COMPUTATIONAL METHODS
in Engineering & Science

Proceedings of the EPMESC X,
Aug. 21-23, 2006, Sanya, China

Editors
Z. H. Yao
M. W. Yuan
Y. Q. Chen

TSINGHUA UNIVERSITY PRESS
Springer

图书在版编目(CIP)数据

工程与科学中的计算方法＝Computational Methods in Engineering & Science：Proceedings of the EPMESC X Aug. 2006，Sanya，China/姚振汉等编. —北京：清华大学出版社，2006.8
ISBN 7-302-13530-4

Ⅰ. 工…　Ⅱ. 姚…　Ⅲ. ①工程技术－计算方法－国际学术会议－文集－英文 ②自然科学－计算方法－国际学术会议－文集－英文　Ⅳ. ①TB115-53 ②N32-53

中国版本图书馆 CIP 数据核字(2006)第 083897 号

出 版 者：清华大学出版社
http://www.tup.com.cn
社 总 机：010-62770175
责任编辑：陈朝晖
印 刷 者：清华大学印刷厂
装 订 者：三河市春园印刷有限公司
发 行 者：新华书店总店北京发行所
开　　本：185×260　印张：22.25
版　　次：2006 年 8 月第 1 版　2006 年 8 月第 1 次印刷
书　　号：ISBN 7-302-13530-4/TB・101
印　　数：1～800
定　　价：88.00 元

地　　址：北京清华大学学研大厦
邮　　编：100084
客户服务：010-62776969

PREFACE

The 9th EPMESC was successfully held in Macao, November of 2003. At the end of the conference the Board of the EPMESC series decided that the next conference will be held in a city of the mainland of China. Also I was assigned to be the Chair person of the Conference. No doubt this is a great honor to me and also a challenge for the situation that there are so many professional international conferences in computational mechanics happened frequently in the world. After the successful organizing of WCCM6 in Beijing, September of 2004, I engaged to organize the 10th EPMESC.

First of all, choose the venue of the Conference. After some investigation and a lot of negotiation we came to see the site of the venue, Sanya, Hainan Island, the south-most city in China. Finally we made the decision. The most important reason of the choice is the ecological environment of this city. It is beneficial to our health after a hard working. We scientists and engineers need a good relax place after heavy duty and a place to enjoy the life with friends and family. Sanya is an ideal one and a real green city. Blue sky and white cloud, peaceful sea and the long beach with white sand, shells and pearls, no pollution and no industry, everything is so beautiful.

After the first call for paper, the response is unexpected strong. We got more than 190 abstracts from 23 countries and regions. About half participants come from the mainland of China. The rest are from Macao of China, Japan, Portugal, Australia, USA, Germany, Russia, Poland, Singapore, Malaysia, Brazil, UK, Israel, Indonesia, France, Spain, India, Korea, Czech, Chile, Hong Kong and Taiwan of China etc. We are glad to have so many friends from so many countries and regions to get together for exchanging their professional research results and taking part the social activities.

We have the honor to invite many famous experts in computational mechanics to give plenary and semi-plenary lectures in the conference. Serge Cescotto, Genki Yagawa, Zhenhan Yao are the plenary speakers. Win Kam Liu, Fred W. Williams, Roman Lackner, Ioannis Doltsinis, Helder Rodrigues, Nasser Khalili, Nori Miyazaki, Yao Zheng, Yeong-Bin Yang, Ka Veng Yuen, Gui Rong Liu, Chung-Bang Yun and Dajian Han are the semi-plenary speakers. All of them have achieved a great progress in their own fields of computational mechanics. I appreciate their outstanding contribution to the conference. This is the mark of the scientific level of this conference.

As one of the highlights, the student paper competition is the traditional program retained in the history of the EPMESC series. This will keep the young students to track the latest advances in research of computational mechanics. Also it will encourage them to claim the peak top of the science and technology. I like to thank my friend, Prof. Kai Meng Mok of University of Macau, for his assistance in organizing the student paper competition.

I like to thank my friend, Prof. Zhenhan Yao of Tsinghua University, for his outstanding work on the proceedings. He did a long term and patient work on the abstracts and papers in full length. He carefully read all the papers and abstracts and corrected a lot of mistake. He made this proceedings be a consistent valuable reference and beautiful looking. I also like to thank my colleagues, Dr. Yongqian Chen and Yang Kuei, for their assistance in my work.

I like to appreciate the China National Science Foundation for their generous support.

I wish the success of EPMESCX and the health of all the participants. I hope we will have a pleasant time in Sanya, 21-25 August 2006.

Mingwu Yuan
Chairman, EPMESC X
Professor, Peking University

CONFERENCE BOARD

J. Bento	(Instituto Superior Técnico, Portugal)
S. Cescotto	(University of Liège, Belgium)
Y. K. Cheung	(University of Hong Kong, Hong Kong, China)
C. K. Choi	(Korea Advanced Institute of Sc. & Tech., Korea)
I. Doltsinis	(Stuttgart University, Germany)
D. J. Han	(South China University of Technology, China)
V. P. Iu	(University of Macau, Macao, China)
T. Kawai	(Nippon Marc Co., Japan)
S. P. Lin	(Shanghai Jiao Tong University, China)
W. K. Liu	(Northwestern University, USA)
H. Mang	(Vienna University of Technology, Austria)
E. Arantes e Oliveira	(Instituto Superior Técnico, Portugal)
B. A. Schrefler	(University of Padova, Italy)
A. I. Tolstykh	(Russian Academy of Sciences, Russia)
S. Valliapan	(University of New South Wales, Australia)
F. W. Williams	(University of Wales, Cardiff University, UK)
G. Yagawa	(University of Tokyo, Japan)
Y. B. Yang	(Taiwan University, Taiwan, China)
M. W. Yuan	(Peking University, China)
W. X. Zhong	(Dalian University of Technology, China)

ORGANIZING COMMITTEE

Mingwu Yuan	Chairman	(China)
Dajian Han	Vice-Chairman	(China)
Zhenhan Yao	Secretary -General	(China)

Members:

S. Cescotto	(Universityof Liège, Belgium)
C. K. Choi	(Korea Advanced Institute of Sc. & Tech., Korea)
I. Doltsinis	(Stuttgart University, Germany)
L. N. Lamas	(National Laboratory of Civil Engineering, Portugal)
S. Sloan	(University of Newcastle, Australia)
G. R. Liu	(National University of Singapore, Singapore)
S. P. Lin	(Shanghai Jiao Tong University, China)
W. K. Liu	(Northwestern University, USA)
H. Mang	(Vienna University of Technology, Austria)
E. Pereira	(Instituto Superior Técnico, Portugal)
B. A. Schrefler	(University of Padova, Italy)
A. I. Tolstykh	(Russian Academy of Sciences, Russia)
S. Valliappan	(University of New South Wales, Australia)
F. W. Williams	(University of Wales, Cardiff University, UK)
G. Yagawa	(University of Tokyo, Japan)
Y. B. Yang	(Taiwan University, Taiwan, China)

LOCAL ORGANIZING COMMITTEE

Mingwu Yuan	Chairman	(Peking University, Beijing, China)
Zhenhan Yao	Secretary -General	(Tsinghua University, Beijing, China)

Members:

Dajian Han,	(South China University of Technology, Guangzhou, China)
Shaopei Lin	(Shanghai Jiaotong University, Shanghai, China)
Kai Meng Mok	(University of Macau, Macao, China)
Yao Zheng	(Zhejian University, Hangzhou, China)
Jiashou Zhuo	(Hohai University, Nanjing, China)

CONFERENCE SECRETARIAT

Yongqiang Chen	Scientific Secretary	(Peking University, Beijing, China)
Kai Meng Mok	Scientific Secretary	(University of Macau, Macao, China)
Yazheng Yang	Administration Secretary	(Chinese Society of Theoretical and Applied Mechanics, Beijing, China)
Yanan Tang	Administration Secretary	(Chinese Society of Theoretical and Applied Mechanics, Beijing, China)
Yang Kuei	Administration Secretary	(Peking University, Beijing, China)

CONTENTS

Preface i

Conference Board and Committees ii

* denotes the presenter

in alphabet order of the regular session and first-author's name

Plenary Lectures

1 Management of water pollutants based on multi-criteria analysis and fuzzy logics, 1
Cescotto S, Roubens M, Rigo N, Gao SX et al*

2 Enriched element method and its applications to solid mechanics, 15
Yagawa G, Matsubara H*

3 Large-scale boundary element analysis in solid mechanics using fast multipole method, 19
Yao ZH, Wang PB, Lei T, Wang HT*

Semi-plenary Lectures

4 Optimization and robustness of deformable systems with randomness, 35
Doltsinis I, Kang Z*

5 Simulation of Stochastic Fluctuating Wind Field Using the Wave Superposition Method with Random Frequencies, 51
Han DJ, Luo JJ*

6 Monotonic and Cyclic Analysis of Granular Soils, 59
*Khalili N**

7 Adaptive meshfree methods using local nodes and radial basis functions, 71
Liu GR, Kee BBT, Zhong ZH, Li GY, Han X*

8 Multiresolution mechanics for material design and manufacturing, 87
*Liu WK**

9 Application of computational mechanics to reliability studies of electronic packaging, 88
Miyazaki N, Ikeda T*

10 Topology optimization of structures: applications in the simulation and design of cellular materials, 101
*Rodrigues HC**

11 Rigid body considerations for geometric nonlinear analysis of structures based on the updated Lagrangian formulation, 113
Yang YB, Lin SP, Chen CS*

12 Nano-modeling structure and micromechanical properties of mesoscopic composite systems, 129
*Yanovsky YuG**

13 An extremely efficient finite-element model updating methodology with applications to damage detection, 139
*Yuen KV**

14 Dynamic infinite elements for soil-structure interaction analysis in a layered soil medium, 153
Yun CB, Kim JM*

List of other semi-plenary lectures 168

ABSTRACTS OF REGULAR SESSIONS

Computational Fluid Mechanics

15 Numerical simulation of cavitation generation in tandem cascades, 169
Kang C, Liu D, Yang MG*

16 Numerical simulation of atrium fire using two CFD tools, 170
*Sin VK, Tam LM, Lao SK, Choi HF**

17 Investigation of the particulate matters with the aid of CFD, 171
Tam LM, Sin VK, Sun HI, Wong KI*

18 CFD analysis of fire in a forced ventilated enclosure, 172
Tam LM, Sin VK, Lao SK, Choi HF*

19 Development of the diffusion control system using air shutter, 173
Asami T, Nakabayashi Y*

20 A high order compact difference scheme for solving the unsteady convection-diffusion equation, 174
Xie ZH, Lin JG, Zhou JT*

21 Computation of one-dimensional dam-break flow using ENO scheme, 175
Liu YL, Guo YT, Fan WB*

22 Numerical simulation of 2D dam-break flood waves using TVD scheme, 176
Wei WL, He WY*

23 Motion analysis of the elevating ball by the effect of buoyant force, 177
Matsuo Y, Nakabayashi Y*

24 Development of an educational flow simulation system, 178
Nakanishi T, Shibata H, Sato M*

25 Using finite element program generator to solve N-S equation, 179
Wan S, Nielsen MP, Chai G*

26 Experimental and CFD study of the effects of design parameters on Reynolds number in a short duration hypersonic test facility, 180
Al-Ralahi A, Yusaf T, Yusoff MZ*

27 Investigation of multiphase flows near walls with textures by the lattice Boltzmann method, 181
Chew YT, Huang JJ, Shu C, Zheng HW*

28 Numerical Simulation of the microstructure of magnetorheological fluids in magnetic fields, 182
Peng XH, Li HT*

29 Implementation of a 3D multilaminated hydromechanical model for analysis of an unlined high pressure tunnel, 183
*Leitao NS, Lamas LN**

30 Prediction of mixing and reacting flow inside a combustor, 184
*De Bortoli AL**

31 Large Eddy Simulation of Turbulent Reactive Flow, 185
Liu Y, Chen YQ, Chen JG, Yang R*

32 Computational modeling of coal water slurry combustion processes in industrial heating boiler, 186
*Zhu LJ, Gu BQ**

33 Large eddy simulation of unsteady turbulent flow and pressure fluctuation in an axial-flow pump with various SGS models, 187
Cong GH, Wang FJ, Zhang L*

34 Computation of turbulent flows in natural gas pipes with different rectifiers, 188
Li ZL, Zhang YX*

35 Computation of unsteady incompressible turbulent flow by using an implicit SMAC method, 189
Zhang YX, Li ZL, Zhu BS*

36 Simulation on vortex effect for superconducting devices, 190
Lei SL, Lao MI, Chan IN*

Computational Solid Mechanics

37 Simulation of corrosion rate of carbon steel subjected to elastic/plastic strain, 191
Ridha M, Aoki S*

38 Effect of surface traction on the shakedown limit under moving surface loads, 192
*Shiau J**

39 Elasto-plastic finite element analysis of tapered steel silo, 193
Xu CL, Luo YF, Song HJ*

40 Numerical simulation of failure process in heterogeneous elastoplastic materials, 194
*Li YZ, Chen YQ**

41 Fatigue damage analysis of reactor vessel model under repeated thermal loading, 195
Takagaki M, Toi Y, Asayama T*

42 Interaction of moving interfacial cracks between bonded dissimilar elastic strips under antiplane shear, 196
*Das S**

43 Stress intensity factor of a wide range of semi-elliptical partly through-wall crack in a finite-thickness plate, 197
*Kou KP**

44 Numerical simulation of the fracture spacing in two-layered material subjected to thermal and mechanical loading, 198
Li LC, Tang CA, Liang ZZ*

45 VCCM rule-based meshing algorithm for an automatic 3D analysis of crack propagation of mixed mode, 199
Murotani K, Yasuyoki K, Fujisawa T, Yagawa G*

46 The state-of-the-art methodology to compute 3-D stress intensity factors for arbitrary shaped cracks in complex shaped structures, 200
Okada H, Yagawa G, Kawai H, Shijo K et al*

47 3D crack propagation analysis using free mesh method, 201
Osaki H, Matsubara H, Yagawa G*

48 Finite element method for analyzing stress intensity factor of a surface crack in tubular joints, 202
Shao YB, Du ZF, Hu WD*

49 The solutions of stress and displacement fields of orthogonal anisotropic plate with edge-crack, 203
Tian ZR, Sun Z, Li ZY*

Computational Structural Mechanics

50 Nonlinear FE model for RC shear walls based on multi-layer shell element and micro-plane constitutive model, 204
Miao ZW, Lu XZ, Jiang JJ, Ye LP*

51 Numerical modelling and simulation of an internal combustion engine piston with a surface coating, 205
*Niezgoda T, Kurowski Z, Malachowski J**

52 Reliability analysis using saddlepoint approximation, 206
Wang J, Yuen KV, Au SK*

53 Advanced computational method for reliability analysis of concrete-faced rockfill dam, 207
Wu QX, Zhao KZ, Yang MZ*

54 Structural dynamic reliability of solid rocket motor grains, 208
Zhang SJ, Ren JG*

55 Wave propagation in orthotropic elastic shells: theoretical and numerical modeling, 209
Tie B, Aubry D*

56 Study on the criterion of in-plane instability of non-reinforced U-shaped bellows, 210
Chen Y, Gu BQ*

57 Coupled thermal-dynamic stability analysis of large-scale space structures by FEM, 211
Li W, Xiang ZH, Xue MD*

58 Numerical modelling of the lateral-torsional buckling of stainless steel I-beams: comparison with Eurocode 3, 212
Lopes N, Vila Real PMM, Simoes da Silva L, Mirambell E*

59 Research on simulation analysis for stability problem of pressure-penstock with imperfection, 213
Meng WY, Li XQ, Zhuo JS*

60 Nonlinear finite element buckling analysis of square reinforced concrete long columns confined with carbon fiber reinforced plastic sheets under axial compression, 214
Ren QX, Chen TG, Huang CK, Liu YH*

61 A kind of channel-section beam element for transient coupled thermal-structural dynamic analysis, 215
Duan J, Xue MD, Xiang ZH*

62 Semi-analytical analysis of super tall building bundled-tube structures, 216
Gong YQ, Li K*

63 Computational design of beam sections under impact loading, 217
Hou SJ, Li Q, Long SY, Yang XJ*

64 Pretension control of the long-span roof structure of South Shanghai Railway Station, 218
Huang Y, Luo YF, Yu R*

65 Damage detection and sensor placement design for two highway bridges, 219
Li YQ, Xiang ZH, Zhou MS, Swoboda G, Cen ZZ*

66 A new iterative method for solution of rectangular elastic structure, 220
*Lin FY**

67 Overall stability of the long span steel roof structure of Hangzhou International Conference Center, 221
Luo YF, Liu X, Wang ZB*

68 Regionwise modeling approach for the analysis of layered structures, 222
*Mohite PM, Upadhyay CS**

69 Computational and experimental study of energy absorption metter by composite structures, 223
Niezgoda T, Barnat W*

70 The dynamic analysis of main building of Hangzhou International Conference Center, 224
Song HJ, Luo YF, Xu CL, Yang MW*

71 Second-order analysis for steel frame structures with a distributed plasticity numerical model, 225
Wang K, Tong LW, Li T*

72 Pretension simulation of the long span truss string supported by the temporary structures, 226
Yu R, Luo YF, Huang Y*

73 Accurate form-finding method for cable-dome structures based on catenary element, 227
Zhao XZ, Tang RW, Shen ZY*

74 Higher order modes in thin-walled beam analysis, 228
Vieira R, Virtuoso F, Pereira E*

75 Research on rigidity limits of bridge with conventional spans for Chinese high-speed railway, 229
Gao MM, Pan JY, Yang YQ*

76 Numerical implementation and calibration of a hysteretic model for cyclic response of end-plate beam-to-column steel joints under arbitrary cyclic loading, 230
Nogueiro P, Simoes da Silva L, Bento R*

Finite Element Analysis

77 Finite element analysis of singular inplane stress field around an inclusion's corner tip, 231
Chen MC, Ping XC*

78 Finite element analysis for the metallic gasket effective width, 232
Feng X, Gu BQ, Liu R*

79 Finite element analysis of electrochemical-poroelastic behaviors of conducting polymer (PPy) films, 233
Jung WS, Toi Y*

80 Finite element analyses of multi-material wedges and junctions with singular antiplane stress field, 234
Ping XC, Chen MC, Xie JL*

81 Plane strain finite element analysis of a piled bridge abutment on soft ground, 235
Wang HT, Chen ZP, Xiao LJ*

82 Finite element analysis of a coal liquefaction reactor during lifting, 236
Wang ZB, Luo YF, Liu X*

83 Finite element analysis of welded cruciform joint, 237
Wu AH, Syngellakis S, Mellor BG*

84 Static and dynamic testing of the SATUOeiras viaducts, 238
Xu M, Santos LO, Rodrigues J*

85 Finite element approach to resin flow during the resin film infusion process, 239
*Yang M, Yan SL**

86 Numerical simulation of a new complex FRP pipe culvert by FEA, 240
*Yang MW**

Heat Transfer and Temperature Related Problems

87 Numerical study of two-dimensional transient heat conduction using finite element method, 241
Choi LY, Keong WS, Woon OH, Kiong SC*

88 Chemical reaction, heat and mass transfer on nonlinear MHD boundary layer flow through a vertical porous surface with thermal stratification in the presence of suction, 242
Kandasamy R, Periasamy K, Sivagnana Prabhu KK*

89 Development of a mathematical model for heat and mass transfer inside a granular medium, *Petry VJ*, De Bortoli AL, Khatchatourian O* 243

90 Factor Analysis for convective heat transfer problem by using the ANN method, *Tam HK*, Tam SC, Ghajar AJ, Tam LM* 244

91 Thermally induced mechanical changes around a potential nuclear waste repository in China, *Liu YM*, Wang J, Cai MF, Wang SR* 245

92 Research on thermo quality transmission problems for large-scale slab with creep, *Wang JX*, Wang XC* 246

93 Current developments on the coupled thermomechanical computational modeling of metal casting processes, *Agelet de Saracibar C*, Chiumenti M, Cervera M* 247

94 Application of the mushy cell tracking method for Gallium melting, *Liang SJ*, Jan YJ, Chung MS* 248

High Performance FEM and SBFEM

95 New FDM for plane elasticity in polar coordinate, *Zhu BQ*, Zhuo JS, Zhou JF* 249

96 Computational strategies for curved-side elements formulated by quadrilateral area coordinates (QAC), *Cen S*, Song DP, Chen XM, Long YQ* 250

97 Studies of 4-node membrane element with analytical stiffness-matrix based on the quadrilateral area coordinates (QAC), *Du Y*, Cen S* 251

98 Special hybrid multilayer finite elements for 3-D stress analyses around quasi-elliptic hole in laminated composites, *Tian ZS*, Yang QP, Zhang XQ* 252

99 A 3-dimensional assumed stress hybrid element with drilling degrees of freedom, *Wang AP*, Tian ZS, Zhang XQ* 253

100 Suppression of zero-energy modes in hybrid finite elements via assumed stress fields, *Zhang CH*, Wang DD, Zhang JL* 254

101 Analysis of concentrated boundary loads in the scaled boundary finite element method, *Vu TH*, Deeks AJ* 255

102 A frequency-domain approach for transient dynamic analysis using scaled boundary finite element method (I): approach and validation, *Yang ZJ*, Deeks AJ, Hong H* 256

103 A frequency-domain approach for transient dynamic analysis using scaled boundary finite element method (II): application to fracture problems, *Yang ZJ, Deeks AJ*, Hong H* 257

Inverse Problems

104 A novel fuzzyexpert diagnosis system of inner-faults for three-phase squirrel cage induction motors, *Cheang TS*, Chan SL, Sekar BD, Dong MC* 258

105 Updating noise parameters of Kalman filter using Bayesian approach, *Hoi KI*, Yuen KV, Mok KM* 259

106 Damage detection of vibrating structure from limited natural frequencies, *Li XL*, Okuda H, Yagawa G* 260

Meshless Methods

107 Error estimations in LBIEM and other meshless methods, *Chen HB*, Fu DJ, Guo XF, Zhang PQ* 261

108 Parallel computing for enriched free mesh method (EFMM), 262
Kobayashi Y, Yagawa G*

109 3D animation for free mesh method, 263
Nagaoka S, Inaba M, Yagawa G*

110 A stabilized conforming integration procedure for Galerkin meshfree analysis of thin beam and plate, 264
*Wang DD**

111 Element-free Galerkin method with wavelet basis, 265
Liu YH, Liu YN, Cen ZZ*

Micromechanics and Intelligent Materials

112 The numerical prediction of effective properties of non-continuous carbon nano-reinforced composites by the macro-microscopic homogenization method, 266
Luo DM, Wang WX, Takao Y, Kamimoto K*

113 Molecular dynamics simulation of length size effect on mechanical properties of nano-metal, 267
Huang D, Zhuo JS*

114 Molecular dynamic simulations of CNT-water nanostructures, 268
Zou J, Feng XQ, Ji B, Gao H*

115 Computer simulation of quantum dot surface under stress, 269
Liu XM, Zhuang Z, Zhang T*

116 3D BEM for piezoelectric solids of general anisotropy, 270
Denda M, Wang CY*

117 Analysis of quantum dots induced strain and electric-field in piezoelectric semiconductor substrate of general anisotropy, 271
Wang CY, Denda M, Pan E*

Numerical Algorithms

118 Adaptive under-frequency load shedding scheme by genetic algorithm, 272
Lou CW, Dong MC, Wong CK*

119 An effective computer generation method for the domain with random distribution of large numbers of heterogeneous grains, 273
Yu Y, Cui JZ, Han F*

120 Three-dimensional mesh generation using the crossed circle method, 274
Suzuki H, Ezawa Y*

121 Study on displacement prediction of landslide based on grey system and evolutionary neural network, 275
*Gao W**

122 Prediction of ambient PM10 concentration with artificial neural network, 276
Lam LH, Mok KM*

123 A note on the complexity of the PCG algorithm for solving Toeplitz systems with a Fisher-Hartwig singularity, 277
Vong SW, Wang W, Jin XQ*

124 One-point integration that handles shear-locking in cubic splines, 278
Wang SM, Zhang YS*

125 An improved ICCG method of large-scale sparse linear equation group, 279
Zhang YJ, Sun Q*

126 A parallel computing method of object-oriented FEM based on substructure, 280
Zhao HM, Zhang K, Dong ZZ*

127 Promotion of frontier science research by aid of automatic program generation technology, 281
Wu BX, Qian HS, Wan S*

128 Uniformed NURBS surface deformation subject to boundary conditions, 282
Lo KM, Yang ZX*

129 The pseudo-spectral method and Matlab implement, 283
Wang SL, Wu ZR, Cheng YL*

Rock, Soil and Concrete

130 Composite construction in reinforced concrete taking into consideration the non-rigid bond of interfaces in joints, 284
*Lindig V**

131 Optimization of observation condition on inverse analysis for identifying corrosion of steel in concrete, 285
Suga K, Ridha M, Aoki S*

132 A study on temperature distribution in a cross section of concrete box girder bridges, 286
Tan YP, Han DJ*

133 Stress-based effective space anisotropic damage model for concrete, 287
Wu JY, Li J*

134 Identification of electric conductivity and impedance of reinforced concrete by boundary element inverse analysis, 288
Yoshida M, Suga K, Ridha M, Aoki S, Amaya K*

135 Stresses and cracking caused by hydration heat in massive concrete structures, 289
Zhang ZM, Song ZT, Zhang Y*

136 Numerical modeling of consolidation of marine clay under vacuum preloading incorporating prefabricated vertical drains, 290
*Ho SM, Lok TMH**

137 Drag forces applied on rock matrix by fluid flow through fracture network in rock mass, 291
*Chai JR**

138 A 2-D natural element model for jointed rock masses, 292
Yu TT, Ren QW*

139 Numerical implementation of a bounding surface bubble model for structured soils, 293
Maranha JR, Vieira A*

140 Numerical simulation of nonlinear interaction of soil, superstructure and thick raft with irregular plan, 294
Du YF, Di SK, Li H, Song Y, Dang XH*

141 Soil additionally affected by non force loading and its influence on upper structure, 295
Kuklik P, Broucek M*

142 Advances in unsaturated soil mechanics, 296
Mi ZK, Shen ZJ*

143 Numerical simulations of the behavior of foundations on reinforced soil, 297
*Tou CM, Lok TMH**

144 Stress-strain modeling of tire chip-sand mixture, 298
Yu HJ, Lok TMH*

Structural Optimization

145 Multi-objective optimization for shape design of arch dams, 299
Sun LS, Zhang WH, Xie NG*

146 Optimal shape control of multilayered piezoelectric smart plate structure, 300
Wang JG, Ding GF, Qin Y*

147 Engineering structural optimization with an improved ant colony algorithm, 301
Gong YB, Li QY*

148 Optimization studies for crashworthiness design using response surface method, 302
Liao XT, Li Q, Zhang WG*

149 Path optimization of large-scale automated three-dimensional garage based on ant colony algorithm, 303
Meng JJ, Yang ZQ, Peng ZR*

150 A continuous approach to discrete structural optimization, 304
Tan T, Li XS*

151 Parametrical analysis and optimization of partial double-layer reticulated shells using uniform design method and second order rotation method, 305
Xiao JC, Liang T, Liu Y*

152 Optimum design of spiral grooved mechanical seal based on thermo-hydrodynamics, 306
Zhou JF, Gu BQ*

153 Evolutionary topological design of frame for impact loads, 307
Chen XY, Li Q, Long SY, Yang XJ*

154 Topology optimization of space vehicle structures considering attitude control effort, 308
Kang Z, Zhang C*

155 Application and research of structure topology optimization of scraper conveyer with MSC.Nastran.optishape, 309
Sang JB, Liu B, Xing SF, Yang LC, Qie YH*

156 Structural topology optimization using level set method, 310
*Wang MY**

157 Topological optimization analysis of 3-D continuum structure with stress and displacement constraints, 311
Ye HL, Sui YK*

Topics of Computer Software Technology

158 Cross-level sentence alignment, 312
Ho A, Oliveira F, Wong F*

159 CSAT: a Chinese segmentation and tagging module based on the interpolated probabilistic model, 313
Leong KS, Wong F, Tang CW, Dong MC*

160 Overcoming data sparseness problem in statistical corpus based sense disambiguation, 314
Oliveira F, Wong F, Ho AN, Li YP, Dong MC*

161 Application of translation corresponding tree (TCT) annotation schema for Chinese to Portuguese machine translations, 315
Tang CW, Wong F, Leong KS, Dong MC, Li YP*

162 Development of a knowledge based system for the Portuguese code for building acoustics, 316
Graça JM, Patrício J, Lopes LS*

163 Interfacing vision system with robot for pick and place operation, 317
*Lalitha R**

164 A web-based data management and decision support system for slope safety inspection and evaluation, 318
Wang J, Hung MC*

Vibration, Impact and Control

165 Simplified doubly asymptotic approximation boundary for foundations dynamic analysis, 319
*Lei WJ, Wei DM**
166 Limit state analysis of seismically excited 3d r/c beam bearing structures, 320
*Kaufmann N**
167 Earthquake response analysis and energy calculation based on wavelet transform, 321
Wu C, Zhou RZ*
168 Elastoplastic impact of the sphere upon the Uflyand-Mindlin plate, 322
Lokteva IA, Loktev AA*
169 Numerical analysis of impact between cue and ball in billiard (effect of tip structure), 323
Shimamura S, Aoki S*
170 A new multi-harmonic method for predicting the forced response of mistuned bladed disks with dry friction damping, 324
*He EM, Wang HJ**
171 Coupled vibration analysis of multiple launch rocket system by finite element method, 325
*Li BS, Xu XQ**
172 Three-dimensional vibration analysis of functionally graded material rectangular plates by Chebyshev polynomials, 326
Li Q, Iu VP, Kou KP*
173 A hybrid elasticity method for bending and free vibration of composite laminates, 327
*Lü CF, Chen WQ**
174 Vibration assessment of railway viaducts under real traffic using bridge-track models, 328
Rigueiro C, Rebelo C, Simões da Silva L*
175 In-plane vibration of rectangular plates with rectangular cutouts, 329
*Shufrin I, Eisenberger M**
176 Optimal control of temperature gradient in a large size magnetic Czochralski silicon crystal growth by response surface methodology, 330
Yu HP, Sui YK, Wang J, Dai XL, An GP*
177 Active vibration control analysis of piezoelectric intelligent beam, 331
Wang T, Qin R, Li GR*
178 Interval dynamic analysis using interval factor method, 332
*Gao W**
179 Sensibility analysis of violin plates, 333
Razeto M, Staforelli C, Barrientos G*
180 Effect of pier and abutment non-uniform settlement on train running behavior, 334
Xiong JZ, Yu HB, Gao MM*

Author Index 335

COMPUTATIONAL METHODS IN ENGINEERING AND SCIENCE
EPMESC X, *Aug. 21-23, 2006, Sanya, Hainan, China*

Management of Water Pollutants Based on Multi-Criteria Analysis and Fuzzy Logics

Serge Cescotto [1]*, Marc Roubens [2], Nicolas Rigo [3], Shixiang Gao [4], Xiaodong Wang [4], Aiquan Zhang [4], Nelson Lourenco [5], Jiti Zhou [4], Xuemin Xiang [4], Joao Paulo Lobo Ferreira [6]

[1] *Department M&S ANAST, University of Liège, Belgium*
[2] *Department of Mathematics, University of Liège, Belgium*
[3] *Department ANAST, University of Liège, Belgium*
[4] *School of the Environment, Nanjing University, Nanjing, China*
[5] *Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa, Lisboa, Portugal*
[6] *Laboratorio Nacional de Engenharia Civil, Lisboa, Portugal*

Email: serge.cescotto@ulg.ac.be

Abstract This work has been developed in the frame of the MANPORIVERS research project funded by the European Commission. The goal is to identify effective and sustainable policies for the management of surface and ground water pollutants, taking account of their relationships with food production and human health. A methodology based on the combination of fuzzy logics and multicriteria analysis is proposed as a decision aid tool for the development of such policies. An example of application in the Huai river basin is given.

Key words: Rivers, pollutant, methodology, management, policy

OBJECTIVES AND ACTIVITIES

The goal of the MANPORIVERS project is to identify effective and sustainable policies for the management of surface and ground water pollutants, taking account of their relationships with food production and human health. The aim is the definition of policies with a very broad range of applicability that could be used for many river basins. They can be used interactively for different basins exchanging water. They can also be used at different scales in a recursive manner, from small tributary basins to large basins.

Table 1 Description of the tasks

Task number	Description of the tasks
	The different tasks develop methodologies for :
WP1.a	Evaluation of non accidental pollutant input
WP1.b	Evaluation of accidental pollutant input
WP1.c	Evaluation of input evolution in the future
WP2.a	Analysis and selection of surface water pollutant transport models
WP2.b	Analysis and selection of groundwater pollutant transport models
WP3.a	Identification and analysis of techniques for water cleaning
WP3.b	Identification and analysis of accident remediation techniques
WP4.a	Assessment of the use of drink water
WP4.b	Assessment of the use of irrigation water
WP4.c	Assessment of water used in food industries
WP4.d	Assessment of water used for fish breeding
WP4.e	Assessment of other uses of water
WP4.f	Evaluation of water use in the future
WP5	Analysis of the relationships of pollutants with health
WP6	Pollution management priority policies by fuzzy logics and multicriteria analysis

The activities presented in this paper are summarized in Fig. 1 and Table 1. Although we mainly concentrate here on task WP6, it is worth giving some information on the work achieved in tasks WP1 to WP5 as they constitute a support for WP6.

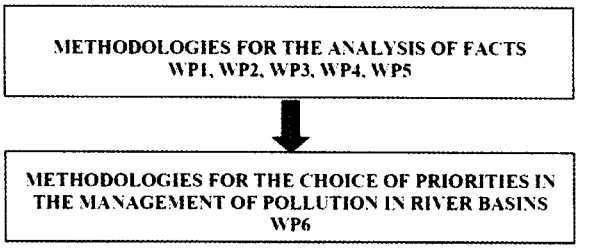

Figure 1: General Organization of the activities

METHODOLOGIES FOR THE ANALYSIS OF FACTS

1. Methodologies for the evaluation of accidental and non accidental pollutant input (WP1) [1] Pollutant sources are classified into two categories: non accidental pollutant input and accidental pollutant input.
The research work completed consists of two parts: (1) Development of evaluation methodologies for the two categories; (2) Application to the Xuyi County (Huai river basin) and to the Xizhijiang River basin (Pearl River delta).

2. Methodologies for the choice of models for the transport of pollutant by surface water and groundwater (WP2) [2-5] The objective is to evaluate existing models for pollutant transport, both for surface waters and groundwater, as tools contributing to the management policies of water pollutants.

1) *Transport of pollutant by surface waters* The analysis of different softwares has been performed. The following ones were considered and a methodology for their selection and use developed: (a) Mike 11 DHI Danish Hydraulic Institute from Denmark; (b) U.S. Geological Survey (USGS) from USA: a set of 42 sofwares for different purposes; (c) SOBEK Delft Hydraulics from Netherlands; (d) InfoWorks RS; Wallingford from Great Britain; (e) HEC-RAS (Army Corps of Engineer's Hydraulic Engineering Center (HEC)); (f) River Analysis System (RAS) from USA; (f) WOLF software from Belgium.

The required parameters, the basic characteristics and use limitations are examined.

2) *Transport of pollutant by groundwater* The application capabilities of several flow and pollutant transport models available on the Internet are studied, aiming at creating a methodology for their selection and use: (a) FEFLOW (Diersch, 1998); (b) MT3D (McDonald e Harbaugh, 1988); (c) ASMWIN (Chiang et al., 1998); (d) RBCA Tiers Analyser (Roy et al., 2000); (e) AQUA3D (Vatnaskil Consulting Engineers, 1988); (f) FLOWPATH II (Eviksov et al., 1998); (g) WINTRAN (Rumbaugh e Rumbaugh, 1995).

Conclusions on the possibilities, data requirements and accuracy corresponding to these softwares are summarized in tables that help decision makers to chose the appropriate model according to the site to be studied.

3. Methodologies for the choice of sanitation and remediation techniques (WP3) [6] The objective is to identify and evaluate existing techniques to decrease pollution levels in waters, due to accidental and non accidental input in order to support management policy decisions by appropriate selection charts and methodology.

1) *Non accidental pollutant input* Various sanitation techniques are examined according to the specific pollutants. Their working mechanisms and characteristics, the advantages and disadvantages, the suitable application domains, the equipments and technologies used as well as the costs are considered. The emerging innovative techniques are also identified and their potentials are evaluated. The technical specifications and the financial aspects are also taken into consideration so that they could be applied in real industrial cases.

2) *Accidental pollutant input* This part recapitulates and analyses some of the major accidents in drinking water as well as surface and groundwater pollution in order to gain a better understanding of the causes of accidental pollutant input. It is found that traffic accidents and vehicle overloads are the two main factors causing the release of some toxic chemicals into water body.

A variety of remediation technologies are recommended for hazard minimization, among which chemical and biological methods provide successfully techniques. Biological degradation methods are also holding promising perspectives.