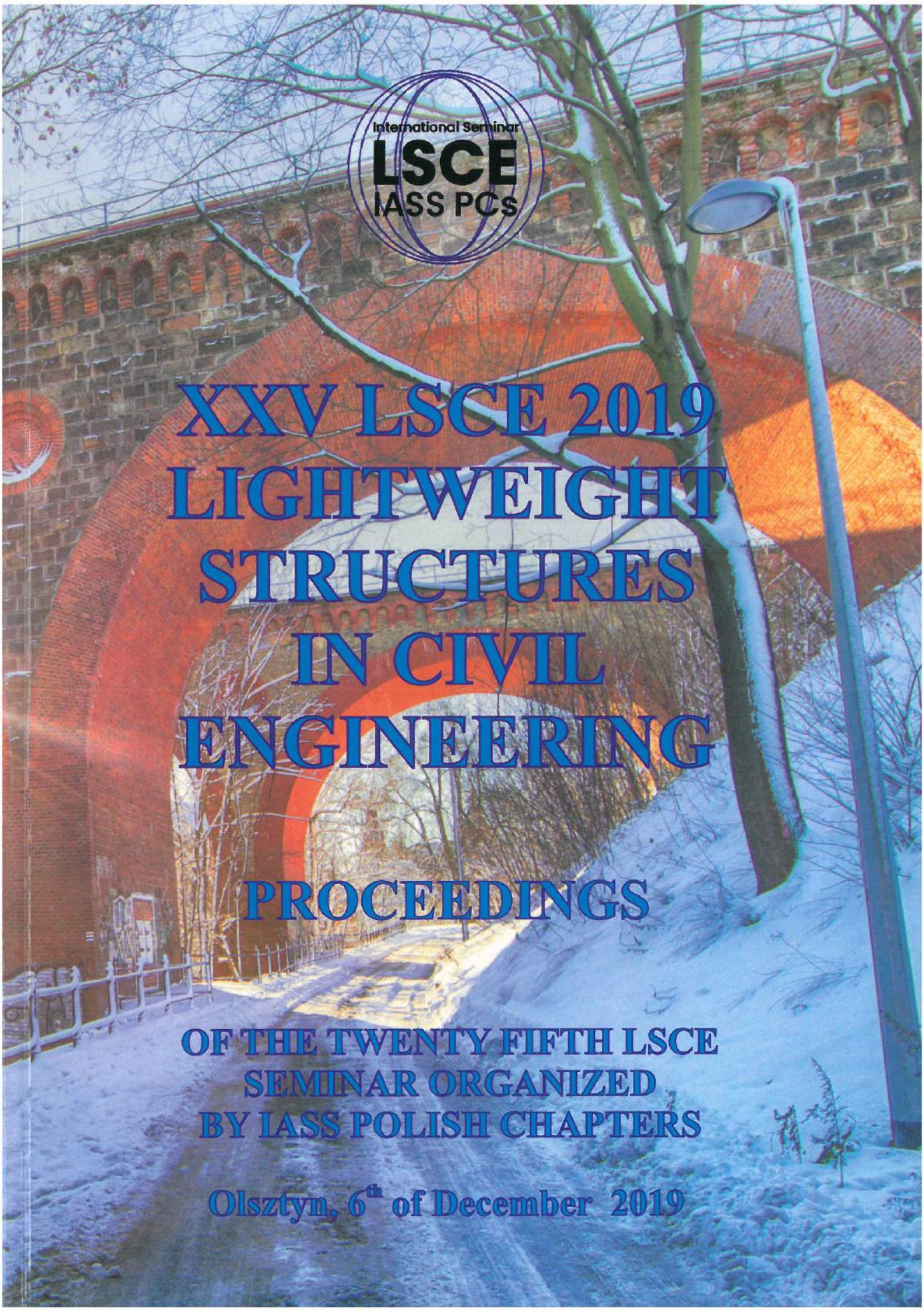


XXV LSCE 2019 LIGHTWEIGHT STRUCTURES IN CIVIL ENGINEERING

PROCEEDINGS

OF THE TWENTY FIFTH LSCE
SEMINAR ORGANIZED
BY IASS POLISH CHAPTERS

Olsztyn, 6th of December 2019

XXV LSCE 2019 LIGHTWEIGHT STRUCTURES IN CIVIL ENGINEERING

PROCEEDINGS

PROCEEDINGS OF THE TWENTY FIFTH LSCE SEMINAR
ORGANIZED by IASS POLISH CHAPTER
6th of DECEMBER 2019, OLSZTYN, POLAND

XXV LSCE 2019
LIGHTWEIGHT STRUCTURES IN CIVIL ENGINEERING

Edited by
Piotr Bilko & Leszek Małyszko

University of Warmia and Mazury in Olsztyn
Faculty of Geodesy, Geospatial and Civil Engineering
Department of Mechanics and Building Structures

Olsztyn, 6th December, 2019

ISBN 978-83-948487-6-7

Published by: Institute of Building Engineering Faculty of Geodesy, Geospatial and Civil Engineering University of Warmia and Mazury in Olsztyn, Poland

Printed in: Printing House, ul. Jana Heweliusza 3, 10-957 Olsztyn
tel. +48 89 523-45-06; tel./fax 523-47-37;

Cover photo by Wojciech Krom, Olsztyn City Hall Archives.

CONTENTS

LSCE 2019 – Committees

PATRONAGE

- Permanent Organizing Committee of IASS Polish Chapters
- Faculty of Geodesy, Geospatial and Civil Engineering, UWM in Olsztyn
- Dean of the Faculty
  Prof. dr habil. Eng. Paweł Wielgosz
- Vice-Dean for Research
  Dr habil. Eng. Jacek Rapiński, professor

SCIENTIFIC COMMITTEE – Reviewers

1. Dr habil. Eng. Leszek Małyszko, professor of University of Warmia and Mazury - Chairman
2. Prof. dr habil. Eng. Wojciech Gilewski, professor of Warsaw University of Technology
3. Prof. dr habil. Eng. Marian Giżejowski, professor of Warsaw University of Technology
4. Dr habil. Eng. Irena Gołębiowska, professor of UTP University of Science and Technology
5. Dr habil. Eng. Jarosław Górski, professor of Gdańsk University of Technology
6. Dr habil. Eng. Arch. Barbara Gronostajska, professor of Wrocław University of Science and Technology
7. Prof. dr habil. Eng. Stanisław Jemioło, professor of Warsaw University of Technology
8. Prof. dr habil. Eng. Marcin Kamiński, professor of Lodz University of Technology
9. Dr habil. Eng. Piotr Korzeniowski, professor of Gdańsk University of Technology
10. Prof. dr habil. Eng. Jan B. Obrębski, professor emeritus of Warsaw University of Technology
11. Prof. dr habil. Eng. Jarosław Przewłócki, professor of Gdańsk University of Technology
12. Dr habil.Eng. Jacek Rapiński, professor of University of Warmia and Mazury
13. Dr habil. Eng. Jacek Szafran, Lodz University of Technology
14. Dr habil. Eng. Arch. Romuald Tarczewski, professor of Wroclaw University of Science and Technology
15. Prof. dr habil. Eng. Paweł Wielgosz, professor of University of Warmia and Mazury

ORGANIZING COMMITTEE OF XXV LSCE 2019

Members of IASS Polish Chapter at University of Warmia and Mazury in Olsztyn, Poland
Chapter Representative – Leszek Małyszko

1. Piotr Bilko, PhD, Eng.- – *Chairman*
2. Edyta Kowalska, MSc. Eng.
3. Andrzej Rutkiewicz, MSc. Eng. – *Secretary*
4. Robert Szmit, PhD, Eng.

LIGHTWEIGHT STRUCTURES in CIVIL ENGINEERING
CONTEMPORARY PROBLEMS
XXV Scientific Seminar Organized by Polish Chapters of
International Association for Shell and Spatial Structures
Olsztyn, 6th of December 2019 (Friday)
University of Warmia and Mazury in Olsztyn
Faculty of Geodesy, Geospatial and Civil Engineering

FOREWORDS

by

L. Małyszko [1], R. Tarczewski [2]

[1] **Chairman of IASS PCs Seminar in Olsztyn, Member of Permanent Organizing Committee of IASS PCs**
[2] **Member of IASS Advisory Board, Chairman of Permanent Organizing Committee of IASS PCs**

FOREWORD by *Romuald Tarczewski*

The 2019 Annual Seminar Lightweight Structures in Civil Engineering is extraordinarily special for all members of Polish Chapters of the International Association for Shell and Spatial Structures because it marks both the 60th Anniversary of the Association and is already the 25th seminar of this series.

Since the first gathering in Warsaw in 1995, it has become the custom to have an annual meeting on the first Friday of December, initially mainly in Warsaw, and later also in many other Polish cities. These seminars are primarily an opportunity to present the achievements of Polish members of the IASS but also attract many participants from abroad, both those related to IASS and others for whom the subject of lightweight spatial structures is close. Several of the LSCE seminars were large international scientific events. It should be mentioned first of conferences in 1995, 1998, 2002, 2005 and 2013. Conferences in 2002 and 2013 had the status of the Annual International IASS Symposia.

The achievements of LSCE seminars include more than a thousand delivered papers and twenty-four conference books, containing full texts of papers, which are distributed not only among seminar participants but also among many individual and institutional recipients around the world. This year's Proceedings will be twenty-fifth.

However, the main achievement of the seminars is the integration of the environment of Polish scientists and engineers, stimulation of their activity and involvement in the international forum. We owe this to the tireless activity and hard work of prof. Jan B. Obrębski, who is the initiator of the LSCE and a long-term main organizer of the seminars. The result of this work is very numerous participation in the work of IASS. The Polish Chapter was the largest national group in the Association, and after organizational changes, smaller Chapters that emerged from it dominate among all IASS Chapters. On the initiative of prof. Obrębski, in 2012, Polish Chapters formed the Permanent Organizing Committee, which coordinates the work related to the organization of annual LSCE seminars.

Acting as part of IASS and being primarily its members, we also feel our separateness resulting from both historical determinants and the specificity of the conditions in which we operate. It also affects the research that we conduct, and therefore we are strongly convinced that the forum for the exchange of views and information that LSCE creates for us is very necessary and contributes to improving the quality of our work. The future of these meetings is in our hands and I am sure that thanks to joint efforts, we will participate in them for many years to come.

FOREWORD by *Leszek Małyszko*

The LSCE 2019 Seminar has been again held at the University in Olsztyn after three years of break under the patronage of the authorities of the Faculty of Geodesy, Geospatial and Civil Engineering. Among a wide range of studies offered by the faculty, there are several hundred students of civil engineering since the beginning of the year 2015. There is also a course in the subject of building and lightweight structures and a group of scientists creating one of the IASS Polish Chapters. The seminar takes place in Olsztyn for the third time. I hope that the seminar participants will once again admire the beauty of the campus and their stay here will remain in their friendly memory.

The annual meetings of LSCE organized under the auspices of Permanent Committee of Polish Chapters of the International Association for Shell and Spatial Structures (IASS) cultivate tradition that has started in 1995. Since then they won a prominent place among the other events of this kind in Poland and beyond. Although they have never been aimed at mass scale, always gathered a large group of participants, often from many countries of the world. Statistics of these publications is impressive both with the number of authors from many countries around the world, as well as with the extent of their interest. More information on the LSCE seminars can be found on the website http://www.lsce.en/.

This year's seminar is the 25th seminar. Because of this anniversary, the Seminar Proceedings you hold in your hand contain covers of all LSCE Seminars together with tables of contents, apart from scientific papers. The scientific papers are the result of the work of authors throughout the current year and often longer. I am deeply convinced that presented results of their work not only arouse interest in the engineering environment but will also find application in practice. I wish to thank all the authors for their effort to the preparation of such valuable scientific papers.

I also hope that the scientific monograph of the selected articles which is prepared by the participants separately form the Seminar Proceedings for the first time, will have a positive impact on the development of lightweight structures not only in Poland but also in the world and will strengthen the activities of IASS Polish chapters. I wish to thank all the authors of the individual monograph chapters for their effort to the preparation of such valuable scientific papers. I would like to particularly thank the reviewers for their insightful and immediate reviews.

I would also like to thank all those with whom I had the pleasure to cooperate in the preparation of the seminar proceedings and the monograph of the LSCE 2019.

LIGHTWEIGHT STRUCTURES in CIVIL ENGINEERING
CONTEMPORARY PROBLEMS
XXV Scientific Seminar Organized by Polish Chapters of
International Association for Shell and Spatial Structures
Olsztyn, 6th of December 2019 (Friday)
University of Warmia and Mazury in Olsztyn
Faculty of Geodesy, Geospatial and Civil Engineering

DEDICATION FOR PROFESSOR MAMORU KAWAGUCHI 1932-2019

J.B. Obrębski [1)]
[1)] Retired full Professor, Faculty of Civil Engineering, Warsaw University of Technology, POLAND,
jobrebski@poczta.onet.pl

Keywords: Dedication, Mamoru Kawaguchi, President IASS.

Fig. 1.Mamoru Kawaguchi, Montpellier 20.09.2004.
Photo: Jan B. Obrębski

1. THE SAD INFORMATION

At 4 June, 2019 was coming to me by e-mail following sad information sent by Ken'ichi Kawaguchi:

Dear Prof. J. and Mrs. Obrebski;

With great sorrow, I have to inform you of passing of my father, Mamoru Kawaguchi, on 29th of May at the age of 86.

He has been suffered from interstitial pneumonia since about three years ago. (...)

I deeply thank you for your close friendship with my father during his long membership and in the warm circle of people of the IASS. Mamoru loved the IASS and to be with you.

Thank you and sincerely,
Ken'ichi

Immediately after reading it (at 7.06.2019) was send by me by SMS to several members of IASS Polish Chapter the sad information. Also at 7.06.2019 were coming to me in the almost same time answers from: W. Przybyło, R.Szmit, J.Szafran, R.Tarczewski and P.Stobiecki expressing their sorrow and words of condolences.

2. IASS ABOUT MAMORU KAWAGUCHI (Ref. 2)

In the book written in celebration of the 50-th Anniversary Jubilee of the IASS, Ref. 2 - page 122 we can find following information about Professor Mamoru Kawaguchi.

Graduated from Fukui University in 1955, he worked in the office of Professor Yoshikatsu Tsuboi, and be contributed to the suspended roof designed by Kenzo Tange for the 1964 Tokyo Olympics. Later, he designed a number of innovative and daring membrane structures in Japan, including air-supported structures for Expo'70 held in Osaka.
In 1972 he became a Professor of Hosei University. Most recently he developed the Patadome System with eight major realizations. His design work has extended to a number of special spatial structures: pneumatic and membrane structures, timber structures, seismic isolation systems, bridges, towers, monuments and others like the Flying Carp "Jumbo Koinobori". All these projects were described in the exhibition "Mamoru Kawaguchi - Structural Engineer: Innovation and Tradition in Structural Design" (Valencia 2009 *(Symposium in 50 years of the IASS)*).

Member of the International Association for Shell and Spatial Structures since 1980, President from 1990 *to* 1991 and 2000-2006, he received the Torroja medal in 2001, and was awarded *(by title)* Honorary Membership in 2007. He is recipient numerous other awards from prestigious associations and universities. See also http://kawa-struc.com.

On the page 121 of book Ref. 2 we can read also:

During the annual Symposium held in Istanbul in May 2000, the executive *(Council)* elected Mamoru Kawaguchi (Japan) as new IASS President. The *Journal of the IASS* reported:

> With his design office, KAWAGUCHI & ENGINEERS, he has been involved in structural design of a number of important buildings with a variety of structural systems. Among his realized structures are the Grand Roof for Expo'70 in Osaka with a double-layer space frame, the Fuji Group Pavilion for the Expo'70 with an air-inflated membrane structure, and the West Japan Exhibition Center with a cable-stayed roof system.

Kawaguchi is a pioneer for field of movable structures to facilitate construction. He experimented with successful erection process based on designed finite mechanisms that are stabilized by additional components at the final stage erection. His patented Pantadome System is exemplified by the Palau San Jordi for the 1992 Barcelona Olympics *(Spain)*, one among several realizations (Figure 15).

The Grand Roof for Expo'70 was not only the largest in span but also showed a new direction toward systematization of metal spatial structures with respect to nodes, members and erection/demolition. It was designed by Yoshikatsu Tsuboi with Mamoru Kawaguchi.

The Fuji Group Pavilion on Expo'70 in Osaka is the biggest air-tube structure. The pavilion was composed of 16 arched tubes each of 4m diameter. Each tube had the same external length of 72m. The arched tubes were air-inflated and stand side by side on a circle of 46m diameter.

In 1977 M. Kawaguchi designed with architect Arata Isozaki the West Japan general exhibition. The structure, imitating a cable-stayeds bridge, however required heavy anchor blocks at the end of the back-stay cables.

3. MAMORU KAWAGUCHI AND IASS POLISCH CHAPTERS

Professor Mamoru Kawaguchi has writing to books of our LSCE conferences in Warsaw four times. In it he was presenting the following lectures and texts: □ in 1995 (page 770): *A structural system suitable for rational construction*. □ In 2002 (page 50): *On some characteristics of pantadome system*. Moreover, Foreword on page 5. □ In 2004 (page 11): Foreword. □ In 2005 (page 20): *On some of my recent works of lightweight structures*. Also He write the Foreword to LSCE 2005 book (page 10). So, He was visiting Warsaw three times: 1995, 2002 and 2005. Just in 2005 during of LSCE He has obtained anniversary medal, Fig.4.

Fig. 2. In the front professor M. Kawaguchi with His wife, LSCE 1995. (*Photo on the order of Jan B. Obrębski*)

Fig. 3. Mamoru Kawaguchi presents the Torroja Medal awarded Him during IASS Symposium 9-13 Oct. 2001 in Nagoya, Japan. *Photo: Jan B. Obrębski.*

Fig. 4. Mamoru Kawaguchi presents the Commemorative Medal No 2 awarded Him at 12 Sep. 2005 during Opening Ceremony LSCE, on occasion of X years of IASS Polish Chapter. (*Photo on the order of Jan B. Obrębski*)

Fig. 5. Opening Ceremony of LSCE 2005, 14 Sept. 2005. From right: speaking President IASS – Prof. M.Kawaguchi; Dean of Faculty of Civil Engineering Prof. G.Jemielita; and Prof. J. Obrębski. (*Photo on the order of Jan B. Obrębski*)

Fig. 6. Moment of introduction by President Mamoru Kawaguchi in Century Hall in Hotel Nikko New Century Beijing. *Photo: Jan B. Obrębski.*

Engineer's outstanding activity the best presents the photos 7-15, given below. They were selected personally by Mamoru Kawaguchi and presented in Warsaw by Him. As we can see, He was designing many different type and destination civil engineering objects. To it, He had to use different materials: steel, fabric, natural Stones, etc.

Fig. 7. Prefabricated prestressed concrete piles for compressive members (columns). M.Kawaguch, LSCE 2005.

Fig. 8. General View of "Inachus Bridge" with natural stone upper chord. M. Kawaguchi, LSCE 2005.

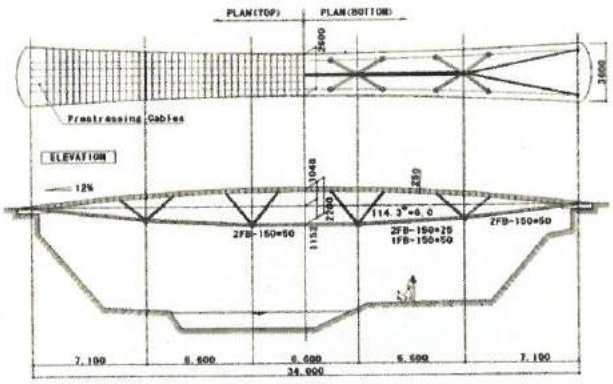


Fig. 9. General Drawing of the Bridge. M. Kawaguchi, LSCE 2005.

Fig. 10. Genome Tower, by M.Kawaguchi & Engineers, Japan.
The photo sent by Mamoru to J.B. Obrębski with New Year greetings.

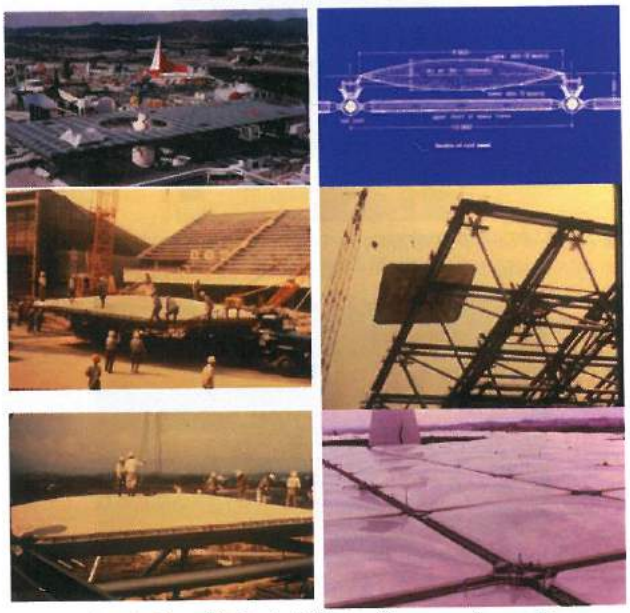


Fig. 11. Expo '70 Festival Plaza with pneumatic panels.
Architect: K. Tange, structure M.Kawaguchi.
From presentation of Mamoru Kawaguchi. LSCE 2005.

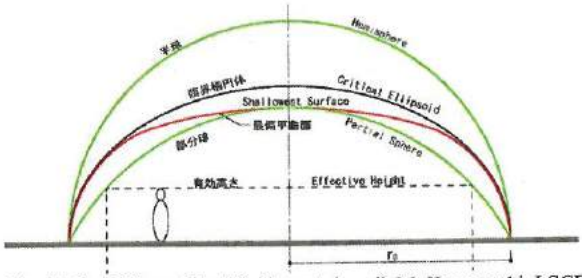


Fig. 12. Definition of the "shallowest dome". M. Kawaguchi, LSCE 2005.

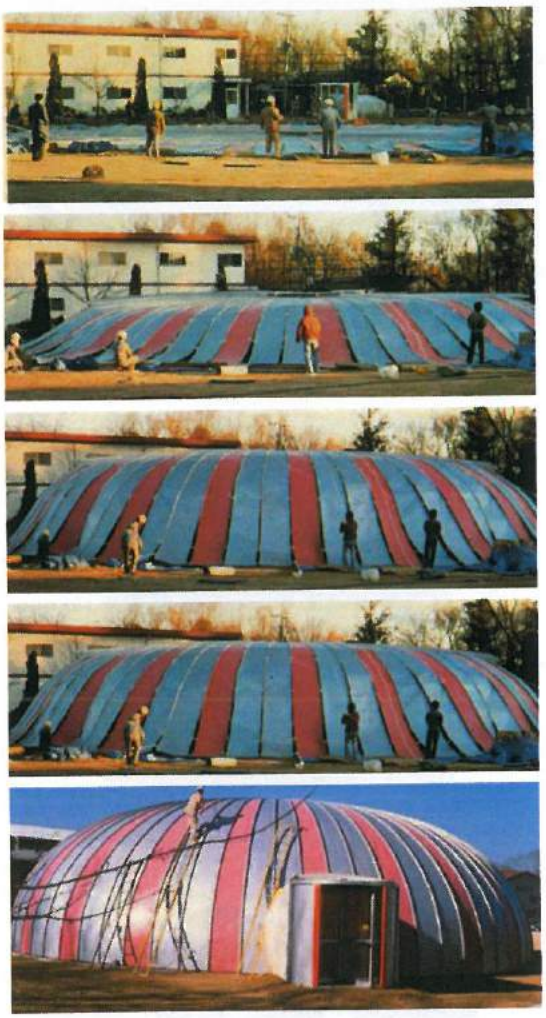


Fig. 13. Erection Process of the Steel-Air Composite Dome.
From presentation of Mamoru Kawaguchi. LSCE 2005.

Fig. 14. Idea of Pantadomes. Namihaya Dome & Narahall.
From presentation of Mamoru Kawaguchi. LSCE 2005.

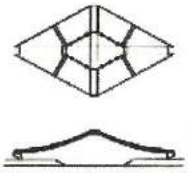
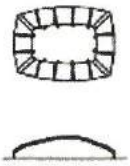
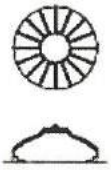
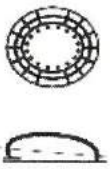
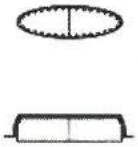
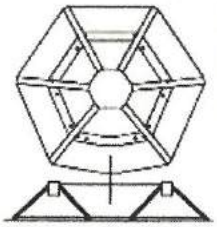
NAME	WORLD	SINGAPORE	ST. JORDI	FUKUI	NAMIHAYA	NARA HALL	COAL STORAGE
SHAPE AND DIMENSION							
	110 m	200 m	128 m	116 m	127 m	127 m	251 m
BUILT	1984	1989	1990	1995	1996	1998	2001
COVERD AREA	7,700 m²	14,000 m²	12,000 m²	10,500 m²	11,000 m²	6,500 m²	40,000 m²
TOTAL WEIGHT	1,680 t	2,600 t	8,000 t	5,430 t	4,690 t	4,660 t	7,500 t
STEEL WEIGHT	760 t	1,250 t	950 t	2,770 t	1,140 t	———	6,500 t
LIFTING HEIGHT	20 m	20 m	32 m	28 m	29 m	14 m	30 m
LIFTING POINTS	18	12	12	8	16	32	14
SPECIAL FEATURES	OVAL PLAN FIRST ATTEMPT	RECTANGULAR PLAN ABROAD	PRESTRESSED SHAPE ABROAD	TIMBER CIRCLE HEAVY SNOW	INCLINED ROOF QUICK LIFT	PRESTRESSED CONCRETE UNITS	BIG COVERED AREA LIGHT WEIGHT

Fig. 15. Realized pantadomes. M. Kawaguchi, LSCE 1995.

Fig. 16. Mamoru Kawaguchi during the visit in velodrome hall in Pruszków, Poland, LSCE 2005.
In the photo you can find besides Mamoru, also: Z.Bieniek, W.Zabłocki, Z.Kowal, A.T.Mircea, C.Mircea, J.Zdziechowski, J.Rębielak, K.Obrębski, R.Walentyński, M.Burt, L.Małyszko, J.Obrębski and others …
Photo by photo camera of Jan B. Obrębski.

4. MY PERSONAL CONTAKTS

Professor Mamoru Kawaguchi was attending in Warsaw first international conference on Lightweight Structures in Civil Engineering, presenting His beautiful ideas and realizations. He sent His proposal very late. Therefore, His paper was printed in the Volume II, together with S. Du Chateau, V.Sedlak, A.Samartin, H.A.Mang, M.Majowiecki and a few more, only. Next, He was returning to Warsaw twice – in 2002 and 2005. At each time His presentations were truth feast for other participants. We were met together also during IASS Symposia, I think each year up to Tokyo 2016. Slowly, as it is pointed in e-mail of Ken'ichi Kawaguchi our relations were very friendly. It resulted just in His three active visits in Warsaw.

10. REFERENCES

1. Lightweight Structures in Civil Engineering. Series of 24 Scientific Conferences in Poland 1995-2018: Warsaw (1995-1999, 2002, 2005-2010, 2012, 2014), Cracow (2000), Wroclaw (2001), Rzeszów (2003, 2015), Częstochowa (2004), Łódź (2011), Olsztyn (2013, 2016, *2019*), Bydgoszcz (2017).
2. Ihsan Mungan & John F. Abel (Editors): Fifty years of Progress for Shell and Spatial Structures. IASS, CEDEX – Laboratorio Central de Estructuras y Materiales. In celebration of the 50th Anniversary Jubilee of the IASS (1959-2009). Printed by SODEGRAF, Madrid 2011.