

IPA Booklet Series



International Press-in Association

Advanced Technologies



IPA Booklet Series

Advanced Technologies

International Press-in Association

Preface

The International Press-in Association (IPA) is proud to present this latest volume in the IPA Booklet Series, focusing on advanced technologies, which reflects our continued commitment to advancing knowledge and innovation in the field of geotechnical and foundation engineering. This edition brings together cutting-edge insights and practices, emphasizing the integration of digital innovation, sustainability, and resilient infrastructure development.

One of the key highlights of this booklet is the innovative management system for infrastructure, utilizing 3D point cloud data based on a Geographic Information System (GIS) platform. Topics such as optimizing foundation design, seismic response analysis of ground and geo-structures, and structural health monitoring are addressed through a multidisciplinary and data-driven approach.

It also introduces recent technological developments from the Japanese construction industry, showcasing tools such as Smart Pile and Smart Foundation, which enhance performance monitoring and lifecycle management. In support of global environmental goals, the booklet discusses approaches toward achieving carbon neutrality and presents numerical simulation techniques, along with city-scale disaster prevention and mitigation strategies.

The knowledge shared herein is envisioned to strengthen the engineering community's readiness in addressing future challenges through the integration of advanced technologies. On behalf of the IPA Publicity Committee and the International Press-in Association, I extend our deepest appreciation to all contributors for their valuable articles and insights. We hope this booklet will inspire meaningful advancements and collaborative efforts. Enjoy your reading.

Nor Azizi Bin Yusoff

Vice president of IPA

Chair of the Publicity Committee

Note: In this booklet, author affiliations and titles are, as a general rule, presented as they were at the time of writing. In cases where changes have occurred, current information is included only when necessary. Additionally, certain articles have been revised or updated in accordance with the authors' requests.

Contributors

Dr. Hiroshi Dobashi	Director, Maintenance and Traffic Management Department, The Metropolitan Expressway Co., Ltd.
Prof. Mounir Bouassida	Professor, University of Tunis El Manar. National Engineering School of Tunis
Prof. Akira Asaoka	Professor Emeritus, Nagoya University Senior Research Advisor, Association for the Development of Earthquake Prediction
Prof. Toshihiro Noda	Professor, Nagoya University
Dr. Kenichi Horikoshi	General Manager, Technology Planning Department, Taisei Advanced Center of Technology, Taisei Corporation (at the time of writing) President and Representative Director, Seiwa Consultants Co., Ltd. (currently)
Prof. Atsushi Iizuka	Professor, Kobe University (at the time of writing) Professor, Chuo University Emeritus Professor, Kobe University (currently)
Prof. Kenichi Soga	Distinguished Professor, Donald H. McLaughlin Chair in Mineral Engineering, University of California, Berkeley
Dr. Jignasha Panchal	Technical Manager, Keltbray Piling, London, UK (at the time of writing) Engineering Manager, A2 Advanced Monitoring (currently)
Dr. Yoshiaki Kuriyama	President, National Institute of Maritime, Port and Aviation Technology
Prof. Atsushi Yashima	Professor, Gifu University
Prof. Yosuke Higo	Professor, Kyoto University

Prof. Kazuyoshi Tateyama

Professor, Research Organization of Science and
Technology, Ritsumeikan University

Prof. Tetsuo Yoshimoto

Professor, College of Business Administration,
Ritsumeikan University

Contents

1 Innovative management system for infrastructure by utilization of 3D point cloud data based on GIS platform

Originally published in IPA Newsletter Vol. 3, No. 2 in 2018

Hiroshi Dobashi

1.1	Introduction	1
1.2	Outline of InfraDoctor	2
1.2.1	GIS platform	2
1.2.2	All-around video	3
1.2.3	Three-dimensional point cloud data	4
1.3	Applications of point cloud data	6
1.3.1	Detection of damage and displacement of structures	6
1.3.2	Three dimensional measurements	7
1.3.3	Creation of two-dimensional CAD drawing	8
1.3.4	Creation of three-dimensional CAD model	9
1.4	Smart Infrastructure Management System, i-DREAMs	9
1.5	Summary	11
	References	12

2 Optimizing the design of foundations on soils reinforced by columns

Originally published in IPA Newsletter Vol. 3,3 in 2018; updated in 2025

Mounir Bouassida

2.1	Introduction	15
2.2	Reinforcement using end-bearing columns	17
2.2.1	Case study 1: Oil tank at Zarzis terminal (Tunisia)	17
2.2.2	Case study 2: Damiette project	19
2.3	Reinforcement using floating columns	21
2.3.1	Case study 3: Oil tank foundation on homogeneous Tunis soft clay	22
2.3.2	Case history 4: Oil storage facility at Ghannouche (Tunisia)	26

2.4	Concluding remarks	31
	References	32
	Abbreviations	34

3 Seismic Response Analysis of Ground/Geo-structures using Geo Analysis Integration Code

Originally Published in IPA Newsletter Vol. 3,3 in 2018

Akira Asaoka and Toshihiro Noda

3.1	Introduction	37
3.2	Seismic response analyses of ground considered as being saturated	38
3.2.1	Embankment collapse due to the 2007 Noto Peninsula Earthquake (Sakai and Nakano, 2012)	38
3.2.2	Extended ground liquefaction damage at Urayasu City caused by surface waves generated from the edge of sloped bedrock during the Great East Japan Earthquake (Nakai et al., 2015)	39
3.2.3	Application of the Sand Compaction Pile (SCP) Method (Noda et al., 2011)	42
3.2.4	Application of the Pore Water Pressure Dissipation Method for shore protection structures (Noda et al., 2015; Nonaka et al., 2017)	43
3.2.5	Advanced development of the elasto-plastic constitutive equation of the soil skeleton — the combined hardening elasto-plastic constitutive equation (Yamada and Noda, 2015)	45
3.3	Three-phase seismic response analysis that is also applicable to unsaturated soils	46
3.4	Analysis of associated strike-slip fault formation in ground surface layers	48
3.4.1	Analysis of associated strike-slip faults resulting from lateral strike-slip fault formation (Toyoda et al., 2019)	48
3.5	Conclusion	50
	References	51

4 Technology Developments in Japanese Construction Industry

Originally published in IPA Newsletter Vol. 4, No. 4 in 2019

Kenichi Horikoshi

4.1	Introduction	55
4.2	Recent trends in Japanese construction industry	56
4.3	Improving productivity in construction industry	58
4.3.1	Unmanned construction system	58
4.3.2	Automatic concrete slab finisher and cleaner	62
4.3.3	Advanced positioning system for pile installation	64
4.3.4	Systems developed for safer tunnel construction	65
4.4	Summary	66
	References	67

5 Paradigm shift of disaster prevention and mitigation by city scale simulation

Originally Published in IPA Newsletter Vol. 5,2 in 2020; updated in 2025

Atsushi Iizuka

5.1	Demonstration of IES	69
5.2	IES, From Integrated Earthquake Simulator ²⁾ to Integrated Engineering System	71
5.3	Proposal of "Kobe model"	72
5.4	Paradigm shift of disaster prevention and mitigation	74
	References	75
	Applendix	76

6 Smart Pile, Smart foundation and Smart infrastructure?

Originally Published in IPA Newsletter Vol. 6,2 in 2021

Kenichi Soga

6.1	Introduction	79
6.2	Smart Foundation	80

6.3	Distributed fiber optic sensing technology	81
6.4	A smart pile in California	82
6.5	A smart pile in London	84
6.6	The value of smart foundation	86
	References	87

7 Redefining the way sustainable construction is delivered

Originally Published in IPA Newsletter Vol. 7,2 in 2022; updated in 2025

Jignasha Panchal

7.1	Background	89
7.2	HIPER® Pile	90
7.3	HS2 HIPER Pile case study	92
7.4	Conclusions	96
	References	96

8 Research Projects at National Institute of Maritime, Port and Aviation Technology, Japan, for Achieving Carbon Neutrality

Originally Published in IPA Newsletter Vol. 7,2 in 2022

Yoshiaki Kuriyama

8.1	Introduction	100
8.2	National Institute of Maritime, Port and Aviation Technology (MPAT)	100
8.3	Research projects toward carbon neutrality	100
8.3.1	Offshore wind farm	100
8.3.2	Zero-emission ship	105
8.3.3	Blue Carbon	107
8.3.4	Fixed Flight-Path Angle (Fixed-FPA) Descent for efficient aircraft arrival operations	108
8.4	Future development	109
	References	109

9 The challenge to Structural Health Monitoring of Expressway Embankment

Originally Published in IPA Newsletter Vol. 8,1 in 2023

Atsushi Yashima

9.1	Introduction	111
9.2	Geophysical exploration techniques for inspection	112
9.3	Evaluation of initial mechanical property of expressway embankment	113
9.4	Change in shear wave velocity with time	116
9.5	Passive linear array exploration	117
9.6	Distributed Acoustic Sensing (DAS)	120
9.7	Conclusions	122
	Acknowledgments	122
	References	123

10 Numerical Simulation of Penetration into Ground

Originally Published in IPA Newsletter Vol. 8,3 in 2023

Yosuke Higo

10.1	Introduction	125
10.2	Material Point Method	125
10.3	Steel Sheet Pile Penetration	128
10.4	Footing Penetration	131
10.5	Summary and Future Perspectives	135
	Acknowledgements	135
	References	135

11 Facing a Society with a Declining Population

- Challenges and Opportunities for the Construction Industry -

Originally Published in IPA Newsletter Vol. 10,2 in 2025

Kazuyoshi Tateyama and Tetsuo Yoshimoto

11.1	Issues Facing the Construction Industry in Japan	137
------	--	-----

11.2	Government Policies to Solve the Problems of the Construction Industry	140
11.2.1	i-Construction for improvement in productivity	140
11.2.2	i-Construction began with earthworks	142
11.2.3	Toward construction reform in the DX Era – Infrastructure DX-	143
11.2.4	i-Construction 2.0	145
11.3	Significance of ICT Introduction	146
11.3.1	Promotion of efficiency and saving of manpower in construction work	147
11.3.1.1	Example of effective use of ICT (example of slope construction)	147
11.3.1.2	Automation and Robotization in Construction	148
11.3.2	Creation of opportunities for diverse human resources	149
11.3.3	Reduction of excess through precise management	151
11.4	Conclusion	153
	References	154