

# ACE 2018



## 13<sup>th</sup> INTERNATIONAL CONGRESS ON ADVANCES IN CIVIL ENGINEERING

organized by Ege University

12 - 14 September 2018

Radisson Blu / Çeşme - İzmir, Turkey





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# PROCEEDINGS



## PROGRAMME OUTLINE

DAY	TIME	CESME I HALL	CESME II HALL	DALYAN HALL
12 September 2018	09:30-10:15	Opening Ceremony		
	10:15-11:00	Keynote Speech <i>Çelik Özyıldırım</i>		
	11:00-11:30	Coffee Break		
	11:30-13:00	STR1	STR2	MAT1
		Earthquake Design	System and Damage Identification of Structural Systems	Self-Healing
	13:00-14:00	Lunch		
	14:00-14:45	Keynote Speech <i>B. Mutlu Sümer</i>		
	14:45-15:45	STR3		MAT2
		Damage and Mechanical Observation		Sustainability
15:45-16:15	Coffee Break			
16:15-17:45	STR4	STR5	MAT3	
	Structural Mechanics, Repair and Strengthening	Structural Performance	Sustainability, Mechanical Properties and Uniformity	
13 September 2018	09:15-10:00	Keynote Speech <i>F. Necati Çatbaş</i>		
	10:00-11:00	STR6		MAT5
		Seismic Response Modification Devices		Geopolymer and Alkali Activated Mixtures
	11:00-11:30	Coffee Break		
	11:30-13:00	STR7	STR8	MAT6
		Steel Structures	Structural Mechanics, Repair and Strengthening	Temperature Effect on Behavior of Materials
	13:00-14:00	Lunch		
	14:00-14:45	Keynote Speech <i>Burçin Becerik-Gerber</i>		
	14:45-15:45	STR9		MAT7
Infill-Structural Frame Interaction			Durability	
15:45-16:15	Coffee Break			
16:15-17:45	STR10	STR11	MAT8	
	Soil-Structure Interaction and Response of Buried Structures	Experimental and Numerical Modeling	Fresh State Properties	
20:00-23:00	Networking Event (Cocktail Prolange)			
14 September 2018	09:15-10:00	Keynote Speech <i>Erik Schlagen</i>		
	10:00-11:00	STR12		MAT10
		Bridges		Binders
	11:00-11:30	Coffee Break		
	11:30-13:00	STR13		MAT11
		Dynamic Analysis and Earthquake Engineering		Fiber Reinforced and ECC Mixtures
13:00-13:30	Closing Ceremony			
13:30-16:00	ACE Advisory Committee Meeting			



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FOCA HALL	URLA HALL	ILICA HALL	ALACATI HALL
<b>Coffee Break</b>			
<b>HYD1</b>	<b>TRA1</b>	<b>GEO1</b>	<b>MAN1</b>
Computational Hydraulics	Transportation Engineering I	Environmental Geotechnics	Project & Construction Management I
<b>Lunch</b>			
<b>HYD2</b>	<b>TRA2</b>	<b>GEO2</b>	<b>MAN2</b>
Fluvial Hydraulics and Environmental Engineering	Transportation Engineering II	Foundation Engineering / Geosynthetics	Education
<b>Coffee Break</b>			
<b>HYD3</b>	<b>TRA3</b>	<b>GEO3</b>	<b>MAT4</b>
Flood and Drought	Transportation Engineering III	Soil Improvement	Characterization and Application
<b>HYD4</b>			
Sediment Modelling			
<b>Coffee Break</b>			
<b>COAS1</b>	<b>TRA4</b>	<b>GEO4</b>	<b>MAN3</b>
Coastal Engineering	Transportation Engineering IV	Soil Modeling and Numerical Methods	Project & Construction Management II
<b>Lunch</b>			
<b>HYD5</b>	<b>TRA5</b>		<b>MAN4</b>
Water Resources and Statistical Hydrology	Transportation Engineering V		Energy & Sustainability
<b>Coffee Break</b>			
<b>HYD6</b>	<b>TRA6</b>	<b>GEO5</b>	<b>MAT9</b>
Spatial Modeling in Hydrology	Transportation Engineering VI	Geotechnical Earthquake Engineering	Binders
<b>Networking Event (Cocktail Prolange)</b>			
<b>HYD7</b>	<b>TRA7</b>		
Pipe Flow	Transportation Engineering VII		
<b>Coffee Break</b>			
<b>HYD8</b>	<b>TRA8</b>	<b>GEO6</b>	
Open Channel Hydraulics	Transportation Engineering VIII	Soil Behavior	
<b>Closing Ceremony</b>			
<b>ACE Advisory Committee Meeting</b>			

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**09:30-10:15**    **OPENING CEREMONY**

**10:15-11:00**    **KEYNOTE SPEECH 1 – SPEAKER: ÇELİK ÖZYILDIRIM / CESME I HALL**  
*Chair: Sinan Turhan Erdoğan*

**11:00-11:30**    **COFFEE BREAK**

**11:30-13:00**    **STR 1- EARTHQUAKE DESIGN / CESME I HALL**  
*Chair: Cem Topkaya*

**ASSESSMENT OF THE SEISMIC DESIGN CODE-BASED VERTICAL SPECTRUM FUNCTIONAL FORMS**  
Ö. Kale

**CALCULATION OF EARTHQUAKE DAMAGE COST AND EVALUATION OF ITS EFFECT ON PERFORMANCE BASED DESIGN**  
G. Olgun, O. Bozdog

**HIGH RISE BUILDING DESIGN ACCORDING TO THE NEW PROPOSED EARTHQUAKE CODE IN TURKEY**  
G. Tunç, T. Tanfener

**NUMERICAL MODELING OF COLD-FORMED STEEL SHEAR WALLS WITH WOOD-BASED SHEATHING UNDER LATERAL LOADING**  
Y. Topcuoglugil, E. Baran, C. Topkaya

**COMPARATIVE ANALYSIS OF EARTHQUAKE LOADS ON REINFORCED CONCRETE STRUCTURES USING TSEC-2018 AND TEC-2007**  
A. Şahin, C. Aksoylu, M. H. Arslan

**THE EFFECT OF SOFT STORY IRREGULARITY ON PERFORMANCE OF THE EXISTING BUILDINGS**  
B. T. Cayci, I. Avcı, M. Inel

**11:30-13:00**    **STR 2- SYSTEM AND DAMAGE IDENTIFICATION OF STRUCTURAL SYSTEMS / CESME II HALL**  
*Chair: F. Necati Çatbaş*

**DAMAGE IDENTIFICATION STUDIES OF A REINFORCED CONCRETE PORTAL FRAME BY SENSITIVITY-BASED FINITE ELEMENT MODEL UPDATING METHOD**  
E. Durmazgezer, U. Yucel, O. Ozelcik

**MODEL UPDATING STUDIES OF A MASONRY COURTYARD WALL OF ISABEY MOSQUE USING OUT-OF-PLANE AMBIENT VIBRATION MEASUREMENTS**  
O. Ozelcik, I. S. Misir, U. Yucel, O. Girgin, E. Durmazgezer, C. Amaddeo, F. Kuran, E. Tuna, G. Yucel, I. B. Youssouf

**DETERMINATION OF P-WAVE VELOCITY IN CONCRET E**  
S. Tayfur, A. Nuhoglu, N. Alver

**USE OF AVS TO DETERMINE THE DYNAMIC MODES OF AN OVERPASS BRIDGE IN ISTANBUL**  
F. Aras

**PERIOD PREDICTION EQUATION FOR CONCRETE GRAVITY DAMS**  
A. Aldemir

**PERFORMANCE EVALUATION OF A RC BUILDING EXPOSED TO REBAR CORROSION FROM ONE OR TWO FACADES**  
G. B. Sakcalı, İ. Yüksel



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### 11:30-13:00 **MAT 1- SELF-HEALING / DALYAN HALL**

*Chair: Mustafa Tokyay*

#### **ENGINEERED CEMENTITIOUS COMPOSITES FOR REDUCING HIGH CO<sub>2</sub> EMISSIONS THROUGH INTRINSIC SELF-HEALING MECHANISMS**

O. Öztürk, G. Yıldırım, Ü. S. Keskin, M. Şahmaran, H. Siad, M. Lachemi

#### **SELF-HEALING OF CEMENTITIOUS COMPOSITES WITH NANO-POLYMERIC AGENTS**

O. Üzümlü, C. Türkcay Kayhan, E. Fezioğlu Demir, E. Özçalışkan, S. Akgöl, Ö. Andıç-Çakır

#### **OPTIMIZATION OF MORPHOLOGY OF SODIUM SILICATE/POLYURETHANE MICROCAPSULES USED FOR SELF-HEALING IN CEMENTITIOUS MATERIALS**

A. Beglarigale, D. Eyice, Y. Seki, H. Yazıcı

#### **MULTI-FUNCTIONAL CEMENTITIOUS COMPOSITES WITH AUTOGENOUS HEALING FUNCTIONALITY**

H. Ulugöl, G. Yıldırım, O. Coşkun, B. Tolunay, M. Şahmaran

#### **PARTICLE SIZE OPTIMIZATION APPROACH IN ENGINEERED CEMENTITIOUS COMPOSITES DESIGN**

S. B. Keskin, Ö. Kasap Keskin, K. Tekin, H. Karaca

### 11:30-13:00 **TRA 1- TRANSPORTATION ENGINEERING I / URLA HALL**

*Chair: Baha Vural Kök*

#### **EFFECT OF COMPACTION DEGREE ON MOISTURE DAMAGE OF ASPHALT PAVEMENTS**

E. İskender, G. Malkoç, A. Sayın, C. İskender, A. Aksoy

#### **ENGINEERING PROPERTIES OF AGED POLYPROPYLENE-MODIFIED ASPHALT MIXTURES**

A. H. Al

#### **EVALUATION OF WATER -INDUCED DAMAGE OF HOT MIX ASPHALT PREPARED WITH WASTE PERIDOTITE AGGREGATE AND HYDRATED LIME**

İ. Ç. Görkem, M. Özkan

#### **EVALUATION OF AGGREGATE SIZE EFFECT ON ASPHALT MIXTURE HOMOGENEITY USING IMAGE ANALYSIS**

A. O. Yücel, M. Guler

#### **INVESTIGATING MATERIAL TOUGHNESS OF ASPHALT CONCRETE UNDER DIRECT TENSION LOADING**

Y. Karakaya, M. Guler

#### **LASER SCANNING COUPLED WITH HIGH-DEFINITION COLOR IMAGING FOR DEFECT LOCALIZATION AND QUANTIFICATION**

B. Güldür Erkal



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**11:30-13:00**    **HYD 1- COMPUTATIONAL HYDRAULICS / FOCA HALL**

*Chair: Dejana Djordjevic*

**TRAJECTORY LENGTH DETERMINATION FOR BOTTOM OUTLET OF INOREN REGULATOR AND HEPP**

C. Yavuz, S. Gokmener, K. Yilmaz

**CFD STUDY OF DRAG FORCE ON THE PIERS OF ONGÖZLÜ BRIDGE IN DIYARBAKIR, TURKEY**

M. M. Bülbül, N. Denli Tokyay, T. E. Tokyay

**NUMERICAL INVESTIGATION OF TURBULENT FLOW THROUGH POROUS ZONE INSIDE A CONTACT TANK**

M. A. Kizilaslan, E. Demirel

**MODELLING OF SURFACE TENSION WITH VARIOUS TYPES OF FLUID INTERACTIONS USING SMOOTHED PARTICLE HYDRODYNAMICS**

B. K. Cirpici, B. D. Rogers, Y. C. Wang

**SMOOTHED PARTICLE HYDRODYNAMICS (SPH) MODELLING OF BUBBLE FORMATION AND RISE THROUGH A SUBMERGED ORIFICE**

B. K. Cirpici, B. D. Rogers, Y. C. Wang

**CONTAMINANT TRANSPORT IN MULTILAYERED DISCONTINUOUS AQUIFERS USING MODFLOW**

S. Korkmaz

**11:30-13:00**    **GEO 1- ENVIRONMENTAL GEOTECHNICS / ILICA HALL**

*Chair: Selim Altun*

**TRIAXIAL RESPONSE OF THE SAND-WASTE TIRE RUBBER MIXTURES**

Z. Karabash, A. F. Cabalar, M. M. Khalaf

**COMPRESSIBILITY BEHAVIOR OF IZMIR BAY'S DREDGED MATERIAL**

I. Develioglu, H. F. Pulat

**INDEX PROPERTIES AND SHEAR STRENGTH BEHAVIOR OF IZMIR BAY'S DREDGED SOIL BLENDED WITH SILICA FUME**

G. Gormus, I. Develioglu, H. F. Pulat

**ENGINEERING ASSESSMENT OF COFFEE WASTE BASED GEOPOLYMER**

T. Eskişar

**EXPERIMENTAL STUDY ON THE EFFECT OF CRUDE OIL AND TOLUENE ON EXPANSIVE SOIL**

S. Rehab Bekkouche, G. Boukhatem, D. Mendjel

**CHANGE IN SWELL INDEX OF POLYMER TREATED BENTONITES DEPENDING ON SAMPLING AND DRYING CONDITIONS**

T. Özdamar Kul, İ. Çirkin, A. H. Ören





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11:30-13:00

**MAN 1- PROJECT & CONSTRUCTION MANAGEMENT I / ALACATI HALL**

*Chair: Gürkan Emre Gürcanlı*

**CALCULATION OF DAILY OCCUPATIONAL SAFETY RISK SCORES FOR CONSTRUCTION INDUSTRY**

S. Bilir, G. E. Gurcanlı

**BENEFITS AND CHALLENGES OF BUILDING COMMISSIONING PROCESS IN TURKEY**

B. Ozorhon, S. Caglayan, E. Ilicali

**CONSTRUCTION DELAYS ASSESSMENT - A CASE STUDY OF INTERCHANGE PROJECT IN PAKISTAN**

M. B. Ali, K. Ateeq, H. M. Ali, S. S. S. Gardezi

**INVESTIGATING THE IMPACT OF PROJECT MANAGER SKILLS ON PROJECT SUCCESS**

B. Ozorhon, O. F. Akgemik, S. Caglayan

**EFFECTS OF INTERNATIONAL RELATIONS ON MULTINATIONAL CONTRACTS**

G. Gelisen

**A STRATEGIC PLAN FOR THE IMPLEMENTATION AND MONITORING OF PERFORMANCE-BASED MAINTENANCE CONTRACTING (PBMC) FOR TURKISH CONSTRUCTION SECTOR**

H. I. Ozturk, G. Atasoy, K. Ates

13:00-14:00

**LUNCH**

14:00-14:45

**KEYNOTE SPEECH 2 – SPEAKER: B. MUTLU SÜMER / CESME I HALL**

*Chair: Gökçen Bombar*

14:45-15:45

**STR 3- DAMAGE AND MECHANICAL OBSERVATION / CESME I HALL**

*Chair: Sadık Can Girgin*

**ESTIMATION OF DETERIORATION IN REINFORCED CONCRETE USING VIBRATION PROCESSING TECHNIQUES**

A. S. Kırlangıç

**EFFECT OF ELEVATED TEMPERATURE ON BOND STRENGTH OF CONCRETE**

M. M. Molla, M. H. Rashid, I. M. Taki

**LEAK DETECTION IN HIGH PRESSURE PIPES USING ACOUSTIC EMISSION METHOD**

T. Arslan, E. Ercan, T. Erünlü, N. Alver

**INFLUENCE OF NANO CLAY ON ACOUSTIC EMISSION BEHAVIOR OF CONCRETE UNDER FLEXURE**

S. Tayfur, H. Y. Ünal, Y. Pekbey, N. Alver



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### 14:45-15:45 **MAT 2- SUSTAINABILITY / DALYAN HALL**

*Chair: Şakir Erdoğan*

#### **INFLUENCE OF SOURCE CONCRETE QUALITY ON RECYCLED AGGREGATE CONCRETE**

B. Çelik, T. Özturan

#### **DETERMINATION OF POZZOLANIC ACTIVITY AND MECHANICAL PROPERTIES OF STANDARD MORTARS INCORPORATING RECYCLED GLASS POWDER**

H. Ö. Öz, H. E. Yücel, M. Güneş

#### **PHYSICAL PROPERTIES AND STRENGTH OF CONCRETE CONTAINING LIGHTWEIGHT AGGREGATE PRODUCED BY RECYCLING SILT OF A DAM**

B. Rabehi, Y. Ghemouti and K. Boumchedda

#### **USE OF RECYCLED BRICK AND MARBLE POWDERS AS REPLACEMENT OF CEMENT FOR IMPROVING DIMENSIONAL STABILITY OF SELF-COMPACTING MORTAR**

D. Boucherit, F. Debieb, Z. Skendar

### 14:45-15:45 **TRA 2- TRANSPORTATION ENGINEERING II / URLA HALL**

*Chair: İlgin Göktaşar*

#### **INVESTIGATION OF TRAFFIC SAFETY EFFECTS OF SPEED LIMIT INCREASES IN MAIN ARTERIALS**

F. Türe Kibar, H. Tuydes Yaman

#### **EFFECTS OF THE ROAD CONDITIONS FOR TRAFFIC ACCIDENTS**

E. Cicek

#### **ANALYZING OF KARSİYAKA TRAM ACCESSIBILITY WITH DIFFERENT ROUTES**

E. Odabasi, Y. Alver

#### **BUS NETWORK FREQUENCY OPTIMIZATION USING FIREFLY ALGORITHM FOR OPERATOR COST MINIMIZATION: A CASE STUDY FOR KARAMAN, TURKEY**

M. M. Mutlu, I. C. Aksoy, Y. Alver

### 14:45-15:45 **HYD 2- FLUVIAL HYDRAULICS AND ENVIRONMENTAL ENGINEERING / FOCA HALL**

*Chair: Serdar Korkmaz*

#### **MORPHODYNAMIC DIFFERENCES INDUCED BY A WIDENING OF THE TRIBUTARY CHANNEL IN A RIVER CONFLUENCE**

P. M. Abreu, G. Bombar, A. H. Cardoso

#### **ON THE EFFECT OF BED ELEVATION DISCORDANCE IN CONFLUENCES WITH UNEQUAL CHANNEL WIDTHS**

D. Djordjevic

#### **LIFE CYCLE ASSESSMENT OF WIND TURBINE FOUNDATIONS IN A WIND FARM**

M. Secer, H. F. Erdem

#### **ESTIMATION OF BIOCHEMICAL OXYGEN DEMAND WITH MULTIVARIABLE ADAPTIVE REGRESSION SPLINES (MARS)**

O. T. Baki, E. Aras, S. Nacar

#### **AN EXPERIMENTAL INVESTIGATION OF METHODS TO REDUCE THE MAXIMUM SCOUR DEPTH AROUND LABYRINTH SIDE WEIRS**

M. Tunc, M. E. Emiroglu



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14:45-15:45

### **GEO 2- FOUNDATION ENGINEERING / GEOSYNTHETICS / ILICA HALL**

*Chair: Ali Hakan Ören*

#### **ABRASIVE WEAR IN GEOMEMBRANES AND RESULTING INTERFACE SHEARING MECHANISM MOBILIZED AGAINST GRANULAR MATERIALS IN COMPOSITE LAYERED INFRASTRUCTURAL SYSTEMS**

T. Karademir

#### **PULLOUT BEHAVIOR OF GEOCELL IN GRANULAR SOIL**

A. Işık, A. Ayhan

#### **SEISMIC PERFORMANCE OF HIGHWAY EMBANKMENTS ON GEOGRID REINFORCED SAND**

A. Edinçliler, Y. S. Toksoy

#### **EFFECT OF DIFFERENT LOADING RATES ON THE BEARING CAPACITY OF STRIP FOUNDATIONS**

A. İçen, H. S. Aksoy, M. Gör

#### **OVERALL STABILITY ANALYSIS OF NAILED RETAINING WALLS**

L. Belabed, F. Z. Benamara

14:45-15:45

### **MAN 2- EDUCATION / ALACATI HALL**

*Chair: Zeynep Işık*

#### **EXPERIMENTAL STUDY ON USAGE LEVELS OF LATERAL THINKING SYSTEMS IN CONSTRUCTION ENGINEERING STUDENTS**

G. (Tantekin) Çelik, S. Aydınlı, B. Bağrıaçık

#### **STUDENT ATTENTION PREDICTION MODELS WITH OPERATIVE TEMPERATURE AND CO<sub>2</sub> CONCENTRATION**

M. Kuru, G. Calis

#### **IS CIVIL ENGINEERING EDUCATION AT KOCAELI UNIVERSITY HELPING STUDENTS REALIZE THEIR POTENTIALITIES?**

H. Erdoğan, C. Gazeloğlu, S. Engin, S. B. Coşkun, M. T. Atay, S. Mert Kutsal

#### **CIVIL ENGINEERING STUDENTS AND INSTRUCTORS VIEWS ON USING DIGITAL MATERIALS IN LABORATORY COURSES**

Ö. Andıç-Çakır, F. Sarsar, A. Rovshenov, İ. H. Özdemir

15:45-16:15

### **COFFEE BREAK**



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### 16:15-17:45 STR 4- STRUCTURAL MECHANICS, REPAIR AND STRENGTHENING / CESME I HALL

*Chair: Ninel Alver*

#### BUCKLING ANALYSIS OF CIRCULAR CYLINDRICAL STEEL TANK UNDER LATERAL EXTERNAL PRESSURE

A. Hayır, F. Kadioglu

#### NUMERICAL LARGE DEFLECTION ANALYSIS OF ANNULAR PLATES

E. Demirkan, S. Kömürçü, M. Yılmaz

#### BENDING BEHAVIOR OF A COMPOSITE LAMINATED PLATE UNDER TEMPERATURE RISING

Y. Z. Yüksel, Ş. D. Akbaş

#### ANALYTICAL APPROXIMATIONS FOR ELASTIC STRESSES AND DISPLACEMENTS OF VARIABLE THICKNESS ROTATING DISKS VIA IMPROVED ADOMIAN DECOMPOSITION METHOD

S. Mert Kutsal, S. B. Coşkun

#### REPAIR OF DAMAGED REINFORCED CONCRETE BEAMS BY EPOXY INJECTION TECHNIQUE

B. Aykaç, A. Yavuzcan, İ. Kalkan

#### PERFORMANCE OF AERATED AUTOCLAVED BRICK MASONRY WALLS STRENGTHENED BY PLASTER WITH GFRP NET AND FIBERS

A. M. Turk

### 16:15-17:45 STR 5- STRUCTURAL PERFORMANCE / CESME II HALL

*Chair: Kadir Güler*

#### PERFORMANCE EVALUATION OF A HISTORICAL BRICK MASONRY BUILDING USING LINEAR AND NONLINEAR ANALYSES

K. Demirlioglu, S. Gonen, S. Soyoz

#### INVESTIGATION OF THE CROSS INTERACTION BETWEEN CLOSELY SPACED STRUCTURES

M. Ada, Y. Ayvaz

#### THE EFFECT OF HYSTERETIC MODELS ON THE CALCULATED BEHAVIOR OF EXISTING STRUCTURES

E. Ozer, M. Kamal, M. Inel

#### INVESTIGATION OF SECTION DAMAGE LIMITS BASED ON DIFFERENT METHODS

C. C. Karakas, A. Kalkan, M. Palancı, S. M. Senel

#### COMPARISON OF RECOMMENDED SHEAR CAPACITY EXPRESSIONS FOR FIBER REINFORCED POLYMER WRAPPED BEAMS

O. Gedik

#### INVESTIGATION OF A THEORY FOR DETERMINING HAILSTONE RESISTANCE

T. Bircan, M. E. Uz, H. Kirmak, E. Erdem, M. Gören, D. Kop



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**16:15-17:45** **MAT 3- SUSTAINABILITY, MECHANICAL PROPERTIES AND UNIFORMITY / DALYAN HALL**

*Chair: Halit Yazıcı*

### ENHANCING WATER ABSORPTION CHARACTERISTIC OF COARSE RECYCLED CONCRETE AGGREGATES

H. Hosseinnzhad, Ş. Orhan, G. E. Başarmak, K. Ramyar

### THE EFFECTS OF CEMENT DOSAGE ON THE MECHANICAL PROPERTIES OF CONCRETE PRODUCED WITH WASTE MARBLE AGGREGATE

E. T. Tunc

### APPLICATION OF VORONOI POLYGONS AND 3-POINT CORRELATION FOR IDENTIFYING UNIFORMITY OF THE CONCRETE SAMPLES

M. Ozen, M. Guler

### EVALUATION OF THE COMPRESSIVE STRENGTH OF CONCRETE BY MEANS OF CORES TAKEN FROM DIFFERENT CASTING DIRECTION

Ş. Erdoğan, Ş. Kurbetci, U. Kandil, M. Nas, S. Nayır

**16:15-17:45** **MAT 4- CHARACTERIZATION AND APPLICATION / ALACATI HALL**

*Chair: Tahir Kemal Erdem*

### PRELIMINARY STUDY FOR CHARACTERIZING THE BRICKS OF AL-HADBA' MINARET, MOSUL-IRAQ

A. Al-Omari, S. Khattab

### ADVANCEMENTS AND CHALLENGES IN GLASS CONCEPTS, MANUFACTURING AND APPLICATIONS

C. J. de Lima, F. Veer, O. Çopuroglu, R. Nijssse

### COMPARISON OF SEVERAL LABORATORY COMPACTION PRACTICES APPLIED ON ROLLER COMPACTED CONCRETE PAVEMENTS

E. Sengun, R. Shabani, B. Alam, M. A. Aykutlu, I. O. Yaman

### CONCRETE CANOE PRODUCTION: MATERIAL DEVELOPMENT, STRUCTURAL ANALYSIS AND DESIGN

A. Beglarigale, Ç. Yalçinkaya, B. Göksu, S. C. Girgin, K. E. Erginer, S. Kahraman, H. Yazıcı

### TECHNICAL CONCRETE APPLICATIONS OF CALCIUM ALUMINATE CEMENT: NOVEL CASE STUDIES

M. Sucu, M. Severoğlu, T. Delibaş

### PROPERTIES OF REINFORCED CONCRETE BEAMS WITH CO-POLYMER SYNTHETIC FIBERS

S. Bekele, H. Karaca, O. I. Taş, S. B. Keskin, R. Birgul



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### 16:15-17:45 **TRA 3- TRANSPORTATION ENGINEERING III / URLA HALL**

*Chair: Yalçın Alver*

#### **PREDICTING MINIMUM DELAY FOR MULTI-LANE TRAFFIC CIRCLES**

S. Tanyel, S. P. Çalışkanelli, M. Özuysal

#### **AN IMPROVED DIFFERENTIAL EVOLUTION ALGORITHM FOR COORDINATED SIGNALIZED NETWORKS**

C. Ozan, O. Baskan

#### **TRAFFIC FLOW CHARACTERISTICS OF AN URBAN ARTERIAL BASED ON DIFFERENT TRAFFIC FLOW MODELS**

O. Altıntasi, H. Tuydes-Yaman, K. Tuncay

#### **DISTRIBUTION OF TIME HEADWAYS ON APPROACH LEGS OF AN URBAN SIGNALIZED ROUNDABOUT: A CASE STUDY IN KONYA**

E. C. Saltık, H. T. Yaman

#### **CALIBRATION OF AASIDRA FOR CAPACITY OF MULTI-LANE ROUNDABOUTS IN TURKEY**

İ. Hepdurgun, N. Büyükkamacı, S. Tanyel

#### **EVALUATION OF THE EFFECTS OF AUTONOMOUS PUBLIC TRANSPORTATION VEHICLES ON TRAFFIC CONDITIONS**

I. Gökaşar, A. A. Arısoy

### 16:15-17:45 **HYD 3- FLOOD AND DROUGHT / FOCA HALL**

*Chair: Nuray Tokyay*

#### **SPI-BASED DROUGHT SEVERITY-DURATION-FREQUENCY ANALYSIS**

H. Aksoy, B. Onoz, M. Cetin, M. I. Yuçe, E. Eris, B. Selek, H. Aksu, H. I. Burgan, M. Esit, S. Orta, Y. Cavus

#### **METEOROLOGICAL DROUGHT ANALYSIS IN SINOP, TURKEY**

U. Zeybekoglu, H. Alrayess, A. Ulke Keskin

#### **FLOOD INUNDATION ASSESSMENT; A CASE STUDY**

N. Beden, A. Ulke Keskin

#### **NUMERICAL MODELING OF TWO-DIMENSIONAL UNSTEADY DAM-BREAK FLOW**

O. Şimşek, N. G. Soydan, M. Salih Kırkgöz, M. S. Aköz

#### **INVESTIGATING THE EFFECT OF PRECIPITATION DEFICITS ON HYDROLOGICAL SYSTEMS IN DAM BASINS WITH DIFFERENT GEOGRAPHICAL CHARACTERISTICS IN THE MARMARA REGION USING THE SPI METHOD**

G. Aktürk, O. Yıldız



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**16:15-17:45**    **GEO 3- SOIL IMPROVEMENT / ILICA HALL**

*Chair: Yeliz Yükselen Aksay*

**IMPACT OF DURABILITY TESTS ON THE STABILITY OF LIME TREATED SOIL**

A. H. Aldaood, A. A. Khalil, I. M. Alkiki

**MAPPING OF HIGH PLASTICITY CLAY SOILS IN THE CITY OF KIRIKKALE AND IMPROVEMENT  
RECOMMENDATIONS FOR REDUCING SWELLING POTENTIAL**

B. Toprak, İ. Kalkan, E. Totiç

**A THEORETICAL METHOD FOR THE INVESTIGATION OF THE EFFECTS OF SOIL  
IMPROVEMENT ON TRAIN INDUCED GROUND-BORNE VIBRATIONS**

C. Bayındır, A. S. Kesten, E. Etminan

**IMPROVEMENT OF EXPANSIVE SOILS BY USING PHOSPHOGYPSUM**

İ. Özkan, E. Çokça

**COMPARISON OF ENGINEERING PROPERTIES OF A SOIL STABILIZED WITH CALCIUM  
CARBIDE AND CEMENT**

T. Eskişar, S. Altun

**EFFECT OF BLAST FURNACE SLAG ON STRENGTH AND COMPRESSIBILITY OF BENTONITE  
CLAY**

G. Bilgen, Ö. F. Çapar, D. C. Turhan, E. Dağlı



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**09:15-10:00**    **KEYNOTE SPEECH 3 – SPEAKER: F. NECATİ ÇATBAŞ / CESME I HALL**  
*Chair: Ninel Alver*

**10:00-11:00**    **STR 6- SEISMIC RESPONSE MODIFICATION DEVICES / CESME I HALL**  
*Chair: Cemalettin Dönmez*

**INFLUENCE OF FRP REINFORCEMENT RATIO ON THE DUCTILITY VALUES OF CONCRETE BEAMS WITH HYBRID FRP-STEEL REINFORCEMENT**

S. Kartal, I. Kalkan, H. C. Mertol, E. Baran

**INTRODUCING AN INNOVATIVE PLATE ANCHORAGE SYSTEM FOR FRP FLEXURAL-STRENGTHENED RC BEAMS**

J. Esmaili, O. R. Aghdam, M. Rakhshanimehr, J. Kasaei, K. Andalibi

**USE OF STEEL CUSHIONS MECHANISMS ON REINFORCED CONCRETE FRAME AS ENERGY DISSIPATION MECHANISM**

G. Gökdağ, A. A. Dindar, F. Karadoğan

**IMPROVEMENT OF A LOCKING MECHANISM FOR THE SEISMIC ISOLATION SYSTEM MADE OF SPRING TUBE BRACES**

H. Doluyurt, A. A. Dindar, E. Yüksel

**BEHAVIOR OF HOLD DOWN DEVICES USED IN CFS CONSTRUCTION**

B. M. Pehlivan, E. Baran, C. Topkaya

**10:00-11:00**    **MAT 5- GEOPOLYMER AND ALKALI ACTIVATED MIXTURE S/ DALYAN HALL**  
*Chair: İsmail Özgür Yaman*

**PRODUCTION OF SILICA FUME-BASED GEOPOLYMER FOAMS**

S. Shakouri, S. T. Erdoğan

**EFFECT OF ACTIVATOR PROPERTIES ON FLEXURAL PERFORMANCE OF ALKALI-ACTIVATED SLAG MORTARS UNDER QUASI-STATIC AND IMPACT LOADING**

S. Aydın, M. Y. Yardımcı

**THE INVESTIGATION OF MECHANICAL EFFECTS OF NANO SiO<sub>2</sub> PARTICLES FOR DIFFERENT SODIUM ION CONCENTRATIONS ON FLY ASH BASED GEOPOLYMER MORTAR**

U. Durak, O. Karahan, B. Uzal, S. İlkentapar, C. D. Atış

**EFFECT OF SODIUM HYDROXIDE ON FRESH STATE PROPERTIES OF SODIUM CARBONATE ACTIVATED BLAST FURNACE SLAG PASTES**

B. Akturk, A. B. Kızılkant, N. Kabay





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### 10:00-11:00 **HYD 4- SEDIMENT MODELLING / FOCA HALL**

*Chair: Özgür Kirca*

**A RELATIONSHIP BETWEEN FLOW DISCHARGE, SEDIMENT DISCHARGE AND SUB-BASIN AREAS IN CEYHAN CATCHMENT**

M. İ. Yüce, M. Eşit, B. Ercan

**SEDIMENT DEPOSITION IN HASANLAR DAM RESERVOIR BY BATHYMETRIC FIELD STUDIES**

Y. Darama, B. Selek, Z. Selek

**COUPLED 1-D HYDRODYNAMICS AND SEDIMENT TRANSPORT MODELLING IN FLOOD ANALYSIS: SAMSUN-TERME RIVER APPLICATION**

G. Onder, Z. Akyurek

**COMPARISON OF PERFORMANCES OF TEACHING LEARNING-BASED OPTIMIZATION AND CLASSICAL REGRESSION FOR SUSPENDED SEDIMENT PREDICTION**

B. Yılmaz, E. Aras, O. T. Baki

**WATER SURFACE PROFILES OVER A BROAD -CRESTED WEIR**

N. A. Ghaznawi, S. Korkmaz

### 11:00-11:30 **COFFEE BREAK**

### 11:30-13:00 **STR 7- STEEL STRUCTURES / CESME I HALL**

*Chair: Özgür Eğilmez*

**ESTIMATION OF THE LATERAL DISTORTIONAL BUCKLING (LDB) MOMENTS OF DOUBLY-SYMMETRIC STEEL CELLULAR I-BEAMS**

S. Bas, F. Ertenli, I. Kalkan

**EFFECT OF DIFFERENT BRACING CONFIGURATION ON GLOBAL RESPONSE OF BUCKLING RESTRAINED BRACED FRAMES**

M. B. Bozkurt, Y. O. Özkılıç, C. Topkaya

**TOP WIND STIFFENER AND SHELL INTERACTION FOR OPEN-TOP CYLINDRICAL STEEL TANKS**

Ö. Zeybek, C. Topkaya

**EVALUATION OF A STEEL ROOF OF A FOOTBALL FIELD THAT COLLAPSED DUE TO A HEAVY SNOWFALL**

İ. Ustabaş, V. Süme, V. A. Baki, A. Gürbüz

**DIRECTIVITY-PULSE AND FLING-STEP EFFECTS ON STEEL ARCH BRIDGES**

D. Yılmaz, K. Soyuluk

**INVESTIGATION ON CONNECTION DETAILS FOR WELDED OVERLAP CORE STEEL ENCASED BUCKLING RESTRAINED BRACES**

M. B. Bozkurt, Y. O. Özkılıç, C. Topkaya



**13 SEPTEMBER 2018**

**11:30-13:00 STR 8- STRUCTURAL MECHANICS, REPAIR AND STRENGTHENING / CESME II HALL**

*Chair: Egemen Teomete*

**DESIGN OF REINFORCED CONCRETE DEEP BEAMS USING PARTICLE SWARM OPTIMIZATION TECHNIQUE**

Q. F. Hasan

**EXPLICIT FORMULATION OF ELASTOPLASTIC BENDING BY NEURAL NETWORKS**

A. E. Kurtoglu, A. Çevik, İ. H. Güzelbey

**OVERLAPPING LATTICE APPROACH FOR NONLINEAR ANALYSIS OF REINFORCED CONCRETE COLUMNS**

B. B. Aydın, K. Tuncay, B. Binici

**INVESTIGATION OF AERODYNAMIC AND STRUCTURAL FEATURES OF TWISTED TALL BUILDINGS**

S. Bilgen, B. Ö. Ay, N. Sezer Uzol, E. Orbay

**INVESTIGATING THE FLEXURAL BEHAVIOR OF LIGHTWEIGHT CONCRETE BEAMS REINFORCED WITH BASALT (BFRP) BARS**

S. Bakirci Er, E. Avanoğlu Sicacik, N. Kaya, A. Filazi, I. Elmas

**EVALUATION AND REHABILITATION OF BOMBED DAMAGED REINFORCED CONCRETE BUILDINGS**

H. M. Albegmrlri, M. Abbu, A. Alhayani

**11:30-13:00 MAT 6- TEMPERATURE EFFECT ON BEHAVIOR OF MATERIALS / DALYAN HALL**

*Chair: Lütfullah Gündüz*

**EFFECT OF TEMPERATURE ON RHEOLOGICAL PROPERTIES OF LIME-BASED GROUTS**

B. Dinc, N. Yuzer, D. Oktay

**EFFECTS OF DIFFERENT CURING CONDITIONS ON SOME MECHANICAL AND DURABILITY PROPERTIES OF CONCRETES CONTAINING SILICA FUME**

Ş. Erdoğdu, Ş. Kurbetci, U. Kandil, S. Nayır, M. Nas

**ELECTRICAL HEATING PERFORMANCE OF MULTI WALL CARBON NANO TUBE REINFORCE D CEMENT COMPOSITES**

A. Karagöz, E. Teomete

**ENERGY CONSUMPTION OF A DAY-OCCUPIED BUILDING UTILIZING PHASE CHANGING MATERIAL INCORPORATING GYPSUM BOARDS**

Ç. Meral Akgül, İ. Gürsel Dino, B. Şimşek

**COMPARISON OF THREE ALTERNATIVES FOR DETERMINING DATUM TEMPERATURE AND APPARENT ACTIVATION ENERGY TO ESTIMATE CONCRETE STRENGTH BY MATURITY METHOD**

M. Atasever, M. Tokyay

**RECOVERY OF REINFORCED CONCRETE BEAMS AFTER ISO-834 FIRE EXPOSURE**

A. H. Akca, N. Özyurt



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### 11:30-13:00 TRA 4- TRANSPORTATION ENGINEERING IV / URLA HALL

*Chair: Jülide Öner*

#### A NEW TEST METHOD TO DETERMINE THE COHESION PROPERTIES OF MODIFIED BINDER

B. V. Kök, M. Yılmaz, Y. Erkuş

#### THE EFFECTS OF COMBINED USAGE OF THREE DIFFERENT ADDITIVE ON RHEOLOGICAL PROPERTIES OF BITUMEN

B. V. Kök, M. Yılmaz, Y. Erkuş

#### EVALUATION OF MOISTURE CHARACTERISTICS ON DIFFERENT SOURCES BITUMENS

J. Oner, B. Sengoz

#### SHORT TERM AND LONG TERM AGING PERFORMANCE EFFECTS OF MIXING CONDITIONS ON THE RHEOLOGICAL CHARACTERISTICS OF STYRENE-BUTADIENE-STYRENE MODIFIED BITUMEN

D. Kaya, A. Topal, B. Sengoz, P. Aghazadeh Dokandari

#### INVESTIGATION OF PHASE SEPARATION AND STORAGE STABILITY BEHAVIOUR OF SBS POLYMER MODIFIED BITUMENS CONTAINING SEPIOLITE NANOCCLAY

D. Uncu, A. Topal, M. O. Seydibeyoglu, B. Sengoz

#### DETERMINING THE CONSISTENCY VALUES OF SLURRY SEAL MIXTURES HAVING DIFFERENT AMOUNTS OF WATER, EMULSION AND MINERAL FILLER

Ş. Aslan, B. Aktaş

### 11:30-13:00 GEO 4- SOIL MODELING AND NUMERICAL METHODS / ILICA HALL

*Chair: Devrim Ş. Erdoğan*

#### A COMPARISON OF HIGH MODULUS COLUMNS AND RAMMED AGGREGATE PIERS IN GROUND IMPROVEMENT USING NUMERICAL MODELING

H. Mungan, A. B. Sunbul, F. Sunbul

#### TAILOR-MADE REHABILITATION OF HYDRAULIC STRUCTURES – INNOVATIVE SOLUTIONS

A. Schmitt, W. Weckbecker, J. Franzmann

#### ASSESSMENT OF PERFORMANCE OF STEEL SLAG USED IN ROAD BASE BY FINITE ELEMENT ANALYSIS

H. Karatağ, S. Fırat, N. S. Işık

#### A NUMERICAL STUDY OF EFFECTIVENESS OF JET-GROUT COLUMNS ON THE SETTLEMENTS OF SATURATED SOILS

M. Mahmudi, D. S. Erdogan

#### APPLICATION OF SANICLAY-D MODEL ON THE BEHAVIOR OF FULL-SCALE SAINT ALBAN EMBANKMENT

M. Hajjalilue-Bonab, A. Shirmohammadi, D. Dadras-Ajirloo, M. Mahmudi

#### FIELD MEASUREMENTS AND NUMERICAL EVALUATION OF REINFORCED JET GROUTING COLUMNS AS A SHORING SYSTEM ON SATURATED SOILS

M. Mahmudi, D. S. Erdogan, M. Hajjalile Bonab, A. Shirmohammadi



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### MAN 3- PROJECT & CONSTRUCTION MANAGEMENT II / ALACATI HALL

*Chair: Selim Baradan*

#### PROJECT PLANNING AND MANAGEMENT USING BUILDING INFORMATION MODELING (BIM)

R. R. Politi, E. Aktaş, M. E. İlaç

#### COMPARISON OF CONSTRUCTION COSTS OF PILED RAFT FOUNDATIONS AND JET GROUTING SYSTEMS

S. Aydınli, B. Bağrıaçık, E. Oral

#### ROLE OF CONSTRUCTION-ASSOCIATED PARAMETERS IN FLOOD DISASTER MANAGEMENT

K. Koç, Z. Işık

#### OWNERSHIP OF FLOAT: AN OVERVIEW

G. Polat, H. Turkoglu, A. Damci

#### EVALUATING THE NEED TO APPLY BUILDING INFORMATION MODELING (BIM) CAPABILITIES TO FACILITATE THE IMPLEMENTATION OF OPERABILITY AND MAINTAINABILITY PRINCIPLES IN THE INFRASTRUCTURE PROJECTS

M. Hashemi, E. Saghatforoush

#### REVIEW OF CLASSIFICATION SYSTEMS FOR FACILITIES MANAGEMENT

B. Kula, E. Ergen

11:30-13:00

### COAS 1- COASTAL ENGINEERING / FOCA HALL

*Chair: Elçin Kentel*

#### PROBABILISTIC TSUNAMI RISK ASSESSMENT USING MONTE CARLO SIMULATIONS

C. Yavuz, E. Kentel

#### NEAR FIELD DILUTION OF BRINE DISCHARGES

A. İnan, L. Balas

#### LOWER SLOPE STABILITY WITH CUBE IN A BERM BREAKWATER

Ö. Gülver, Y. Yüksel, E. Çevik

#### LONG TERM WIND AND WAVE CLIMATE STUDY FOR TURGUTREIS COASTAL AREA

L. Balas, A. Numanoğlu Genç

#### GEOMETRICAL PROPERTIES OF THE JET TRAJECTORY OF BRINE DISCHARGES

M. C. Höke, G. Bombar, N. Alpaslan, D. Dölgen

#### A MODIFIED PIPING CRITERION FOR DETERMINATION OF EFFECTIVE FILTER THICKNESS UNDER REVETMENT SLOPES

E. Kılci, V. S. Ö. Kırcı

13:00-14:00

### LUNCH

14:00-14:45

### KEYNOTE SPEECH 4 – SPEAKER: BURÇİN BECERİK-GERBER / CESME I HALL

*Chair: Gülben Çaltış*



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### STR 9- INFILL-STRUCTURAL FRAME INTERACTION / CESME I HALL

*Chair: Serhan Şensoy*

#### BEHAVIOR OF AUTOCLAVED AERATED CONCRETE INFILL WALLS UNDER COM BINED IN-PLANE AND OUT-OF-PLANE ACTIONS

B. Binici, E. Canbay, A. Aldemir, I. O. Demirel, U. Uzgan, Z. Eryurtlu, K. Bulbul, A. Yakut

#### ELASTIC STIFFNESS REDUCTION FACTORS FOR EXTERIOR AND INTERIOR INFILL WALLS WITH OPENINGS

T. Ucar, O. Ozturkoglu

#### MODELLING OF GLAZED CURTAIN WALLS AND CALIBRATION VIA EXPERIMENTAL DATA

Y. S. Erdogan, B. Zengin, B. Toydemir, A. S. İbrahimcioğlu, A. Koçak

14:45-15:45

### MAT 7- DURABILITY / DALYAN HALL

*Chair: Özge Andıç Çakır*

#### SMART CONSTRUCTIONS: AN OVERVIEW FROM THE BUILDING PHASE TO THE DURABILITY SURVEILLANCE

S. Chaves Figueiredo, O. Çopuroğlu, E. Schlangen

#### INVESTIGATION ON STRENGTH AND DURABILITY PROPERTIES OF CONCRETE CONTAINING ZEOLITE

M. Nas, Ş. Kurbetci, S. Nayır

#### INVESTIGATION ON STRENGTH AND DURABILITY PROPERTIES OF CONCRETE WITH METAKAOLIN

M. Nas, Ş. Kurbetci

#### DURABILITY PERFORMANCE OF RUBBERISED FIBRE MORTAR

A. M. Mukaddas, F. N. A. Abdul Aziz, N. A. M. Nasir, A. M. Maleka

14:45-15:45

### TRA 5- TRANSPORTATION ENGINEERING V / URLA HALL

*Chair: Serhan Tanyel*

#### EVALUATION OF PARK AND RIDE FACILITIES IN ISTANBUL THROUGH ACCESSIBILITY PERSPECTIVE

G. Salih, M. S. Yardım, S. Dündar

#### PERCEPTION OF PARKING PRICING AND WILLINGNESS-TO-PAY (WTP): A PRELIMINARY EVALUATION AMONG METU CAMPUS USERS

B. Ipekyuz, V. Gen el, O. F. Ozturk, B. Oz, H. I. Ozturk, H. Tuydes-Yaman

#### INTEGRATION OF CARSHARING WITH RAIL TRANSIT FOR AIRPORT GROUND ACCESS: A CASE OF ISTANBUL SABIHA GÖKÇEN INTERNATIONAL AIRPORT (SAW)

I. Gokasar, G. Gunay

#### THE EVALUATION OF THE EFFECTS OF AUTONOMOUS VEHICLES USING ARTIFICIAL NEURAL NETWORKS

I. Gökaşar, S. Dündar, Y. Çetinel



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**HYD 5- WATER RESOURCES AND STATISTICAL HYDROLOGY / FOCA HALL**

*Chair: Hafzullah Aksoy*

**QUALITY AND HOMOGENEITY ANALYSIS OF PRECIPITATION DATA IN NORTH CYPRUS**

H. Zaifoğlu, B. Akıntuğ, A. M. Yanmaz

**CYPRUS WATER SUPPLY PROJECT: FEATURES AND OUTCOMES**

N. Ağırlioğlu, A. Danandeh Mehr, Ö. Aakdeğirmen, E. Taş

**HOMOGENEITY AND TREND ANALYSIS OF LONG TERM TEMPERATURES IN THE MIDDLE  
BLACK SEA REGION**

V. Demir, U. Zeybekoglu, N. Beden, A. Ulke Keskin

**DETERMINATION OF SEASONAL CHANGES OF WATER QUALITY IN FİLYOS STREAM**

B. Aksoy, İ. H. Özölçer, E. Doğan, A. R. Birben, K. Özdemir

**SNOW COVERED AREA AND WATER LEVEL VARIATIONS OF GÜLDÜRCEK DAM BETWEEN  
2004-2016**

S. Dönmez, A. E. Tekeli

14:45-15:45

**MAN 4- ENERGY & SUSTAINABILITY / ALACATI HALL**

*Chair: Burçin Becerik-Gerber*

**PERFORMANCE-BASED FAÇADES: RETROFIT STRATEGIES FOR ENERGY EFFICIENCY AND  
COMFORT IN EXISTING OFFICE BUILDINGS**

N. Jahed, I. Gürsel Dino

**THE COMPARISON OF REAL-TIME ENERGY CONSUMPTION AND OCCUPANT SURVEY  
RESULTS**

G. Kazar, S. Comu

**MINIMIZATION TECHNIQUES OF CONSTRUCTION AND DEMOLITION (C&D) WASTE: THE CASE  
OF TURKEY**

G. Polat, A. Damci, H. Turkoglu

**CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT BY APPLYING BUILDING  
INFORMATION MODELING (BIM) APPROACHES**

İ. Bayram, Y. Ö. Tetik, Ö. Akboğa Kale, S. Baradan

15:45-16:15

**COFFEE BREAK**



**13 SEPTEMBER 2018**

**16:15-17:45 STR 10- SOIL-STRUCTURE INTERACTION AND RESPONSE OF BURIED STRUCTURES / CESME I HALL**

**HALL**

*Chair: Kadir Güler*

**PARAMETRIC FORCED VIBRATION ANALYSIS OF MINDLIN PLATES RESTING ON WINKLER FOUNDATION WITH NEWMARK METHOD**

Y. I. Özdemir

**VARIATION OF BURIED BOX CULVERT DEFORMATIONS WITH RESPECT TO VARIOUS PARAMETERS UNDER EARTHQUAKE LOADING**

S. Uzun, Y. Ayvaz

**EXPERIMENTAL STUDIES ON REINFORCED CONCRETE PRESSURE TUNNELS**

M. T. Kalaycıoğlu, U. Albostan, G. Işık, E. Canbay, Y. Arıcı, B. Binici, K. Tuncay

**SEISMIC POUNDING BETWEEN ADJACENT BUILDINGS CONSIDERING SOIL-STRUCTURE INTERACTION**

M. Kamal, E. Ozer, B. T. Çaycı, M. Inel

**NUMERICAL MODELING OF REINFORCED CONCRETE PRESSURE TUNNELS USING THE OVERLAPPING LATTICE METHOD**

G. Işık, M. T. Kalaycıoğlu, U. Albostan, E. Canbay, Y. Arıcı, B. Binici, K. Tuncay

**SEISMIC BEHAVIOR OF PRESTRESSED CONTAINMENT VESSEL OF A REACTOR BUILDING**

E. E. Oyguc, R. A. Oyguc

**16:15-17:45 STR 11- EXPERIMENTAL AND NUMERICAL MODELING / CESME II HALL**

*Chair: Serhan Şensoy*

**EXPERIMENTAL DIFFICULTIES AND SOLUTION PROPOSALS IN A THREE-DIMENSIONAL REINFORCED CONCRETE FRAME**

A. Özbayrak, F. Altun

**THE TEST SETUP OF REINFORCED CONCRETE WALL SUBJECTED TO PURE TORSION**

A. Türkay, F. Altun

**EFFECT OF SLAB THICKNESS IN SEISMIC ASSESSMENT OF REINFORCED CONCRETE BUILDINGS**

E. Akin, N. M. Rahmany, A. M. O. M. Salih, B. Yıldız

**THE MEAN AND VARIATION OF DRIFT RATIO DEMANDS OF RC BUILDINGS**

C. Tellal, A. Demir, A. H. Kayhan

**EXPERIMENTAL AND NUMERICAL INVESTIGATION OF STEEL-HIGH STRENGTH CONCRETE COMPOSITE BEAM**

E. Ercan, M. Tuyan

**GEOMETRICAL NONLINEAR INTERACTION MODEL OF THIN INSULATING GLASS UNITS**

M. Yılmaz, S. Kömürçü, E. Demirkan



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### 16:15-17:45 **MAT 8 - FRESH STATE PROPERTIES / DALYAN HALL**

*Chair: Oğuzhan Çopuroğlu*

#### **EFFECTS OF FLY ASH AGGREGATE ON THE RHEOLOGY AND COMPRESSIVE STRENGTH OF SELF-CONSOLIDATING CONCRETE**

E. Bilgiç, S. M. Karahan, H. Y. Ersöz, T. K. Erdem

#### **CHARACTERIZATION OF HEAT-TREATED SELF-COMPACTING CONCRETE CONTAINING GROUND-GRANULATED BLAST-FURNACE SLAG OF EL HADJAR**

R. Derabla, F. Sajedi

#### **USE OF MICROORGANISMS TO IMPROVE VISCOSITY AND RHEOLOGY OF CEMENT-BASED MATERIALS**

M. Azima, Z. B. Bundur

#### **EFFECT OF MICRO FIBER CONTENT ON WORKABILITY OF SELF-COMPACTING CONCRETE**

E. Oztekin, C. Kina, K. Turk

#### **EFFECT OF ANIONIC MONOMER CHANGE OF POLYCARBOXYLATE-BASED WATER REDUCING ADMIXTURE ON FRESH PROPERTIES AND COMPRESSIVE STRENGTH OF SELF-COMPACTING CONCRETE**

A. Mardani-Aghabaglou, S. Özen, M. G. Altun, K. Ramyar, T. Kaptı, A. Ünlü

### 16:15-17:45 **MAT 9 - BINDERS / ALACATI HALL**

*Chair: Ali Uğur Öztürk*

#### **COMPRESSIVE STRENGTH OF MORTAR MIXTURES CONTAINING CLINOPTILOLITE AND ANALCIME BLENDED CEMENTS**

Y. Akgün, Ö. F. Yazıcioğlu

#### **PRODUCTION OF CALCIUM SULFOALUMINATE CEMENTS USING INDUSTRIAL BYPRODUCTS IN TURKEY**

O. Canbek, S. T. Erdoğan

#### **EFFECTIVENESS OF BINARY AND TERNARY CEMENTITIOUS SYSTEMS IN REDUCING ALKALI-SILICA REACTION EXPANSION**

E. Tosun, C. Yüksel, K. Ramyar

#### **PREDICTION OF THE STRENGTH OF GYPSUM PASTES CONTAINING FLY ASH**

O. Cengiz, T. K. Erdem, G. Tayfur

#### **PREDICTION OF THE STRENGTH OF GYPSUM PASTES CONTAINING GROUND GRANULATED BLAST FURNACE SLAG**

O. Cengiz, T. K. Erdem, G. Tayfur





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## 13 SEPTEMBER 2018

16:15-17:45

### **TRA 6- TRANSPORTATION ENGINEERING VI / URLA HALL**

*Chair: Mustafa Özuysal*

#### **COMMUTE MODAL PREFERENCES OF MIDDLE EAST TECHNICAL UNIVERSITY (METU) STUDENTS**

G. Dalkic, P. Karatas-Sevinen, H. Tuydes-Yaman

#### **A METHOD FOR DETERMINING ALIGHTING LOCATIONS OF BUS PASSENGERS**

I. Gökaşar, A. Fidanoğlu

#### **ANALYSIS OF THE EFFECT OF TIME OF DAY ON BUS SPEEDS NEAR A BUS STOP USING GPS DATA**

I. Gökaşar, Y. Cetinel, A. A. Arısoy

#### **PASSENGER DEMAND ESTIMATION FOR RAILWAYS IN TURKEY**

K. Y. Göka, H. Ceylan, S. Haldenbilen

#### **IMPACT OF RAISED PEDESTRIAN CROSSWALK DESIGN ON VEHICLE TRAVEL: CASE STUDY AT METU**

A. A. Kazemi Afshar, F. Ture Kibar, H. Tuydes Yaman

#### **AN EVALUATION INDEX FOR MONITORING INTELLIGENT TRANSPORTATION SYSTEMS (ITS) DEVELOPMENT**

H. Tuydes Yaman, S. Dundar, P. Karatas Sevinen, B. Ipekyuz, E. E. Hun er, G. Evren

16:15-17:45

### **HYD 6- SPATIAL MODELING IN HYDROLOGY / FOCA HALL**

*Chair: Mehmet İshak Yüce*

#### **IMPACT OF THE PERIOD OF RECORD ON THE PERFORMANCE OF THE MAP CORRELATION METHOD**

D. Ocal, E. Kentel

#### **DETERMINATION OF THE RIVER BASIN BOUNDARIES WITH THE HELP OF GIS IN TURKEY**

F. Çay, V. Demir, M. F. Sevimli

#### **SEDIMENT YIELD MAP OF TURKISH RIVERS**

Ö. L. Asikoglu, E. Eris

#### **SPATIAL AND TEMPORAL DISTRIBUTION OF THE LINKAGES BETWEEN THE NORTH ATLANTIC OSCILLATION (NAO) AND HYDROLOGICAL DROUGHTS IN TURKEY**

F. Tosunoglu, I. Can

#### **CHANGE IN SATELLITE DERIVED SNOW COVER PROBABILITIES OVER TURKEY**

A. E. Tekeli, S. Dönmez

#### **EVALUATION OF POINT BASED SNOWPACK MODELING FOR SNOTEL SITES IN TURKEY**

M. C. Ertaş, A. A. Şorman



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**GEO 5- GEOTECHNICAL EARTHQUAKE ENGINEERING / ILICA HALL**

*Chair: Tuğba Eskişar*

**DISPERSION OF THE NEAR-SURFACE SEISMIC WAVES IN ELASTIC -VISCOELASTIC LAYERED HALF-SPACE OF THE OCEAN FLOOR**

S. D. Akbarov, M. Negin

**A PARAMETRIC STUDY ON THE AMPLIFICATION EFFECT OF BURIED BOX CULVERTS ON SEISMIC SITE RESPONSE UNDER LINEAR ELASTIC SOIL CONDITIONS**

R. Şişman, Y. Ayvaz

**ESTIMATION OF SHEAR STRAIN AT SURFACE SOIL LAYER BY 1D DYNAMIC ANALYSIS AND MICROTREMOR MEASUREMENT FOR A SPECIFIC SITE**

O. Subaşı, M. E. Haşal, B. Özaslan, R. İyisan

**NONLINEAR SITE RESPONSE ANALYSIS OF LIQUEFIABLE SITE IN ISTANBUL SEISMIC ZONE: A CASE STUDY**

A. Edinçliler, M. Çalikoğlu

**EQUIVALENT LINEAR AND NONLINEAR SITE RESPONSE ANALYSIS FOR THE SAKARYA REGION**

A. Edinçliler, G. Sezgin Tunçay

20:00-23:00

**NETWORKING EVENT (COCKTAIL PROLONGE)**



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**09:15-10:00** **KEYNOTE SPEECH 5 – SPEAKER: ERIK SCHLANGEN / CESME I HALL**

*Chair: Özge Andıç Çakar*

**10:00-11:00** **STR 12- BRIDGES / CESME I HALL**

*Chair: Özgür Eğilmez*

**SPAN-SKEWED EFFECT ON THE RESPONSE OF THE I- GIRDER PRESTRESSED CONCRETE BRIDGES**

O. Ghzayel, M. T. Karimi, S. Adanur, A. C. Altunışık

**THE EFFECT OF SHEAR CONNECTOR RATIOS ON THE CONCRETE-TO-CONCRETE INTERFACE**

Q. T. Nguyen, C. Serhatoğlu, R. Livaoglu

**RATING ANALYSIS OF STEEL TRUSS RAILWAY BRIDGE WITH DIFFERENT PORTING CONFIGURATION**

M. F. Yılmaz, K. Ozakgul, B. O. Caglayan

**10:00-11:00** **MAT 10- BINDERS / DALYAN HALL**

*Chair: Ali Mardani Aghabaglou*

**POZZOLANICITY EVALUATION OF ROCK-CUT BUILDING'S WASTE MATERIAL IN CAPPADOCIA REGION**

V. Bek, N. Yüzer, S. Ulukaya, Ş. Özata

**EFFECTS OF DIFFERENT CELLULOSE ETHERS ON WHITE CEMENT BASED CERAMIC ADHESIVES**

M. Tangüler-Bayramtan, C. Üstoğlu, B. Alam, M. Sucu, İ. Ö. Yaman

**EFFECT OF WASTE HAZELNUT SHELL POWDER ON THE TECHNICAL PROPERTIES OF CEMENT MORTARS**

Ş. O. Kalkan, L. Gündüz

**EFFECTS OF FILLER INCORPORATION ON THE PROPERTIES OF BLENDED CEMENTS**

Ö. Bozdoğan, M. K. Ardoğa, B. Alam, İ. Ö. Yaman

**MECHANICAL PROPERTIES OF CONCRETE MADE WITH PLAIN AND SURFACE TREATED RECYCLED AGGREGATES**

H. Yıldırım, T. Özturan

**10:00-11:00** **TRA 7- TRANSPORTATION ENGINEERING VII / URLA HALL**

*Chair: Hediye Tüyyeş Yaman*

**PRIORITIZATION AND MODEL DEVELOPMENT FOR URBAN BUS PUBLIC TRANSPORTATION SYSTEMS**

J. S. Qul, S. Haldenbilen, H. Ceylan

**EVALUATION OF LEVEL-OF-SERVICE WITH HCM 2010 IN WEAVING SEGMENTS IN IZMIR, TURKEY**

P. Onelcin, M. Uysal, M. M. Mutlu, Y. Alver

**AN INVESTIGATION OF DRIVERS' PARKING CHOICE BEHAVIOR IN IZMIR, TURKEY**

M. Uysal, Y. Alver

**EVALUATION OF BLUETOOTH TECHNOLOGY TO MEASURE TRAVEL TIME ALONG ARTERIALS**

A. Ozden, A. Faghri, N. Attoh-Okine, K. Partridge



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**10:00-11:00**    **HYD 7- PIPE FLOW / FOCA HALL**

*Chair: Zafer Bozkuş*

**AN EMPIRICAL CORRELATION FOR FRICTION FACTOR ESTIMATION OF NEWTONIAN FLUID IN ANNULUS**

M. Sorgun, E. Ulker, E. Tuncer

**FUZZY LOGIC AND SUPPORT VECTOR REGRESSION MODELS FOR NON-NEWTONIAN FLUID FLOW THROUGH ANNULUS WITH PIPE ROTATION**

E. Ulker, M. Sorgun, M. S. Tuna

**INTRODUCING A NEW COMPUTER CODE, H-HAMMER, TO SOLVE FLUID TRANSIENTS IN PIPE FLOW**

H. Dalgıç, Z. Bozkuş

**EXPERIMENTAL INVESTIGATION OF A SLUG MOTION IN AN INCLINED PIPE SYSTEM**

A. E. Dinçer, Z. Bozkuş

**11:00-11:30**    **COFFEE BREAK**

**11:30-13:00**    **STR 13- DYNAMIC ANALYSIS AND EARTHQUAKE ENGINEERING / CESME I HALL**

*Chair: Cemalettin Dönmez*

**THE COMPARISON OF EXACT AND APPROXIMATE GEOMETRY OF CONICAL HELIX OVER STATIC AND DYNAMIC ANALYSIS**

M. Ermis, B. Ayhan, A. Kutlu, N. Eratlı, M. H. Omurtag

**DUCTILITY EFFECT ON INELASTIC INPUT ENERGY SPECTRA**

T. Uçar, O. Merter

**COMPARISON OF ENERGY-BASED SEISMIC STRUCTURAL RESPONSES BASED ON SIMULATED GROUND MOTIONS WITH EXISTING EMPIRICAL RELATIONSHIPS**

S. Karimzadeh, A. Askan, M. A. Erberik

**CRITICAL ANGLE FOR EARTHQUAKE LOADS FOR IRREGULAR BUILDINGS**

B. Ayar, A. A. Dindar

**SIGNIFICANCE OF STRONG GROUND MOTION ORIENTATION ON SEISMIC RESPONSE OF A SHORT PERIOD REINFORCED CONCRETE STRUCTURE**

D. Birlik Kayı, B. Bayhan, G. Özdemir

**SEISMIC PERFORMANCE OF HOCAALIZADE MINARET STRENGTHENED BY STEEL TUBE**

C. Serhatoğlu, R. Livaoğlu



**14 SEPTEMBER 2018**

11:30-13:00

**MAT 11- FIBER REINFORCED AND ECC MIXTURES / DALYAN HALL**

*Chair: Mert Yücel Yardımcı*

**SHRINKAGE RESISTANCE OF MICRO SYNTHETIC FIBER REINFORCED CONCRETES**

A. Niş, N. Ozyurt, B. Erdal, I. Izmit

**AN EXPERIMENTAL STUDY ON THE FIBER BRIDGING STRESS – CRACK OPENING RELATIONSHIP OF PSEUDO STRAIN-HARDENING CEMENT-BASED COMPOSITES**

M. Keskinateş, B. Felekoğlu

**EFFECT OF DIFFERENT CURING CONDITIONS ON THE TECHNICAL PROPERTIES OF INORGANIC-BONDED FIBER COMPOSITES**

L. Gündüz, Ş. O. Kalkan, A. M. İsker, C. Mocan, S. Hacıoğlu

**AN EVALUATION ON FLEXURAL CAPACITIES OF PVA, BASALT AND GLASS FIBRE REINFORCED CEMENTITIOUS COMPOSITES WITH NANO-CLAY REPLACEMENT**

Z. C. Girgin

**A PRELIMINARY RESEARCH ON THE EARLY AGE PROPERTIES OF FIBER REINFORCED CONCRETE WITH LIGHTWEIGHT EXPANDED CLAY AGGREGATE**

T. K. Erdem, E. Bilgiç, S. Öztürk

**MECHANICAL PROPERTIES OF SINGLE AND HYBRID FIBER REINFORCED CONCRETES CONTAINING FLY ASH AND BLAST FURNACE SLAG**

T. K. Erdem, F. G. Şahin, N. A. Karimzada, T. Yıldırım, C. Türkyener

11:30-13:00

**TRA 8- TRANSPORTATION ENGINEERING VIII / URLA HALL**

*Chair: Atakan Aksoy*

**DEVELOPMENTS OF SELF-HEALING TECHNOLOGIES ON ASPHALT MATERIALS**

B. Sengoz, A. Onsori, A. Z. Albayrak, A. Topal, J. Oner

**SYNTHESIS OF SAFFLOWER OIL AND BORIC ACID- CONTAINING ORGANIC ADDITIVE FOR BITUMEN MODIFICATION**

Ş. Oruç, D. Şahin, K. Sancak

**EVALUATION OF DIFFERENT CONDITIONS AFFECTING THE INDIRECT TENSILE STRENGTH OF HYDRATED LIME ADDITIVE BITUMINOUS MIXTURES BY USING ARTIFICIAL NEURAL NETWORKS METHOD**

M. S. Yardım, S. DüNDAR, B. D. Şitilbay

**EFFECT OF HYDRATED LIME ON INDIRECT TENSILE STRENGTH OF ASPHALT CONCRETE**

B. Varlı Bingöl, M. Güler

**EFFECT OF BIOCHARS OBTAINED FROM PYROLYSIS OF NATURAL BIOMASSES AT DIFFERENT TEMPERATURES ON THE RHEOLOGICAL PROPERTIES OF BITUMINOUS BINDERS**

M. E. Çeloğlu, M. Yılmaz, B. V. Kök

**EFFECTS OF RECYCLE POLYMER WASTE ON THE PROPERTIES OF BITUMINOUS BINDERS**

E. Yalçın, E. Ş. Seyrek, M. Yılmaz, B. V. Kök, H. Arslanoğlu, M. E. Çeloğlu



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### 11:30-13:00 **HYD 8- OPEN CHANNEL HYDRAULICS / FOCA HALL**

*Chair: İsmail Aydın*

#### **FLOW RESISTANCE IN CONVEYANCE CHANNELS**

İ. Aydın

#### **ANALYSIS OF ENERGY DISSIPATION AT THE END SILL OF A SPILLWAY**

J. B. Mumputu, M. İ. Yüce

#### **A NUMERICAL AND EXPERIMENTAL STUDY ON THE FLOW FIELD IN AN OPEN CHANNEL**

B. Kılınç, M. Aksen, N. Bahadıroğlu, G. Bombar, Ş. Elçi, M. Köken, A. H. Cardoso

#### **EXPERIMENTAL INVESTIGATION FOR THE EFFECTS OF TURBULENCE ON THE SETTLING VELOCITIES OF SEDIMENTS**

Ş. Elçi, G. Bombar, B. Vural, M. Ay

### 11:30-13:00 **GEO 6- SOIL BEHAVIOR / ILICA HALL**

*Chair: Mehmet M. Berilgen*

#### **A PARAMETRIC STUDY ON THE BULK DENSITY DETERMINATION OF SOIL SPECIMENS USING CLOSE-RANGE PHOTOGRAMMETRY**

A. Gharehaghajlou, O. Önal

#### **METHYLENE BLUE ADSORPTION AND SWELLING CHARACTERISTICS OF A LIME-TREATED EXPANSIVE CLAY**

İ. Süt-Ünver, M. A. Lav, E. Çokça

#### **EFFECT OF PRE-CONSOLIDATION PRESSURE ON SETTLEMENT TIME RELATIONSHIP**

D. C. Turhan, O. Göktürk, Ö. F. Çapar, E. Dağlı

#### **INVESTIGATION OF BEHAVIORAL THRESHOLDS IN SAND-SILT-CLAY MIXTURES CONSIDERING CONSISTENCY AND COMPACTION**

D. Erdoğan

### 13:00-13:30 **CLOSING CEREMONY**

### 13:30-16:00 **ACE ADVISORY COMMITTEE MEETING**

# On the Effect of Bed Elevation Discordance in Confluences with Unequal Channel Widths

D. Đorđević<sup>1</sup>

<sup>1</sup>Faculty of Civil Engineering, University of Belgrade, Belgrade, Serbia

## Abstract

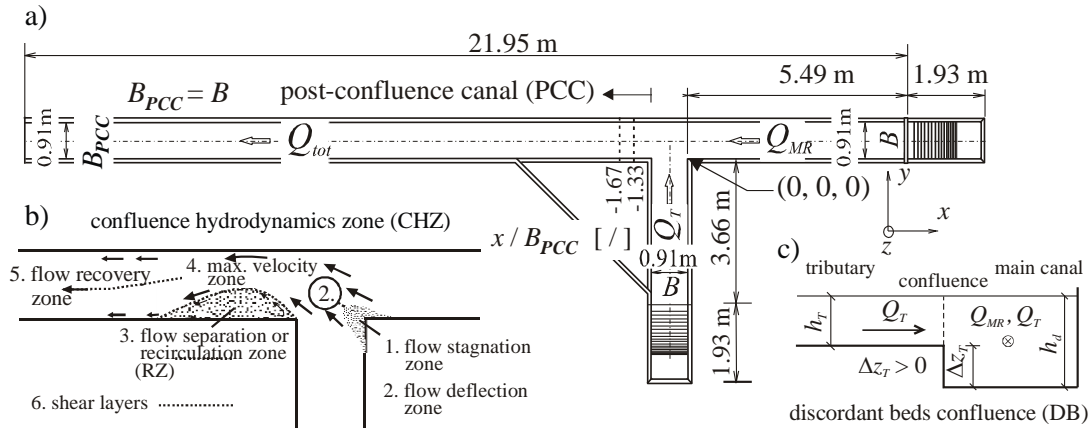
The paper studies the effect of bed elevation discordance on the hydrodynamics in fixed-bed open channel confluences where the tributary channel is narrower than the main channel and where the flow is subcritical. The study is inspired by two facts: 1) that the main river is wider than the tributary in majority of cases and 2) that the bed elevation discordance is a usual morphological feature in alluvial river confluences. To this aim nine confluence layouts with three channel width ratios  $B_T / B_{MR} = \{1.00, 0.75, 0.50\}$  and three extents of bed elevation discordance  $\Delta z_T / h_d = \{0.10, 0.25, 0.50\}$  are analysed under the three possible hydrological scenarios defined by the discharge ratio values  $D_R = Q_{MR} / Q_{tot} = \{0.250, 0.583, 0.750\}$ . It is found that: 1) the tributary flow acts as a jet when  $D_R = 0.250$  regardless of the  $B_T / B_{MR}$  and  $\Delta z_T / h_d$  values, 2) the recirculation zone with several vortices exists throughout the flow depth when  $D_R = 0.250$  and  $B_T < B_{MR}$ , 3) the primary vortex is shifted farther downstream and the secondary one is inclined and attached to the boundary streamline, 4) the strong shear exists both in the horizontal and vertical planes and 5) the shear layer is developed on each side of the inclined recirculation zone.

**Keywords:** river confluence, bed elevation discordance, channel width ratio, 3D numerical model

## 1 Introduction

Stream confluences are important nodes in river channel networks. They play an important role in the drainage of the catchment and transport of sediments and pollutants through the network. With the exception of large alluvial river confluences, the tributary channel is generally narrower than that of the receiving, main-river. Additionally, the bed of the tributary channel is usually elevated above the bed of the main river as shown both by field surveys/observations of alluvial (Kennedy, 1984, De Serres et al. 1999, Đorđević, 2010) and mountainous river confluences (Kennedy, 1984, Leite-Ribeiro et al., 2012, Guillén-Ludena et al., 2017) and experiments in movable bed models of confluences (Mosley, 1976). Although the tributary canal in fixed-bed physical models of confluences was often narrower than the main canal (Gurram et al., 1997, Hager, 1989, Hsu et al., 1998a, b, Taylor, 1944, Weber and Greated, 1965) effects of variable channel width ratio  $B_T / B_{MR}$  on flow characteristics and bed morphology in river confluences were addressed only recently in experimental studies of mountainous river confluences by Leite-Ribeiro et al., 2012 and Guillén-Ludena et al., 2017. Here  $B_T$  stands for the tributary and  $B_{MR}$  for the main canal width. Their experimental work was extended by Birjukova et al.'s 2014 study of three-dimensional flow field in the fixed-bed discordant beds' confluence in the same facility and corresponding numerical study of the influence of the junction angle on the turbulent flow in the confluence by Penna et al., 2018. Although field studies by De Serres et al., 1999 have shown that the extent of bed elevation discordance (i.e. the ratio of the difference in bed elevations between the two converging channels  $\Delta z_T$  and the flow depth in the main river in the confluence  $h_d$ , Fig. 1), changes with the changing hydrological conditions in the confluence, the effect of bed elevation discordance in confluences with the narrower tributary channel has not yet been studied. Thus, the paper aims at investigating how the two controls (the width ratio of the converging channels  $B_T / B_{MR}$  and the extent of the bed elevation discordance between the two, i.e.  $\Delta z_T / h_d$ ) interact and affect confluence hydrodynamics. The study is concerned only with the case of subcritical flow in the confluence which is characteristic for alluvial river confluences such as those in the lower Danube River basin. It is limited to the fixed-bed case for the sake of inferring the combined effect of the two controls on the confluence hydrodynamics rather than studying the morphodynamics of an unequal channel width confluence.

The study is performed by using a 3D finite-volume based model SSIIM2, which solves Reynolds-Averaged Navier-Stokes (RANS) equations with the two equation turbulence model closure. This paper continues the line of Đorđević's previous studies in discordant beds' confluences (for example Đorđević, 2010, 2012 and 2013). It combines the data from equal width channels  $B_T / B_{MR} = 1.0$  (Đorđević, 2013), with new results for confluences with  $B_T / B_{MR} = (0.75, 0.50)$ . A hypothesis of Sukhodolov et al., 2017 that the tributary flow in a discordant beds' confluence behaves like a jet when the velocity ratio of the combining flows exceeds a value of 2 is checked by comparison of the results for different hydrological scenarios in the confluence.



**Figure 1.** a) Plan view of the Shumate's laboratory canal (Shumate 1998), b) subzones in the confluence hydrodynamics zone (CHZ) after Best (1988), c) definition sketch for the discordant beds' confluence

## 2 Setup of Numerical Experiments

To keep up with previous studies, the general layout of Shumate's laboratory right-angled confluence ( $\alpha = 90^\circ$ ) of two straight equal width channels with rectangular cross-sections is used again (Fig. 1a). Distinction between three possible hydrological scenarios in the confluence: 1) dominance of the tributary flow, 2) equal contributions of the combining flows and 3) dominance of the main-canal flow, is made by using discharge data from three (out of six) Shumate's experiments. The discharge ratio values ( $D_R = Q_{MR} / Q_{tot}$ , see Fig. 1a) for the three cases are  $D_R = \{0.250, 0.583 \approx 0.5, 0.750\}$ , respectively. The value of the total downstream discharge,  $Q_{tot} = 0.17 \text{ m}^3/\text{s}$ , is the same in all experiments. The data from these experiments were used in previous studies for validation of the numerical model Đorđević (2010, 2013).

Three hypothetical bed layouts, with small, moderate and high bed elevation discordance ratios  $\Delta z_T / h_d$  (Fig. 1c) are analysed for each of the three considered channel width ratios  $B_T / B_{MR} = \{0.10, 0.25, 0.50\}$ , which gives nine confluence layouts (Table 1). With three discharge combinations, twenty seven different cases are considered. Computational domain covers full lengths of the two canals to ensure that boundary conditions have no influence on the flow pattern in the CHZ (Fig. 1b).

**Table 1.** Analysed confluence layouts and vertical grid sizes in tributary (the block 2) for considered bed elevation discordance and channel width ratio values

$\Delta z_T / h_d$ [ / ]	$B_T / B_{MR}$ [ / ]			Vertical grid size (block 2)
	1.00	0.75	0.50	
0.10	+	+	+	19
0.25	+	+	+	16
0.50	+	+	+	11
	183×38	183×29	183×20	
	<b>Horizontal grid size (block 2)</b>			



### 3 Numerical Modelling

To allow for combination with the data from equal width channels from Đorđević, 2013, the same 3D numerical model (SSIIM2, Olsen, 2000) is used in this study. This is a finite-volume based model which solves RANS equations using the two equation turbulence model closure. As in previous studies, the standard  $k$ - $\epsilon$  model turbulence model is used again. The choice is based on its performance during the model validation procedure in Đorđević, 2010 and 2013. The advantage of SSIIM2 model is that it can solve the governing equations on unstructured multiblock grids, which is perfectly suited for confluence studies where the computational domain has dendritic shape. The grid can be either orthogonal or non-orthogonal. The coupling of the mass and momentum equations is achieved using the SIMPLE algorithm. The second-order upwind scheme is used for discretisation of convective terms in the momentum equations because it provided better agreement with the experimental data (Đorđević 2010, 2013). The rigid-lid approach is used to present the free-surface since it is the only option in SSIIM2. This is acceptable, since subcritical flow is analysed.

Boundary conditions include those at solid and open boundaries. The wall-law is used at solid boundaries, and the zero-gradient condition is applied at the outflow boundary for the three velocity components ( $u$ ,  $v$ ,  $w$ ), turbulence kinetic energy  $k$  and its dissipation rate  $\epsilon$ . The zero-discharge condition is imposed for  $w$ -velocity at the free-surface and the  $k$  is set to half of its bottom value (Olsen, 2000). Constant discharges are prescribed at inflow boundaries and the constant depth of 0.296 m (Shumate, 1998) is prescribed at the outflow boundary.

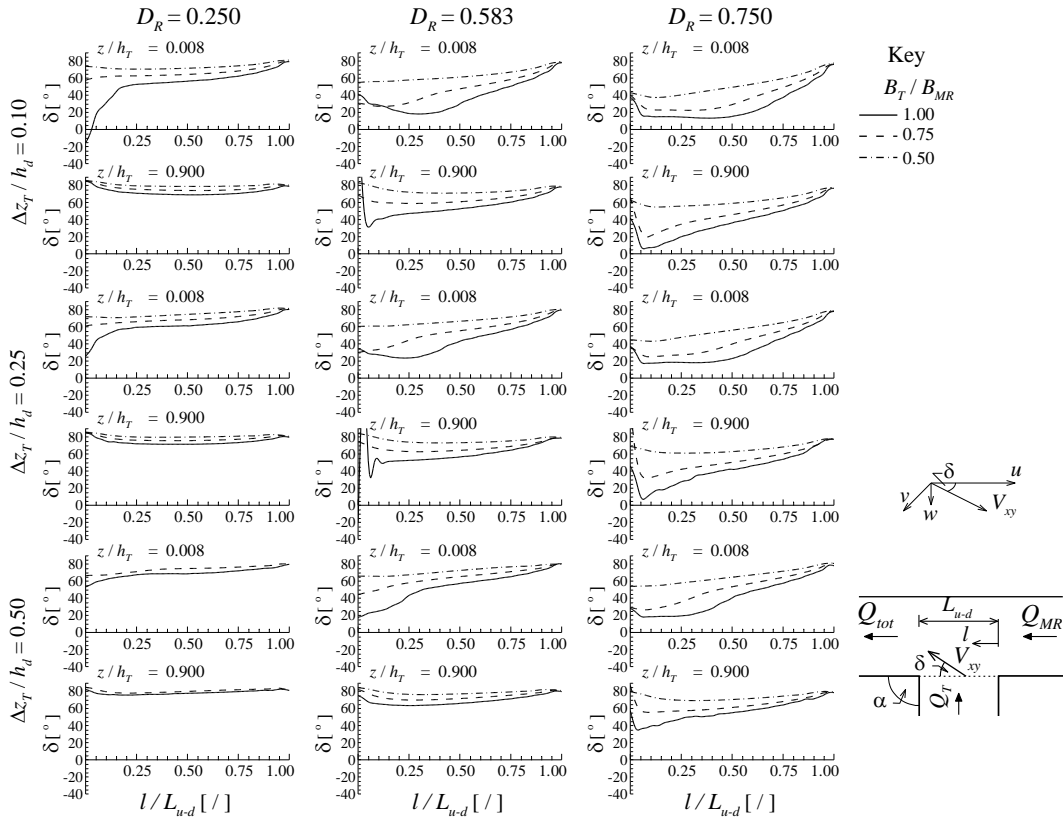
The computational domain is covered with a multiblock grid which consists of two orthogonal structured grids or blocks. Each canal of the Shumate's facility is covered with one block. The main canal is covered with the block 1 and the tributary canal with the block 2. The size of block 1 is the same in all confluence layouts from Table 1. It has 389 cells in the streamwise, 38 cells in the lateral, and 21 cells in the vertical direction ( $839 \times 38 \times 21$ ). The size of block 2 changes with the change in the extent of bed elevation discordance ratio  $\Delta z_T / h_d$ , and the channel width ratio  $B_T / B_{MR}$  as shown in Table 1.

### 4 Results and Discussion

The study begins at the upstream end of the CHZ where tributary flow enters the confluence, i.e. in the flow deflection zone (Fig. 1a) and continues with the analysis of flow characteristics in the post-confluence channel (PCC).

*Flow angles.* Depending on the hydrological conditions in the confluence, its layout and the distance from the tributary bed, the flow from the tributary may deflect either horizontally and vertically, or only horizontally. Flow angles on the horizontal ( $\delta$ ) and vertical ( $\phi$ ) planes near the tributary bottom ( $z / h_T = 0.008$ , where  $h_T$  is the flow depth in the tributary at the entrance to the confluence) and close to the free-surface ( $z / h_T = 0.900$ ) are presented in Figures 2 and 3. The momentum of the tributary flow increases for the same  $D_R$ -value as the tributary channel narrows. Thus, the variation of the  $\delta$ -angle along the junction line reduces throughout the flow depth when compared to the equal width confluence. The deflection from the junction angle ( $\alpha$ - $\delta$ ) is almost constant throughout the channel width in confluences with  $B_T < B_{MR}$  when  $D_R = 0.250$ . It does not exceed  $27^\circ$  near the bottom and  $15^\circ$  near the free-surface. Tributary flow strongly deflects close to the upstream junction corner ( $l < 0.25L_{u-d}$ ) under the influence of faster main channel flow in confluences of equal width channels. The greatest deflection (the lowest  $\delta$ -values) is near the tributary bottom, where velocities are lower and it vanishes by the mid-depth (not presented in this paper). As the contribution of the tributary flow decreases ( $D_R \geq 0.583$ ), variation of the  $\delta$ -angle between two junction corners becomes more pronounced, especially near the bottom. The maximum flow deflection (the minimum  $\delta$ -angle value) occurs near the bottom between 0.05 and  $0.40L_{u-d}$  depending on the extent of bed elevation discordance. It ranges from  $\alpha$ - $\delta = 57^\circ$  for  $\Delta z_T = 0.25h_d$ , when  $D_R = 0.583$ , and to  $\alpha$ - $\delta = 77^\circ$  for  $\Delta z_T = 0.10h_d$ , when  $D_R = 0.750$ . In confluences with  $\Delta z_T = 0.50h_d$ , variations in  $\delta$ -angle are negligible or almost negligible in the upper layers (Fig. 2,  $z / h = 0.900$ ) regardless of values of  $D_R$  and channel width ratio. Flow deflection at the downstream junction corner is practically independent of the confluence layout ( $\Delta z_T / h_d$  and  $B_T / B_{MR}$  values) and the  $D_R$ -value.

Generally, the greatest  $\phi$ -angle values are close to the upstream junction corner where the two flows collide. The angles at the upstream junction corner can be as large as  $60^\circ$  or  $70^\circ$ . However, they rapidly decrease towards zero (by  $0.25L_{u-d}$ , when  $D_R = 0.250$  and by  $0.50L_{u-d}$ , when  $D_R \geq 0.583$ ), which means that the flow in the downstream half of the entrance cross-section is two dimensional. Quite interestingly, in confluences with  $\Delta z_T = 0.10h_d$  the sequence of  $\phi$ -angle reduction near the bed is inverse in cases when  $D_R = 0.250$  and  $D_R = 0.750$ . In the former case the greatest deflection is in the confluence with  $B_T / B_{MR} = 1.00$  and in the latter one, in the confluence with  $B_T / B_{MR} = 0.50$ . When the bed elevation discordance ratio is high ( $\Delta z_T = 0.50h_d$ ),  $\phi$ -angle increases with the increase in dominance of the main river (increase in  $D_R$ -value) as the difference in channel widths reduces.

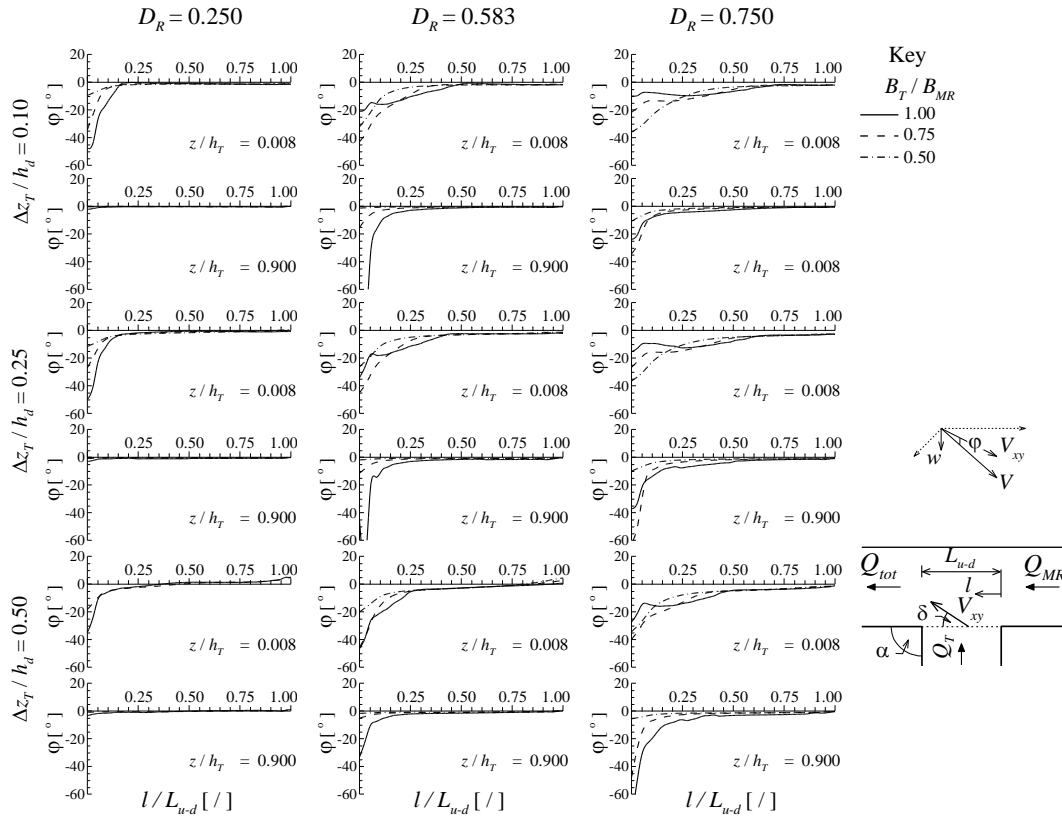


**Figure 2.** Effects of  $D_R$  and  $\Delta z_T / h_d$  on the  $\delta$ -angle at the tributary entrance to the confluence

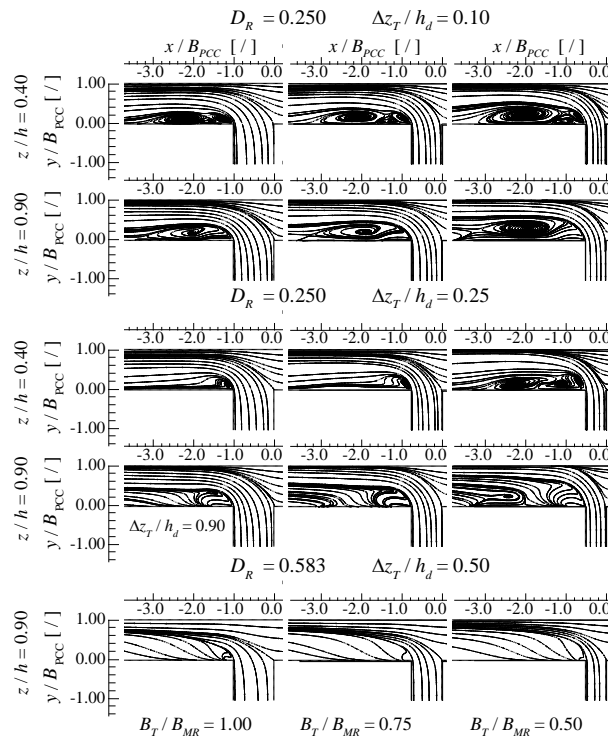
Both  $\delta$ - and  $\phi$ -angle distributions indicate that the tributary flow behaves like a jet regardless of the bed elevation discordance ratio, when  $B_T < B_{MR}$  and  $D_R = 0.250$  (the first columns in Figs. 2 and 3). The same could be said for the confluence of equal width channels, since the area of pronounced flow deflections in both horizontal and vertical planes are limited to the upstream  $0.25L_{u-d}$  of the junction line close to the bottom of the tributary channel.

*Flow pattern in the CHZ* is presented using streamline plots at different elevations above the main channel bed (Fig. 4). Due to limited space, they are presented only for selected cases from Table 1. Since the most complex flow pattern is developed for  $D_R = 0.250$ , the results are presented mainly for this hydrological scenario. Those for  $D_R = 0.583$  and  $D_R = 0.750$  are not presented as they resemble presented ones but with the much smaller recirculation zone and shallower flow penetration into the main channel.

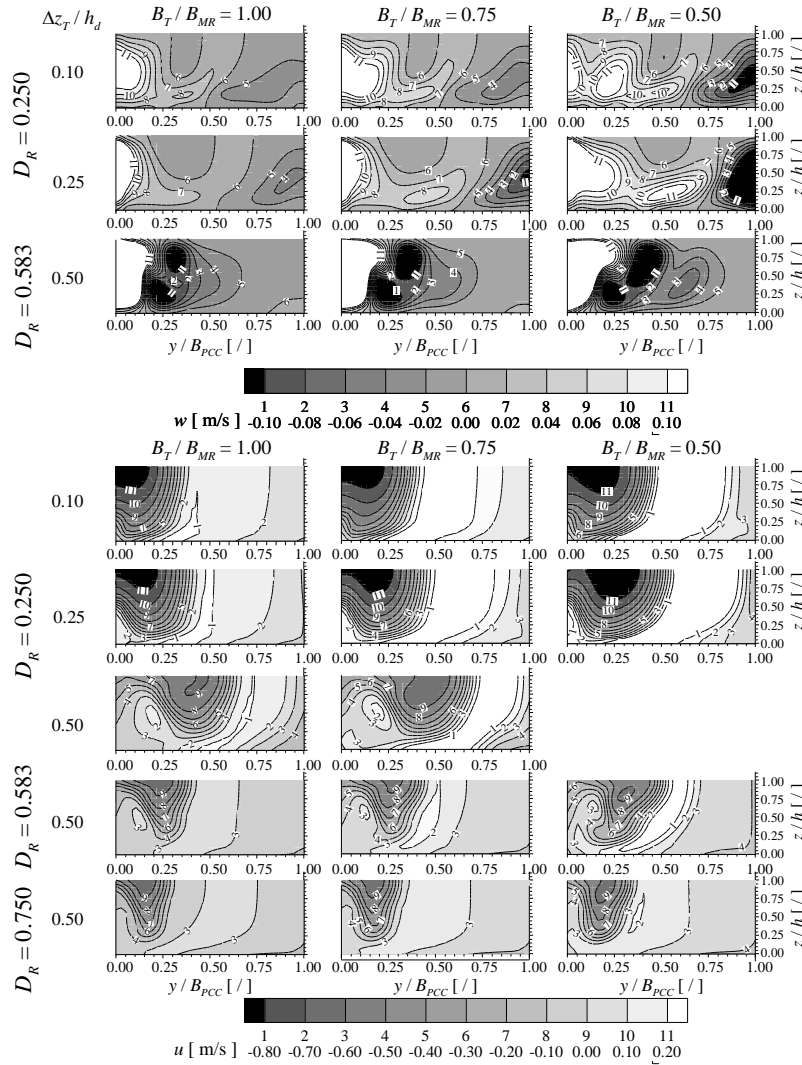
The flow pattern between the boundary streamline and the junction side wall can have several vortices depending on the position of the horizontal plane on which the streamlines are drawn and  $D_R$ -value. The primary vortex is shifted away from the downstream junction corner when  $D_R \leq 0.583$  and  $\Delta z_T \leq 0.25h_d$ . The shift decreases from the bottom to the free surface when  $D_R = 0.250$ . In confluences with  $\Delta z_T = 0.10h_d$  the vortex is moved downstream regardless of the channel width ratio value of the converging streams. The amount of shift ranges between  $0.73$  and  $0.60B_{PCC}$  for  $B_T = 0.75B_{MR}$ , whereas for  $B_T = 0.50B_{MR}$  this range extends from  $0.70$  to  $0.50B_{PCC}$ . In confluences with equal width channels, the vortex is displaced from the junction corner only below  $0.6h$  and the shift varies in a narrow range – between  $1.3$  and  $1.2B_{PCC}$ . When both streams equally contribute to the downstream discharge, the vortex is shifted only when the tributary channel is narrower than the receiving channel. The shift reduces with the decrease in the width ratio value – for  $B_T = 0.75B_{MR}$ , it varies between  $1.00$  and  $1.10B_{PCC}$ , whereas for  $B_T = 0.50B_{MR}$ , the range is between  $0.83$  and  $0.65B_{PCC}$ . In confluences with moderate bed elevation discordance ( $\Delta z_T = 0.25h_d$ ) the RZ exists below the bed step crest only in confluences with  $B_T = 0.50B_{MR}$  when the tributary flow dominates ( $D_R = 0.250$ ). The distance from the junction corner reduces from  $1.10$  to  $0.67B_{PCC}$  between the bottom and  $z = 0.40h$ . Above this elevation it is drawn away from the junction again by  $0.90$  to  $1.50B_{PCC}$ . The secondary and tertiary vortices develop when  $D_R \leq 0.583$ . They develop regardless of the channel width ratio in confluences with  $\Delta z_T = 0.10h_d$  when  $D_R = 0.250$ , and in the confluence with  $\Delta z_T = 0.25h_d$  when  $B_T = 0.50B_{MR}$ . The same holds for the confluence with  $\Delta z_T = 0.10h_d$  when  $D_R = 0.583$ . The secondary vortex it is attached to the boundary streamline and thus inclined at an angle to the junction-side wall. It develops approximately  $0.1h$  above the elevation of the tributary bed and disappears at  $0.3h$ . The tertiary vortex develops next to the secondary one and its axis is parallel to the junction-side wall.



**Figure 3.** Effects of  $D_R$  and  $\Delta z_T/h_d$  on the  $\phi$ -angle at the tributary entrance to the confluence



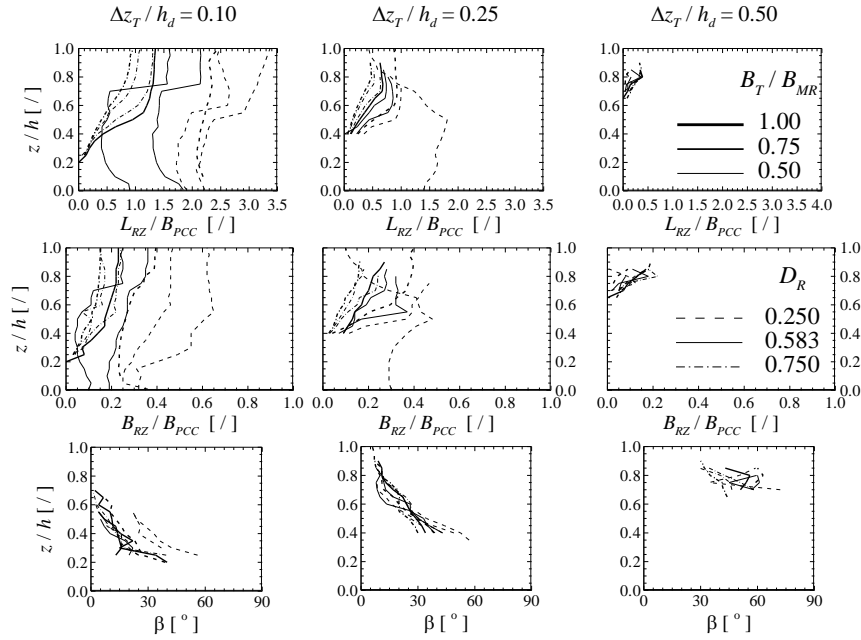
**Figure 4.** Effects of  $D_R$  and  $\Delta z_T/h_d$  on the flow deflection on the horizontal plane at the tributary entrance to the confluence, and size, position and orientation of the RZ



**Figure 5.** Effects of  $D_R$  and  $\Delta z_T / h_d$  on the cross-sectional distributions of vertical  $w$  and streamwise  $u$  velocities. Vertical velocity distributions are presented at  $x / B_{PCC} = -1.67$  when  $D_R = 0.250$  and at  $x / B_{PCC} = -1.33$  when  $D_R = 0.583$ . Streamwise velocity distributions are presented at  $x / B_{PCC} = -1.33$ . First three rows of  $u$ -velocity distributions show results for  $D_R = 0.250$ .

When  $B_T \geq 0.50B_{MR}$  only one, primary vortex is developed as long as  $\Delta z_T \leq 0.25h_d$ . It is attached to the boundary streamline for  $D_R \leq 0.583$ , while for  $D_R = 0.750$  its longitudinal axis is parallel to the junction-side wall (not presented). In confluences with the highest bed elevation discordance ratio ( $\Delta z_T = 0.50h_d$ ) there are no conditions for the vortex development, since the flow is highly three dimensional as can be seen from  $w$ -velocity distributions in Fig. 5.

*Cross-sectional  $u$  and  $w$  velocity distributions* are presented in Figure 5. Again, only selected data are presented. Vertical velocity distributions are given for the cross-sections with the largest core of high velocity magnitudes (at  $x / B_{PCC} = -1.67$  when  $D_R = 0.250$  and at  $x / B_{PCC} = -1.33$  when  $D_R = 0.583$ ), while the streamwise distributions are given for the same cross-section located at  $x / B_{PCC} = -1.33$ . Both  $u$  and  $w$ -velocity distributions clearly indicate that the flow is highly three-dimensional downstream of the downstream junction corner at the distance that is larger than a channel width. Large upward velocities in approximately  $0.10B_{PCC}$  wide belt along the junction side-wall prevent development of the RZ in the bottom layers far downstream of the junction. These velocities are of the same order of magnitude as the streamwise velocity. For  $D_R = 0.583$  they attain  $0.80u$  when  $\Delta z_T = 0.50h_d$ . Existence of upward velocity core along the opposite wall for  $D_R = 0.250$  when  $B_T \leq 0.75B_{MR}$  indicates that the tributary flow penetrates through the whole channel width and that it could undermine the bank. On the other hand, upward velocity cores for  $D_R \geq 0.583$  are attached to the downward one regardless of the channel width ratio value, which means that there is no danger of the collapse of the opposite bank due to undermining. However, they indicate that there is also a large shear in the vertical plane ( $\Delta v / \Delta y = 1.0$  1/s).



**Figure 6.** Variations of: a)-c) length of the primary vortex in the RZ, d)-f) width of the primary vortex the RZ and g)-j) inclination angle of the secondary vortex in the RZ

Streamwise velocity distributions can be used to trace lateral position of the recirculation zone (RZ) within the cross-section. The core of positive  $u$ -velocities (upstream oriented velocities according to the reference coordinate system in Fig. 1a) is attached to the junction-side wall in confluences with  $\Delta z_T = 0.10h_d$  regardless of the  $B_T / B_{MR}$  ratio-value. However, the shear layer in these confluences gradually inclines towards the opposite wall with the narrowing of the tributary channel. Detachment of the core with upstream oriented  $u$ -velocity from the junction-side wall for all  $B_T / B_{MR}$  ratio-values when  $\Delta z_T > 0.25h_d$  indicates that the RZ is inclined to the wall. Additionally, it can be seen that high velocities from the maximum velocity zone go underneath the RZ and cause development of shear layers on the both sides of the RZ. Thus, there is not only shear on the horizontal ( $\Delta u / \Delta y$ ), but also a shear on the vertical plane ( $\Delta u / \Delta z$ ). Both can reach values of  $\Delta u / \Delta y \approx \Delta u / \Delta z \approx 6$  1/s ( $D_R = 0.250$ ,  $B_T / B_{MR} = 0.75$ ,  $\Delta z_T > 0.50h_d$ ).

*Recirculation zone.* Variations of the size of the primary vortex in the RZ and inclination angles of the secondary and primary vortices are shown in Figure 6. In confluences of equal width channels, RZ exists only above the elevation of the tributary bed regardless of the  $\Delta z_T$  and  $D_R$ -values. However, when the tributary channel is narrower, the primary vortex exists throughout the flow depth in confluences with  $\Delta z_T \leq 0.25h_d$ , when  $D_R = 0.250$ . Otherwise, it starts to develop above the tributary bed as in confluences of equal width channels. The largest vortices are developed when  $D_R = 0.250$  and the smallest when  $D_R = 0.750$ . The size of the primary vortex increases with the reduction of the  $B_T$ . For example, when  $D_R = 0.250$  and  $\Delta z_T = 0.10h_d$ , the primary vortex in the confluence with  $B_T / B_{MR} = 0.50$  is 15-35% longer and 30-70% wider than that in the confluence with  $B_T / B_{MR} = 0.75$  and 5-40% longer and 1.5 to 3.2 times wider than that for the case with  $B_T / B_{MR} = 1.00$ . For  $D_R = 0.583$  these ratios become even greater. The vortex for  $B_T / B_{MR} = 0.50$  is 1.3 to 3.3 times longer and 1.5 to 5.5 times wider than that for  $B_T / B_{MR} = 0.75$  and 1.1 to 3.0 times longer and 1.35 to 2.00 times wider than that for  $B_T / B_{MR} = 1.00$ .

For the given  $D_R$ -value, the inclination angle of the secondary/primary vortex longitudinal axis reduces towards the free-surface as  $\Delta z_T / h_d$  decreases, whereas for the given  $\Delta z_T / h_d$ , it increases with the increase in the dominance of the tributary flow.

## 5 Conclusions

The effect of bed elevation discordance in confluences with unequal channel widths was studied numerically using a 3D finite-volume based model SSIIM2, which solves RANS equations on the multiblock grids. The governing equations are closed with the  $k$ - $\epsilon$  turbulence model closure. Nine different confluence layouts that cover three possible extents of bed elevation discordance between the tributary and main channels, and three channel width ratios are analysed under three possible hydrological scenarios in the confluence. Overall twenty seven different cases were considered. The detailed analysis of the results led to the following conclusions.

1. The tributary flow behaves like a jet regardless of the bed elevation discordance ratio, when  $D_R = 0.250$ .
2. Several vortices can be developed between the boundary streamline and the junction side wall when  $D_R \leq 0.583$  and  $\Delta z_T \leq 0.25h_d$ .
3. For low bed elevation discordance ratio value of 0.10 primary vortex is shifted farther downstream from the downstream junction corner regardless of the value of the channel width ratio of the converging streams. The shift decreases from the bottom to the free surface when  $D_R = 0.250$ .
4. The secondary vortex it is attached to the boundary streamline and thus inclined at an angle to the junction-side wall. It develops approximately  $0.1h$  above the elevation of the tributary bed and disappears at  $0.3h$ . The tertiary vortex develops next to the secondary one and its axis is parallel to the junction-side wall.
5. In confluences of equal width channels, RZ exists only above the elevation of the tributary bed regardless of the bed elevation discordance ratio and hydrological conditions in the confluence.
6. The inclination angle of the secondary/primary vortex longitudinal axis reduces towards the free-surface for the given discharge ratio value as the extent of bed elevation discordance decreases. For the given  $\Delta z_T / h_d$ , it increases with the increase in the dominance of the tributary flow.
7. In addition to the shear on the horizontal plane, considerable shear develops in the vertical plane.
8. One shear layers is developed on each side of the inclined RZ.

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