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Department of Civil and Hydraulic Engineering

ICGSAME 2021

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DJAMEL OUZANDJA

For attending the geotechnical, structural and materials engineering first international conference held at Biskra university, Algeria, on 05-07 December 2021,
with an Oral presentation:
"Seismic analysis of concrete gravity dams considering material nonlinearity of dam-foundation rock system"

Co-authors: Amina Tahar Berrabah

General Chair

Dr. Sadok FEIA
Docteur en Géotechnique

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Seismic analysis of concrete gravity dams considering material nonlinearity of dam-foundation rock system

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Keywords

Concrete gravity dam

Dynamic dam-foundation rock interaction

Drucker-Prager model

Multilinear kinematic hardening model

Nonlinear dynamic analysis

Abstract: This paper aims to show nonlinear earthquake analysis of Oued Fodda concrete gravity dam, which is located in Chlef town at northwestern Algeria. For this purpose, linear and nonlinear analyses are performed for dam-foundation rock coupled system using two-dimensional (2D) finite element model. The Druker-Prager and the multilinear kinematic hardening models are employed in the nonlinear analysis for dam concrete and foundation rock, respectively. Water in the reservoir is represented by added mass using the Westergaard approach. All numerial analyses are carried out using ANSYS calcul code. The maximum displacements and principal stress components in concrete dam body attained from linear and nonlinear analyses are compared each other. Material nonlinearity of dam-foundation system can generally decrease the seismic response of the dam. The study demonstrates the nonlinear analysis importance of the dam-foundation rock coupled system.

1. Introduction

There are various factors affecting the dynamic analysis of concrete gravity dams, i.e., the dam-foundation rock interaction, dam-reservoir interaction and material nonlinear response of dam-foundation rock system. The dynamic dam-foundation rock interaction phenomenon was studied and published by several researchers (Chopra and Chakrabarti 1981; Bayraktar et al. 2005; Saleh and Madabhushi 2010; Lebon et al. 2010; Burman et al. 2012; Ouzandja et al. 2014; Ouzandja et al. 2018). Burman and Reddy (2008) investigated response of concrete gravity dams to ground motion considering foundation rock nonlinearity. The results illustrated that nonlinear behavior of foundation rock affects seismic response of dams. Influence of materially nonlinear properties of Sarıyar gravity dam subjected to seismic loading was performed by Akköse and Simesk (2010). The study demonstrated that the concrete dam nonlinearity has a significant effect on response of dam-water-foundation system. Burman et al. (2010) presented finite element analysis of dam-foundation system considering effect of materially nonlinear foundation. Taking into account the nonlinear material response of foundation generates higher displacements and stresses in the dam compared to the results obtained from linear analysis. The seismic performance of concrete gravity dams was presented by Wang et al. (2015) using both linear and nonlinear approaches. Ouzandja and Tiliouine (2015) investigated effect of conditions of contact at dam-foundation on concrete gravity dam seismic behavior employing linear and nonlinear analyses. Their results showed that nonlinear analysis produces lower responses compared to linear analysis. Yazdani and Alembagheri (2017) utilized the material and geometric nonlinearities to study the

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seismic response of Pine Flat dam. Poul and Zerva (2018) conducted nonlinear seismic analyses of concrete gravity dams considering the domain influence of foundation rock.

This paper presents linear and nonlinear time history responses of concrete gravity dams considering dam-foundation rock interaction during earthquake. For this purpose, two dimensional finite element model of dam-foundation rock system is employed in analyses using the ANSYS sofware (2013). Oued Fodda concrete gravity dam, located in Chlef town at northwestern Algeria, is chosen in this study. The Druker-Prager (Druker and Prager 1952) and the multilinear kinematic hardening models are considered in the nonlinear analysis for dam concrete and foundation rock, respectively. The dynamic effect of the reservoir during the analysis is modeled by the Westergaard approach (Westergaard 1933) based on the added mass concept. Nonlinear seismic analysis of the Oued Fodda dam-foundation rock system is carried out. The results obtained from linear and non-linear analyses are compared each other.

2. Numerical model of Oued Fodda gravity dam

2.1. Material properties

Our dam, located approximately 20 km of Oued Fodda, Chlef, northwest of Algeri, was established on Oued Fodda River. The reservoir is used for irrigation. The capacity of the dam is 125.5 hm^3. The maximum height and base width of the dam are 101 m and 67.5 m, respectively. The dam crest is 5 m wide and the maximum height of the reservoir water is considered as 96.4 m. The geometry of the dam-foundation rock sytem is shown in Fig. 1.

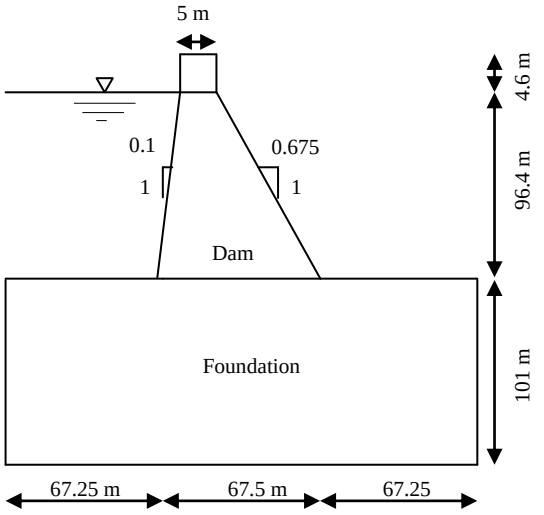

Fig.1. Dimensions of dam-foundation rock system.

The material properties of Oued Fodda concrete dam and its foundation rock are given in Table 1. The cohesion and the angle of internal friction of dam concrete requis in nonlinear response according to the Drucker-Prager model (Druker and Prager 1952) are taken as 2.50 Mpa and 35°, respectively. Nonlinear analysis of foundation rock is defined using multilinear kinematic hardening model. The uniaxial stress-strain curve for foundation rock is given in Fig. 2.

Table 1. Material properties of the concrete dam and foundation rock.

Material	Material properties		
	Modulus of elasticity (MPa)	Poisson's ratio	Mass density (kg/m^3)
Dam	24600	0.20	2640
Foundation	20000	0.33	2000

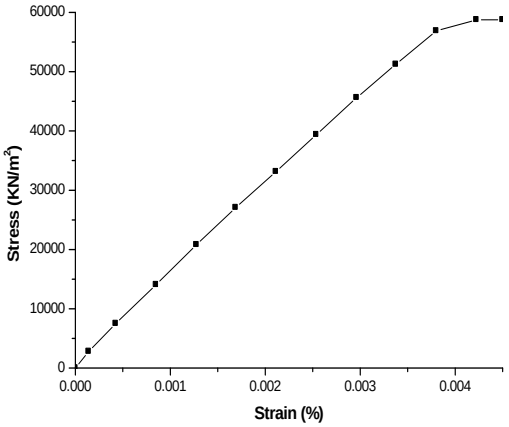

Fig. 2. Uniaxial compressive stress-strain relationship for foundation rock.

2.2. Finite element model

This study considers two-dimensional finite element model of Oued Fodda concrete gravity dam (Fig. 3). The effect of hydrodynamic pressure is incorporated in the analysis by the added mass concept proposed by Westergaard (1933). The solid finite elements (Plane 82) are used to model the dam and the foundation rock; the structural mass finite elements (Mass 21) are used to model reservoir water. In the finite element model, dam body has 240, and foundation rock has 260 solid finite elements. Besides, reservoir water has 20 structural mass finite elements.

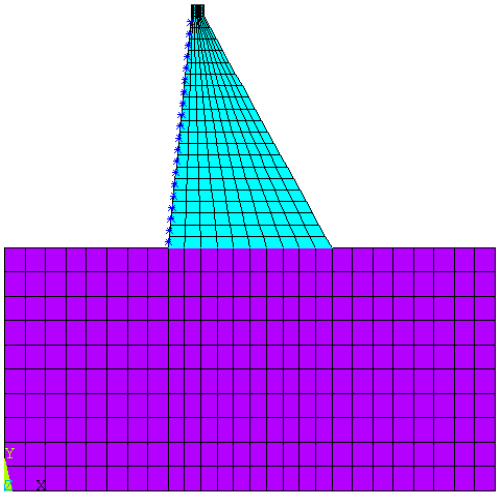

Fig. 3. Finite element discretization of dam-foundation rock system.

3. Earthquake response of Oued Fodda dam

The earthquake response of Oued Fodda concrete gravity dam is evaluated for horizontal component of the 1980 El Asnam earthquake acceleration scaled by factor of 2.5 during 12 s (Fig. 4). In 1980, El Asnam City has already been shaken by strong earthquake (M7). We only have unfortunately a record of a replica of this earthquake with peak ground acceleration (PGA) 0.132 g. We consequently chose the record of replica earthquake with a scaling factor of 2.5 to have an earthquake acceleration record with PGA 0.33 g, equal to PGA of record of the strong earthquake (M7) which occurred in 1980. Linear and nonlinear time-history analyses are performed using ANSYS (2013). The horizontal displacements and principal stress components in dam body attained from linear and nonlinear analyses are compared each other.

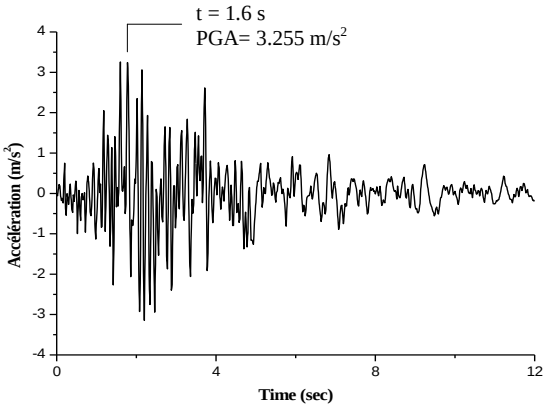

Fig. 4. Time history of horizontal component of 1980 El-Asnam earthquake record scaled by factor of 2.5.

3.1. Displacements

Fig. 5 shows the envelopes of maximum horizontal displacement of the dam in linear and nonlinear transient analyses. As can be seen, horizontal displacements obtained from nonlinear analysis are slightly smaller than ones obtained from linear analysis.

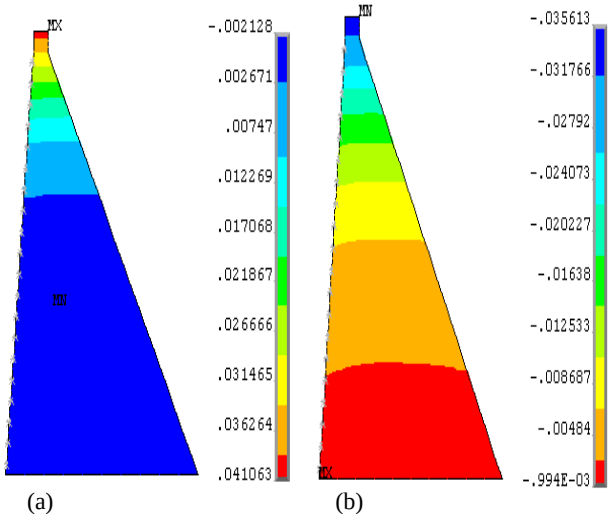

Fig. 5. Maximum horizontal displacement envelopes of the dam: (a) linear analysis; and (b) nonlinear analysis (Unit: m).

The time history of horizontal displacement at the dam crest is presented in Fig. 6 for both linear and nonlinear analyses. The horizontal displacement at the crest decreases from 4.11 cm in linear analysis to 3.56 cm in nonlinear analysis. Therefore, a variation of 13.40 % is observed between the displacement results of the two analyses. Material nonlinearity of dam-foundation rock system can lead to decrease or increase the dam deformations according to ground motion characteristics and mechanical properties of both the dam and foundation rock (Leger and Katsouli 1989; Halabian and Naggar 2002).

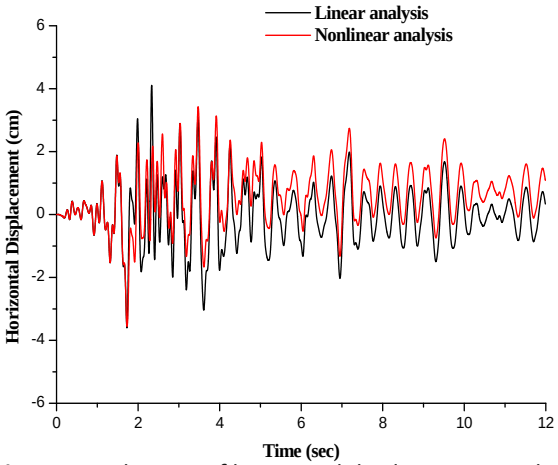

Fig. 6. Time history of horizontal displacement at dam crest using linear and nonlinear analyses.

3.2. Stresses

Figs. 7 and 8 represent the envelopes of maximum principal stresses of the dam in linear and nonlinear

transient analyses. As can be seen, principal tensile and compressive stresses obtained from nonlinear analysis are smaller than ones obtained from linear analysis.

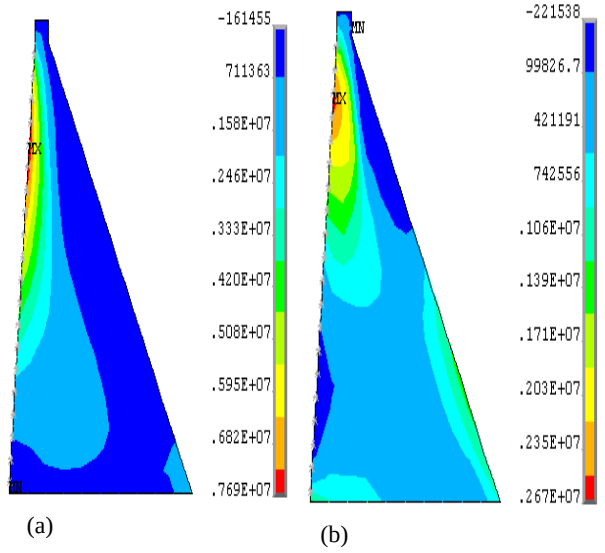

Fig. 7. Maximum principal tensile stress envelopes of the dam: (a) linear analysis; and (b) nonlinear analysis (Unit: Pa).

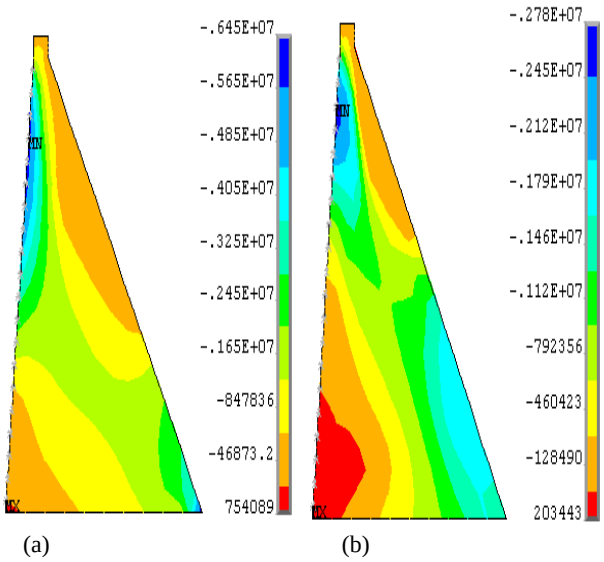

Fig. 8. Maximum principal compressive stress envelopes of the dam: (a) (a) linear analysis; and (b) nonlinear analysis (Unit: Pa).

The time history of principal stresses at the dam heel is depicted in Fig. 9 for both linear and nonlinear analyses. Principal tensile and compressive stresses decrease from 6246.61 and -7313.34 KN/m^2 in linear analysis to 3021.78 and -3297.67 KN/m^2 in nonlinear analysis. Therefore, a decrease in nonlinear analysis of 51.63 % and 54.91 %, respectively, in the amount of principal tensile and compressive stresses is observed. Material nonlinearity of dam-foundation rock system can lead to significantly reduce the principal stresses in the dam according to ground motion characteristics (Leger and Katsouli 1989; Halabian and Naggar 2002).

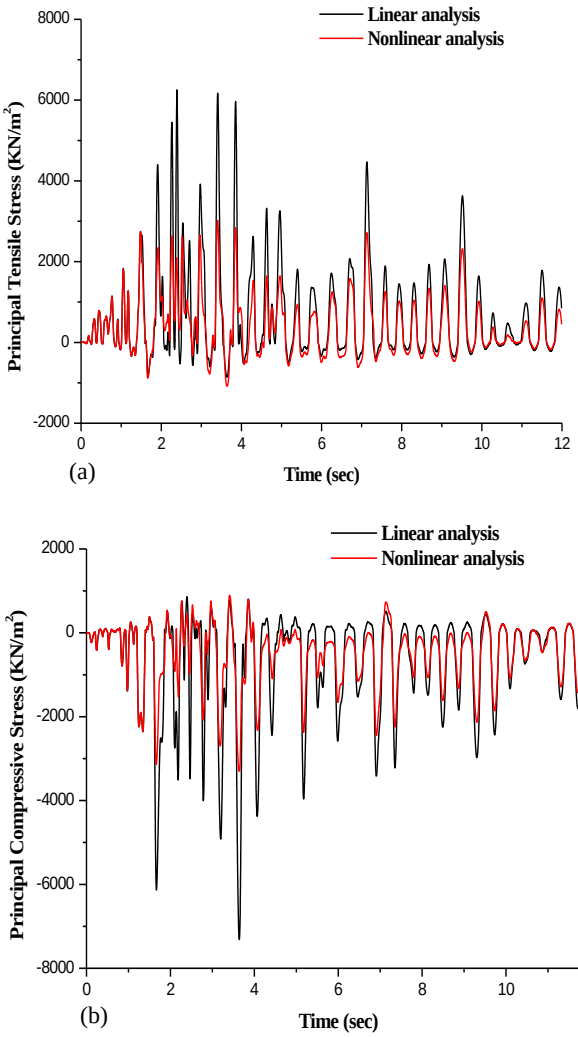

Fig. 9. Time history of principal stresses at dam heel (a) principal tensile stress; and (b) principal compressive stress.

4. Conclusions

Linear and nonlinear seismic responses of Oued Fodda gravity dam is investigated considering dam-foundation rock interaction. The Druker-Prager and the multilinear kinematic hardening models are employed in the nonlinear analysis for dam concrete and foundation rock, respectively. It is evident the taking into consideration the material nonlinearity of dam-foundation rock system can reduce the displacements and stresses in the dam compared to the linear model in this case study on Oued Fodda dam for 1980 El-Asnam earthquake. However, the material nonlinearity of both dam and foundation rock can decrease or increase the dam response according to the

ground motion characteristics and mechanical properties of both the dam and foundation rock (Leger and Katsouli 1989; Halabian and Naggar 2002). Therefore, it is always requested to perform nonlinear analysis of dam-foundation rock interaction system to obtain precise response of the studied dam.

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Sunday 5th December 2021

08:00 - 09:00	Registration	
09:00-10:00	Opening and Welcome Ceremony	
10:00 - 10:30 Plenary session	**Pr. Said KENAI** "Performance of recycled aggregates from construction and demolition waste in ordinary and self-compacting concerete" *Pofessor - Blida 1 University*	
10:30 - 10:50 Plenary session	**Mr. Omar Khaber** "Stratégie nationale de gestion des risques de catastrophes" *Délégation nationale aux risques majeurs - Ministère de l'intérieur*	
10:50 - 11:00	Debate	

11:00 - 11:15	*Coffee break*	
11:15-12:00	Parallel Session 1 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Abdelouahab Tati	
11:15 - 11:30	ID 22	Fracture parameters formulation for single edge notched of composite plate Mostefa Lallam, Abdel Kader Djebli, Abdel Hamid Mammeri
11:30 - 11:45	ID 28	Behaviour of semi-rigid steel frames to sequential earthquakes Mohamed Saadi, Djarir Yahiaoui, Tarek Mansouri
11:45 - 12:00	Debate	

11:15-12:00	Parallel Session 1 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Pr. Sadok Benmebarek	
11:15 - 11:30	ID 576	Modélisation numérique du comportement dynamique d'un mur de soutènement sou Zakaria Bouraoui, Mohamed Babouri
11:30 - 11:45	ID 595	Les géosynthétiques de renforcement dans les ouvrages géotechniques Abdelouahab Abdelkader
11:45 - 12:00	Debate	

11:15-12:00	Parallel Session 1 - Salle de l'Audiovisuel	
	Material theme - Session Chair Pr. Abdelhamid Guettala	
11:15 - 11:30		al composition and thermal behavior of new cellulosic fibers extracted from banana N. Lemita, S. Daghboudj and Fares MohammedLaid Rekbi
11:30 - 11:45		ctive Evaluation via Pulse Echo Method of Damage in DCB Specimen from Composi Fares Mohammed Laid Rekbi, Abdelhak Khechai, Rafik Hlimi,Mabrouk Hecini
11:45 - 12:00	Debate	

12:00 - 13:30	*Lunch*	

14:00-15:00	Parallel Session 2 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Abdelhafid Ounis	
14:00 - 14:15	ID 78	er Analysis of Different Numerical Models for Predicting the Nonlinear Response of R

14:00 - 14:15	ID 78	Abdelhakim ZENDAOUI, Djarir YAHIAOUI, Mohamed SAADI
14:15 - 14:30	ID 213	t of the soil-tunnel interaction on the over ground vibration due to the surface traffic lo Abderrahim Achouri, Mohamed Nadir Amrane
14:30 - 14:45	ID 105	Sliding mode active structural vibration control Leyla Fali, Abdelghani Idder, Khaled Zizouni, Ismail Khalil Bousserhane
14:45 - 15:00	Debate	

14:00-15:00	Parallel Session 2 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Pr. Salah Messast	
14:00 - 14:15	ID 586	rement d'un Ouvrage d'Art sur Oued M'zi au Niveau de Sidi Hakoum : Problème et S Adel Nehaoua
14:15 - 14:30	ID 474	Apports de la télédétection et des systèmes d'information géographique à l'établisser A. SEDDIKI, M. KHEMISSA
14:30 - 14:45		Modélisation numérique de l'interaction sol-Structure traitant le comportement dynam Mohamed Babouri, Zakaria Bouraoui, Abdelmajid Derga
14:45 - 15:00	Debate	

14:00-15:00	Parallel Session 2 - Salle de l'Audiovisuel	
	Material theme - Session Chair Pr. Leila Zeghichi	
14:00 - 14:15		Physical-mechanical behavior of industrial waste-based Naoual Handel, Aziza Boutouta, Sara Djouimaa
14:15 - 14:30		Critical Buckling Temperature Assessment of FGM Sandwich Plates Resting on Elas Chitour M, Bouhadra A. h, Menasria A.R, MAMEN .B ,Tounsi A. O and Benguediab
14:30 - 14:45		estigation on the effects of recycled pavement materialson the properties of self-com Toufik Boubekeur, Mohamed Salhi
14:30 - 14:45	Debate	

15:00-16:00	Parallel Session 3 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Djamel Hamadi	
15:00 - 15:15	ID 135	vestigation on the thermomechanical behavior of honeycomb core sandwich panels w B. MEZIANI, S. AIT TALEB, A. SI SALEM, M.A. BOUZIDI
15:15 - 15:30	ID 174	mparative study between two box CFS sections assembled in different ways in bendi Maizi Salah Eddine, Hadidane Yazid
15:30 - 15:45	ID 180	Modeling of axisymmetric shell structures by the finite element method Bachir Labiodh, Mourad Chalane
15:45 - 16:00	Debate	

15:00-16:00	Parallel Session 3 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Pr. Abdelhak Mabrouki	
15:00 - 15:15	ID 427	ytical model predicting water retention curves for granular materials based on tension L. Bouacida, S. Feia
15:15 - 15:30	ID 439	Shear behavior of sand geotextile interface Sidali Denine, Noureddine Della, Mahdi Missoum Benziane, Hadjer Feknous

15:30 - 15:45	ID 142	Numerical analysis of a cantilever sheet pile wall BAHLOUL ILHAM, BELABED LAZHAR 2, BENAMARA F.ZOHRA 3
15:45 - 16:00	Debate	

15:00-16:00	Parallel Session 3 - Salle de l'Audiovisuel	
	Material theme - Session Chair Pr. Ahmed Bouaziz	
15:00 - 15:15		ctérisation expérimentale des sables de construction de la région sud et sud-est de l'A Abdelaziz Logbi, Toufik Choungara, Mohamed Mani, Tarek Djedid
15:15 - 15:30		study on the reuse of powdered glass waste for developing an ecological self-consoli Bouleghebar Yasmina, Bentchikou Mohamed
15:30 - 15:45		nal stability analysis of thin rectangular FGM plates resting on variable elastic founda Himeur Nabil, Menasria Abderrahmane , Mamen Belgacem , Bouhadra Abdelhakim ,
15:45 - 16:00		ement Analysis of Fire Resilience of Hybrid and Self-Compressed Fiber Reinforced C Mohamed ZITOUNI, Belkacem LAMRI et Abdelhak KADA
16:00 - 16:15		Thermoelastic behavior of FG sandwich plates using HSDTB Billel REBAI, A. Bouhadra
16:15 - 16:30	Debate	

16:00-17:00	Parallel Session 4 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Lamine Belounar	
16:00 - 16:15	ID 547	Seismic analysis of concrete gravity dams considering material nonlinearity of dam-f Djamel Ouzandja, Amina Tahar Berrabah
16:15 - 16:30	ID 579	Further applications of a solid strain based finite element for static and dynamic plate Lazhar Derradji, Toufik Maalem, Tarek Merzouki, Abderraouf Messai
16:30 - 16:45	ID 594	Large deflection geometrically nonlinear bending of sandwich beams with flexible cor Sattar Jedari Salami
16:45 - 17:00	ID 370	Ansys modeling of "rock foundation"-"reservoir water"-" multi-arch dam" interaction p Tahar Berrabah Amina, Belabaci Zeyneb, Djamel Ouzandja, Moussi Wahiba
17:00 - 17:15	Debate	

16:00-17:00	Parallel Session 4 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Dr. Nabil Houhou	
16:00 - 16:15	ID 99	ng-term soil deformations on the performance of RC bridges considering soil-structure K. Bezih , R. Demagh , M. Djenane and M. Laouche
16:15 - 16:30	ID 518	Numerical evaluation of the bearing capacity of strip footings in cohesionless soil und Guetari Ahlem, Remadna Mohamed saddek, Benmebarek Sadok
16:30 - 16:45	ID 552	Reinforcement of buildings located on slopes undergoing shallow landslides using he Mehdi Dib, Besma Bouteche, Salim Kouloughli
16:45 - 17:00	ID 563	ffects of salinity of the porous medium on particle transport behavior in saturated soi Lyacine Bennacer, Nasre-Dine Ahfir , Abdellah Alem
17:00 - 17:15	ID 265	Improvement of bearing capacity of reinforced soft clay Khaoula Chenche, Meriem Fakhreddine Bouali , Ines Hamrouni

18:00 - 21:00	Gala Dinner at Maurice Laban Hotel

18:00 - 21:00 Gala Dinner at Maurice Laban Hotel

Monday 6th December 2021

08:30 - 09:00 Plenary session	**Pr. Atilla ANSAL** "Probabilistic approach in seismic microzonation" *Professor - Özyeğin University, Turkey*
09:00 - 09:30 Plenary session	**Dr. Sadok FEIA** "L'intelligence artificielle sur les investigations géotechnique: Glissement de terrain de Mila 2020" *Maitre de conférences - Université de Biskra*
09:15 - 09:45	Debate

09:45 - 10:00	*Coffe break*

10:00-11:00	Parallel Session 5 - Salle de projection dept. Architecture Structural theme - Session Chair Pr. Mohamed Guenfoud	
10:00 - 10:15	ID 184	umerical evaluation of the performance of a reinforced concrete frame subjected to fi Ismail Haouach, Belkacem Lamri, Abdelhak Kada
10:15 - 10:30	ID 98	Evaluation of a new four-node quadrilateral element for analysis of the shell structures ABDERRAHMANI Sifeddine, HAMADI Djamal
10:30 - 10:45	ID 225	Effet d'un système passif hybride de type HDRB-FPS sur la réponse sismique d'un b Ounis Hadj Mohamed, Zataâr Nassima, Ounis Abdelhafid
10:45 - 11:00	Debate	

10:00-11:00	Parallel Session 5 - Salle des soutenances dept. Génie Civil et Hydraulique Geotechnical theme - Session Chair Pr. Zoha Derriche	
10:00 - 10:15	ID 389	Spatial analysis and mapping of the susceptibility to landslides: application on the roa Mebirouk Nadjib, Messast Salah, Amrane Moussa
10:15 - 10:30	ID 55	Laboratory investigation on the effect of xanthan gum content and sample preparatio Mehdi Missoum Benziane, Goufi Abd Elmalik , Noureddine Della
10:30 - 10:45	ID 84	Lateral pressures acting on circular shafts Abdelmajid Meftah, Naïma Benmebarek, Sadok Benmebarek
10:45 - 11:00	Debate	

10:00-11:00	Parallel Session 4 - Salle de l'Audiovisuel Material theme - Session Chair Pr. Abdelghani Merdas	
10:00 - 10:15		ropagation behavior of steel fiber reinforced rebars concrete (SFRRC) under flexural Nacira Saoudi, Hayet Cherfa, Tabouche Amarouche,Bensaid Samir
10:15 - 10:30		Hygro-thermal buckling of FG sandwich plates resting on elastic foundations S.Refrafi, A.Menasria, A. Bouhadra, A. A.Bousahla, F. Bouazza, A.Tounsi
10:30 - 10:45		Performance study of fiber-reinforced mortars based on dredging sludge Mohamed Salhi, Toufik Boubekeur, Said Choucha, Amar Benyahia. Hachemi Benadd

10:45 - 11:00	Debate

11:00-12:00	Parallel Session 6 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Dr. Mohamed Ouajdi Belarbi	
11:00 - 11:15	ID 593	The Generalized Differential Quadrature for the static and free vibration analysis of c F. Tornabene1, M. Viscoti*1 and R. Dimitri1
11:15 - 11:30	ID 284	Numerical study on granular materials in a confined media: Effect of an obstacle on Mohamed Kechachni, Mohammed Djermane, Mebirika Benyamine
11:30 - 11:45	ID 486	Vibration analysis of plates in interaction with a fluid using a strain-based Kirchhoff el Faiçal Boussem Abderahim Belounar, Lamine Belounar, Fortas Lahcene
11:45 - 12:00	Debate	

11:00-12:00	Parallel Session 6 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Pr. Khelifa Abbeche	
11:00 - 11:15	ID 137	Effect of Vegetal Fibers on the Shear Strength of Sandy Soil Hachemi Adda Berkane, Noureddine Della, Sidali Denine, Mahdi Missoum Benziane
11:15 - 11:30	ID 152	inear Numerical simulation on dynamic soil-structure interaction under earthquake ex Khadidja Sekhri, Djarir Yahyaoui , Bilel Adeel Withra
11:30 - 11:45	ID 206	oratory study on the mechanical behavior of Chlef sand: Effect of different types of fi Mahmoudi, Abdellah Cheriftaiba, Leila Hazout, Amine Taibi, Hamou Azaiez, Mostefa
11:45 - 12:00	Debate	

11:00-12:00	Parallel Session 5 - Salle de l'Audiovisuel	
	Material theme - Session Chair Dr. Ahmed Amine Daikh	
11:00 - 11:15		Remoted presentation
11:15 - 11:30		de comportement dynamique des plaques FGM Sandwich sur fondation élastique va MESSAOUDI, A. Bouhadra, B. MAMEN,A. Menasria, A. TOUNSI and M. BENGUEDI
11:30 - 11:45		Elaboration et étude du comportement mécanique et de durabilité d'une brique de te BENCHEIKH Mohamed , CHOUKEIR Sawsen, AMRIOU Abderrachid
11:45 - 12:00	Debate	

12:00 - 13:30	*Lunch*

14:00-15:30	Parallel Session 7 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Abdelouheb Tati	
14:00 - 14:15	ID 526	Strengthening web post buckling of cellular beam using pultruded GFRP profiles Guedaoura Hamda, Dr Hadidane Yazide
14:15 - 14:30	ID 527	The optimum approach to determine the mechanical properties of Algerian historical Hatem SEBOUI, Allaeddine ATHMAN, Antonio FORMISANO
14:30 - 14:45	ID 528	Dynamic behavior of cracked bridge structures under moving loads Mahieddine Chettah, Sihem Chaib, Nabil Djebbar, Rachid Lassoued
14:45 - 15:00	ID 538	Modelling Of Columns In A Metal Hangar During A Fire

[illegible]	[illegible]	Nadia Otmani-Benmehidi, Wissem Innal
15:00 - 15:15	ID 541	3D numerical analysis of the effect of deep braced excavation on nearby single pile a Tamir Amari, Mohamed Nabil Houhou
15:15 - 15:30	Debate	

14:00-15:30	Parallel Session 6 - Salle de l'Audiovisuel	
	Material theme - Session Chair Pr. Mohammed Sid Ahmed Houari	
14:00 - 14:15		Bending behavior of laminated sandwich beams under hygrothermal loading Aman Garg, H.D. Chalak
14:15 - 14:30		Thermomechanical response of FG plates on variable elastic foundation Mohamed ALI_RACHEDI, Abdelhakim BOUHADRA, Abderrahmane MENASRIA , Sa
14:30 - 14:45		Experimental evaluation of dynamic modulus of elasticity and hygroscopicity behavic oussine Atiki, Bachir Taallah, Sadok Feia, Kamal Saleh Almeasar, Abdelhamid Guett
14:45 - 15:00		mbined use of tires rubber waste and hydrated cement on properties of self compacti Amel Bouabaz, Rachid Djebien, Leila Kharef, Mouloud Belachia
15:00-15:15		Hygro-thermo-mechanical loading effects on bending behavior of FG plates resting o MAMEN, Abdelhakim Bouhadra, Abderrahmane Menasria, Bouzid Merazka, Abdeloua
15:15 - 15:30	Debate	

14:00-15:30	Parallel Session 7 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Pr. Naima Benmebarek	
14:00 - 14:15	ID 266	and prediction of earth dam behavior using monitoring measures and artificial neural Harbi Leyla, Smail Nadia and Rouissat Bouchrit
14:15 - 14:30	ID 329	alysis and prediction of swelling pressure of subgrade clay for flexible pavement desi lali, Debojit Sarker, Rafik-Boufarah, Khaled-Rais, Zied-Benghazi, Ali Hamdane, Mour
14:30 - 14:45	ID 488	Laboratory Study on Undrained Shear Strength Response of Sandy Soils Considering Leila Hazout ,Abdellah Cherif Taiba, Youcef Mahmoudi, Mostefa Belkhatir
14:45 - 15:00	ID 347	mation minimum anchor lengths of anchored retaining walls by improving failure moc Fatima Zohra Benamara, Lazhar Belabed, Ammar Rouaiguia, Ilham Bahloul
15:00-15:15	ID 23	Insight into the effect of polypropylene fibers on the shear strength of sandy soil hamid Flitti, Bilal Abboub, Mahfoudh Rezime, Noureddine Della, Mehdi Missoum Ben
15:15 - 15:30	Debate	

15:30 16:30	Poster session and coffee break

Tuesday 7th December 2021

08:30 - 09:00 Plenary session	**Siavash GHABEZLOO** "behaviour of cement-based materials for integrity assessement of structur

09:00 - 09:30 Plenary session	**Pr. Ashraf AYOUB** "Earthquake damage mitigation of critical structures through vibrationg barriers (ViBa)" *Professor - City university of London, UK*
09:15 - 09:45	Debate

09:45 - 10:00	*Coffe break*

10:00-11:00	Parallel Session 8 - Salle de projection dept. Architecture	
	Structural theme - Session Chair Pr. Lamine Belounar	
10:00 - 10:15	ID 543	Finite element models for the prediction of thermal response of light gauge steel pan Mohammed Hassoune, Abdelhak Kada, Belkacem Menadi, Belkacem Lamri
10:15 - 10:30	ID 546	Numerical analysis of the shear behavior of short concrete corbels reinforced by seve Zaioune Hiba, Mezhoud Samy
10:30 - 10:45	ID 455	he Effect of Non-Linear Behavior on the Seismic Response of Concrete Gravity Dam htar MESSAAD, Messoud BOUREZANE, Djamel OUZENDJA, Amina Tahar BERRA
10:45 - 11:00	Debate	

10:00-11:00	Parallel Session 8 - Salle des soutenances dept. Génie Civil et Hydraulique	
	Geotechnical theme - Session Chair Dr. Mohamed Sadek Remadna	
10:00 - 10:15	ID 411	Effect of micropiles pre-reinforcement system on the stability of shallow tunnels Djamil Nefla, Nasserdine Diaf, Mustapha Hidjeb
10:15 - 10:30	ID 457	Evaluation of pile group efficiency in clay by numerical approach Abdelkrim FERCHAT, Sadok BENMEBAREK and Mohamed Nabil HOUHOU
10:30 - 10:45	ID 339	Bearing capacity of a strip footing on a reinforced slope mmed A.A. Al-hajj, Mohamed Saddek Remadna, Walid Chaabani, Imad Eddine Debba
10:45 - 11:00	ID 353	Effect of palm fibers reinforcement on Desiccation cracking in clayey soils Afaf Zeroual, Sadok Feia, Ahmed Bouazız, Abedali Dadda, Mohamed Nabil Haddoud

10:00-11:00	Parallel Session 7 - Salle de l'Audiovisuel	
	Material theme - Session Chair Dr. Samia Hachemi	
10:00 - 10:15		Effect of proportion of aluminosilicate materials and activator on the mechanical perf Souheila Semache, Fathe Bouteldja, Mouloud Belachia, Sofiane Amziane
10:15 - 10:30		Lightweight blocks with raw earth incorporating expanded polystyrene Safa Layachi, Bachir Taallah, Ouarda Izemmouren
10:30 - 10:45		STATE OF THE ART ON THE FUNCTIONALLY GRADED COMPOSITE MATERIALS Daikh, A.A., Drai, A., Belarbi O, M., Houari, M.S.A
10:45 - 11:00	Debate	

11:00 - 12:00	Closing ceremony and awards