creases the PPV. However, increase in the modulus of elasticity, damping ratio and soil unit weight, decreases the PPV. Also, scrutiny of PPV occurrence time shows that by variation of the influencing parameters, except the modulus of elasticity, this time is almost constant.

Key Words: Pile-driving, ground vibration, pick particle velocity (PPV), Plaxis2D.

EXPERIMENTAL EVALUATION OF THE FLEXURAL BEHAVIOR OF SELF-COMPACTING REINFORCED FIBROUS CONCRETE BEAMS UNDER CYCLIC LOADING

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Abstract

When a structure is hit by an earthquake, a tremendous amount of seismic energy released by the earthquake is injected into the structure as ground motion. The structure is also subjected to reverse loads, which cause severe deterioration of the concrete. To release seismic energy, the structure should be damaged in such a way that, on the one hand, the collapse of the structure should not occur, and, on the other hand, after the earthquake, the damage should be economically feasible to repair. One of the drawbacks associated with fiber reinforced concrete (FRC) is that the addition of fibers to a traditional concrete mix at high fiber content can result in workability problems. The combined use of Self-Compacting Concrete (SCC) and fibers can solve this problem and facilitate placement for a wider range of structural applications. SCC is a new class of high performance concrete that can spread readily into place under its own weight and fill restricted sections, as well as congested reinforcement structures, without the need of mechanical consolidation and without undergoing any significant separation of material constituents. Although several studies have been conducted on the behaviour of FRC beams subjected to monotonic loading, there is limited research on the behaviour of FRC beams under cyclic loading. This paper presents the results of an experimental study conducted on 18 FRC beam specimens tested under cyclic and monotonic loading. The main objective of this research is to investigate the effect of fibers on structural element (beam) behavior. Steel fiber and PolyPhenylene Sulfide (PPS) were used in this work. The content of fiber was 0.1, 0.2, 0.3 and 0.4 of volume, and concrete without fiber is considered as a reference. The results show that adding fiber increases dissipated energy and bearing capacity and also reduces crack width. A comparison of two types of fiber in this study show that concrete containing steel fiber has a higher amount of cumulative dissipated energy, and higher strength than the corresponding amount in concrete containing PPS fiber.

Key Words: Self compacting concrete, fibers, cumulative dissipated energy, load bearing capacity, mechanical properties, cyclic loading.

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Abstract

The strengthening of offshore platforms and structures placed under different environmental conditions are important cases in civil engineering. The use of FRP (Fiber Reinforced Polymer) to strengthen existing steel structures and offshore platforms has become an effective technique. Because the elastic modulus of FRP is close to, or higher than, steel, it has proven to be increasingly favorable for the repair and rehabilitation of the mentioned structures. Despite the evident advantages of FRPs over traditional materials, the greatest impediment to worldwide utilization is represented by the limited knowledge of composite behavior of systems under extreme conditions, such as freeze-thaw or wet-dry. Exposure to extreme environmental conditions will reduce bonding strength and also the durability between CFRP and steel.

In some countries, due to seasonal changes, multiple cycles of freezing and thawing effect the service life of offshore structures. This paper discusses the mechanical performance of the environmental durability of the bond of FRP to steel surfaces. In order to investigate this aspect, two series of specimens with different numbers of plies of FRP have been prepared for two conditions; 60, 120 wet and dry cycles for the first specimens and 170, 210 freeze-thaw cycles for the second series.

The experimental results present bond strength and stiffness, and the failure mode and deformation of strengthened steel elements. It was shown that when specimens were exposed to freeze-thaw conditions, the lower load was carried and, so, this condition is more extreme for the service life of these types of structure. The experimental results also indicate that the ply number on FRP has a low influence on the mechanical properties of the composite system. It is also observed that the failure mode is when the adhesive interface and piling of FRP from the surface occurred.

Key Words: Fiber reinforced polymer, steel, wetting and drying, cyclic freezing and thawing, failure mode.

EFFECT OF SOIL PROPERTIES ON PEAK PARTICLE VELOCITY (PPV) DUE TO PILE-DRIVING USING FINITE ELEMENT ANALYSIS

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Abstract

Pile-driving is a common method of foundation construction where the soil is not strong enough to support the load of the structure through conventional shallow footing. This method is widely used in residential and industrial building, bridges, highways and etc. Along with the benefits of using this method, pile driving is also a source of negative environmental effects. Noise and air pollution are the most commonly expressed concerns, but, ground vibrations originating from the pile driving impact also have important adverse effects. They can cause disturbances to adjacent structures and also disrupt the operation of nearby sensitive equipment and facilities. Permanent settlement, densification and liquefaction may also occur in the soil due to such vibrations. A common factor for evaluating the amount of vibrations is peak particle velocity (PPV), which is maximum velocity that soil particles reach during the pile driving process. PPV is the maximum velocity that a soil particle experiences during the driving of a pile from the ground surface to the desired depth. Ground motion due to pile driving generally depends on (1) the source parameters (method of driving, energy released, and pile depth), (2) the interaction between the driving machine, the pile and the soil, and (3) the propagation of waves through the soil.

In this article, a two-dimensional finite element model is validated using a case study of pile-driving data conducted in the Chennai site in India. Then, by modeling a pile in sandy soil with different soil relative densities, Poisson ratio, moduli of elasticity, Unit weight, friction angle and damping ratio, the effects of these parameters on vibrations of the ground surface, and peak particle velocity on the surface, were studied. The results showed that the increase in friction angle and Poisson ratio in-

Moisture damage, sometimes called stripping, is the progressive deterioration of asphalt mixtures due to loss of adhesion between the asphalt binder and the aggregate surface and/or loss of cohesion within the binder due to the infiltration of water. Stripping usually begins in the bottom of the HMA layer, then, travels upward. A typical situation is a gradual loss of strength over a period of years, which causes rutting and shoving to develop in the wheel path. Many times, stripping is difficult to identify, because surface indicators may take years to show. This type of damage in Hot Mix Asphalt (HMA) is a major cause of pavement failure in tropical regions. There are many possible causes of stripping and inadequate surface drainage or sub-surface drainage is a primary contributor. There are many proposed remedial actions to alleviate the stripping phenomena of asphalt mixtures, such as using anti-stripping agents, lime slurry with compatible aggregates and modified binders.
This study aims to investigate the feasibility of using E.A.F steel slag aggregate in HMA mixtures to reduce their stripping phenomena.
Steel slag is a byproduct that makes 15 to 20% of the iron-processing product in an integrated steel mill. Every year, significant quantities of steel slag are produced as a by-product of steel industries in Iran. Although it can be used as an artificial source of aggregates in the pavement industry, it is disposed for landfills. In this research, the chemical and physical properties of the steel slag were evaluated first. Then, 50% and 100% of the limestone, as fine, coarse and total aggregate in the asphalt mixture was replaced by EAF, and the moisture sensitivity of the mixes was evaluated. The results showed that the use of steel slag as the coarse portion of the aggregates will enhance Marshall stability, resilient modulus, tensile strength and resistance to the moisture damage of HMA mixtures.

Key Words: Steel slag, moisture sensitivity, ITS, resilient modulus.

ANALYZING BEAMS AND ONE-AND TWO-STORY FRAMES WITH EQUAL SPAN LENGTHS, USING RECURRENCE SEQUENCES

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For centuries, mathematicians have used recurrence relations, such as the famous Fibonacci recurrence sequence, and their produced functions for solving mathematics problems. The Fibonacci sequence is named after Leonardo of Pisa, who was also known as Fibonacci. The Fibonacci sequence is a set of numbers that start with a one or a zero, followed by a one, and proceeds based on the rule that each number is equal to the sum of the preceding two numbers. Unfortunately, this amazing aspect of mathematics has not been considered in the analysis of structures. This article is, therefore, particularly focused on using recurrence relations as an innovative method in the analysis of structures.
In this research, first, a continuous multi span beam with equal lengths under end, fixed end and sliding end conditions is considered subjected to a concentrated bending moment at the beginning of the beam. Then, the function of the support moments is calculated and moments are obtained. In this regard, one - and two- story frames with equal span lengths have been considered in order to present the applied procedure. Accordingly, torsional springs have been used instead of columns, ignoring their axial stiffness. The bending moments are then computed again at the connection of the beam and column using recurrence relations.
Analyzing the sub-frame by this method is one of the products of using recurrence sequences for approximate analysis of the frames subjected to gravity loads.
Finally, the effect of shear deformations has been considered for continuous multi span beams with equal span lengths and the structure is analyzed again. In all above mentioned cases, the structures have been analyzed by software as well. The results obtained from analyzing the structures using recurrence sequences are strongly in accordance with those using software.
This article shows that the distribution of internal forces follow recurrence sequences in structures, like many other proportions seen in natural phenomena, such as the arrangement of leaves in plants.

Key Words: Linear recurrence relation; torsional stiffness; support conditions; carry-over-factor.

EFFECT OF FRP ON BEHAVIOR OF STEEL PLATE UNDER EXTREME SERVICE CONDITIONS

and after earthquakes, will present a desired level of performance. New seismic regulations, such as FEMA 356 and the Iranian Seismic Rehabilitation Guideline, use a performance-based design method; nonlinear analysis methods are the main tools of these codes. Also, the main objective of this research is to evaluate the seismic performance of buildings, with different importance levels, designed according to the Iranian Seismic Code, using the Iranian Seismic Rehabilitation Guideline.
In this research, a set of structures, with different categories of occupancy and different numbers of stories, are designed according to the Iranian Seismic Code. The seismic performance levels of the mentioned structures are evaluated using nonlinear static analysis (pushover), based on the Iranian Seismic Rehabilitation Guideline. The results show that the low- and medium-rise buildings behave to a life safety (LS) performance level. In high-rise buildings, with medium importance, the required performance level (LS) is not achieved, and in very high importance (essential) buildings, the required performance level (IO) is not achieved. Therefore, increasing the importance factor, I, does not necessarily lead to improvement in performance levels, but leads to an increase in structural weight; this could be a non-economic decision. By using non-linear analysis in parts of the structure, in which performance level is not met, the structure would be strengthened and achieve the required level of performance.

Key Words: Importance factor, performance level, nonlinear static analysis, inelastic behavior.

EVALUATION OF STRIP FOOTING BEHAVIOR RESTING ON GEOGRID-REINFORCED SOILS

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Abstract
When soil beneath a foundation is weak and cannot bear applied loads, an appropriate method of soil improvement is essential. In cases where weak soil is improved by a replacing method, the improvement depth, due to the stress distribution pattern, is of great importance. However, in some cases, it is very difficult or too expensive to provide enough improvement depth. Hence, additional bearing capacity or other improvement methods are required. Using a geogrid to reinforce soil is an effective alternative way to improve the bearing capacity more effectively and economically.
In this paper, the effect of replacing a loose layer by a dense one on the bearing capacity and settlement of a strip footing has initially been investigated. Then, the influence of a geogrid layer placed on the interface of loose and dense layers is analyzed and investigated using finite difference FLAC □ software. The numerical model is verified and calibrated using experimental data from a physical model developed in the Soil Laboratory of Amirkabir University.
Analyses results show that increasing the depth of compacted soil layer by more than □□□ times the width of the foundation, does not have a considerable effect on the ultimate bearing capacity of strip footings, and only settlements will decrease. Using a geogrid layer between loose and compacted soil will improve the bearing capacity greatly, for a modified depth less than □□□ times the width of the foundation .The most efficient improvement in this method is when the geogrid layer is placed on the boundary of loose and dense layers at a depth of □□□□ the foundation width. The efficiency of reinforcement is reduced by increasing the improvement depth. Using a reinforced layer with a width of less than □□ times the foundation width is not recommended.

Key Words: Bearing capacity, strip footing, improvement, reinforced soil, geogrid.

MOISTURE SENSITIVITY OF ASPHALT MIXTURES CONTAINING E.A.F STEEL SLAG

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A HYBRID METHOD FOR ESTIMATING THE INELASTIC RESPONSE SPECTRUM DUE TO DETERMINATION OF TARGET DISPLACEMENT USING THE N2 METHOD

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Abstract

In recent years, nonlinear static analysis (pushover) has been rapidly developed. Simplicity, speed and ease of interpretation of results are some advantages of this method, rather than the nonlinear dynamic analysis procedure, as the most accurate method for seismic analysis. Target displacement or performance point is a fundamental component of each nonlinear static analysis, where displacements and stresses of structures are evaluated. The N2 method is a well-known procedure for determination of the performance point, by which, target displacement is determined through intersecting the capacity curve and corresponding inelastic response spectrum, using a trial and error method. In this procedure, determination of the inelastic response spectrum is an important problem.

To achieve an easy and quick analysis in the seismic design of structures, using the concept of a spectrum is common. A response spectrum is a simple plot of the peak or steady-state response (displacement, velocity or acceleration) of a series of SDOF systems with various natural frequencies that are forced into motion by the same base vibration. This concept fairly estimates the characteristics of ground motion and maximum amounts of displacement, velocity and acceleration due to an earthquake. Since, in severe ground motions, structures experience deformations beyond the elastic range, the inelastic spectrum is utilized to account for the inelastic behavior. The shape and magnitude of inelastic response spectra are dependent on the period and damping characteristics of the structure, the hysteresis behavior of used material and some seismic parameters, such as soil condition, earthquake magnitude and epicenter distance.

In this paper, with regard to existing equations for determination of the inelastic response spectrum, a combinatory approximate method, based on soil condition and the ductility ratio period of the structure, is developed, by which the inelastic response spectrum is estimated using the elastic design response spectrum. Using this inelastic response spectrum, the target displacement of regular systems is estimated with admirable accuracy.

Key Words: Target displacement, inelastic response spectrum, site conditions, ductility ratio, N2 method.

SEISMIC PERFORMANCE OF STEEL MOMENT FRAMES BASED ON THEIR IMPORTANCE ACCORDING TO THE IRANIAN SEISMIC CODE

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Abstract

The current Iranian Seismic Code, for seismic loading and analysis of structures, (Standard no. 2800) considers linear elastic analysis to be adequate for structural and seismic response prediction for a majority of structures. In this regulation, an importance factor, I, is considered to improve the performance of buildings based on their importance. Linear analysis is inadequate for observing structural performance during earthquakes, because proper seismic behavior and the stability of structures are not just governed by strength; structures need to resist determined amounts of force and should be able to displace determined amounts of displacements. On this basis, it is expected that by using importance factor, I, in linear analysis, the structures will behave properly,

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Abstract

Claims are becoming more popular as a way to survive and, indeed, an integral part of modern contracts, i.e. for non-industrial design and building contracts. It should be considered that although the probability of claim incidences cannot be eliminated in any project, their occurrence in special projects with any contract can be prevented by identifying them. As most claims are propounded by contractors, the authors of this research found 250 cases of claims in projects in Iran offered by design and building contractors (including the contractor and their advisor) in non-industrial design and building contracts. They were discovered through studying diverse references and interviewing experts, and studying documents related to real claims of several projects implemented in non-industrial design and building methods in Iran. In this process, at first, the occurrence of the Algorithm of Legal-Contractual claims was codified by content analysis, and then a closed questionnaire, including the frequency of occurrence and severity of different kinds of legal-contractual claim in non-industrial design and building contracts, was distributed among experts in the field, and the results were accurately analyzed by the authors. These questionnaires aimed to study the frequency of occurrence and severity of claims, and, based on the rate of transparency of existing claims in non-industrial design and building contracts, were categorized in 12 rows, 4 parts, and 2 groups of legal-contractual claims. Understanding and cognizance of these claims can be useful in predicting future claims and in minimizing their effects on similar future non industrial design and building projects. Offering a categorization of claims of non-industrial design and building projects in Iran, from the perspective of the degree of ambiguity and transparency, and codification of the chart of rate of transparency, frequency of occurrence and severity of claim, is a key finding of this research.

Key Words: Legal-contractual claims, algorithm, non-industrial DB projects, occurrence rate, severity of claim, degree of transparency of claims.

EXPERIMENTAL AND ANALYTICAL STUDY OF THE CYCLIC PERFORMANCE OF SPECIAL CONCENTRIC BRACED FRAMES

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Abstract

The special concentrically braced frame (SCBF) is a common type of steel structural system for resisting lateral loading. This type of system provides the required stiffness and strength at relatively low cost. Design codes, based on past research, have recommended some details for connections and braces, in order to ensure sufficient ductility and energy dissipation capacity in this system for their application in seismic design. In this paper, the behavior of four SCBF specimens with different details of connections is studied using experimental and numerical models. They are single story single bay sub-assemblages of frames with a single brace that are subjected to lateral cyclic loads. In the first specimen, a 2tp straight line clearance at the end of the brace was observed, but, in the second specimen, an 8tp elliptical clearance was provided. In the third and fourth specimens, stiffeners were installed to provide enough stiffness for gusset plates, so that they can act as fixed ends for braces. The dimensions of the gusset plates in these specimens were naturally different. Measures such as stiffness, strength, ductility, energy dissipation capacity and equivalent plastic strain are used to compare the behavior of specimens in experiments and finite element analysis. The results show that all specimens satisfy code expectations with regard to seismic performance. For unstiffened gusset plates, the accumulation of plastic strain at the corners of the gusset plates and in the middle of the brace results in crack initiation and fracture in specimens in the final stages of cyclic loading. In stiffened specimens, although gussets are smaller, plastic hinges are formed in the middle and at the end of the brace element, but final cracking and fracture occurs in the middle of the element. In these specimens, higher buckling resistance and lower out of plane displacement of braces are observed.

Key Words: Special concentrically steel braced frame, gusset plate, dissipated energy capacity, ductility, stiffener.

metallic gripping device is fixed on top of this partial core by fastening its side bolts, and torsional moment is applied to the partial core via this gripping device by hand. The applied torsional moment is gradually increased until the partial core is failed, and the maximum (failure) torsional moment is recorded. Using the existing calibration graphs, the ultimate (failure) torsion is converted to the compressive strength of the concrete tested. The results show that the weight of the concrete situated above any level has a positive effect on the strength of the concrete at that level. In addition to the comparison of the obtained results with the respective results of ordinary concrete, the effect of changes in the fillers, segregation and aggregate grading, on the strength of self-compacting concrete, is also studied.

Key Words: Self-compacting concrete, concrete weight, strength, column, fly-ash, friction transfer.

A FUZZY EXPERT SYSTEM AND GENETIC ALGORITHMS TO SCORE THE SAFETY MANAGEMENT PERFORMANCE IN CONSTRUCTION SITES OF IRAN: CONSIDERING SAFETY CLIMATE AND PERSONAL EXPERIENCE

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Abstract
Construction is a dangerous and risky industry with a high accident rate. Safety, therefore, is deemed to be an important issue, and various agencies endeavor to control accidents through different approaches. Contractors procure worker compensation insurance to transfer these risks to insurance companies, but, as the safety management performance decreases, the risk of insuring this site for the insurance companies increases. Therefore, giving a score to the safety management performance in a construction site will help insurance companies to quote optimal premiums. If a contractor's real-time safety management system is robust, the contractor will get a cost-effective insurance cover, which will enable the contractor to compete better in tenders. Those contractors who do not have robust safety management systems in place will be penalized by higher premiums. Meanwhile, this approach will automatically set risky contractors aside and motivate contractors to invest in safety measures in their organizations. In this research, by considering the safety climate, personal experience factors, studying the literature and consulting with experts, the main factors effecting safety in the construction sites of Iran were recognized. Since all of these factors are linguistics, a fuzzy expert system was proposed for scoring their safety management performance. The parameters of the designed expert system, including Yager's t-norm, Yager's s-norm, Yager's complement, Yager's inference engine and Yager's defuzzification parameters, were optimized by genetic algorithms. The performance of the proposed fuzzy expert system for scoring the safety management performance in the construction sites of Iran was tested using the mean squared error (MSE) method. This method was utilized to quantify the difference between values implied by the designed fuzzy expert system and the true values of the quantity being estimated. Testing results validate the effectiveness of the designed fuzzy expert system for scoring the safety management performance in construction sites of Iran.

Key Words: Fuzzy expert system, genetic algorithms, safety management performance in sites, safety climate, personal experience.

DEVELOPING ALGORITHMS OF LEGAL-CONTRACTUAL CLAIMS AND STUDY OF THE OCCURRENCE RATE AND SEVERITY OF IMPACT ON NON-INDUSTRIAL DB PROJECTS OF IRAN

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parison of obtained results in this study with results of 2D analysis, the reliability of 2D models, in order to evaluate lining loads, is investigated. The comparisons show that 3D analysis is superior to 2D analysis, particularly in the presence of surface buildings. The difference between results increases with a decrease in building length and an increase in tunnel depth and building weight.

Key Words: Numerical modeling, mechanized tunneling, lining loads, surface buildings, ground stratification, ABAQUS.

A COMPARATIVE FIELD STUDY OF THE BEHAVIOR OF RAMMED AGGREGATE PIERS AND CONCRETE PIERS UNDER UPLIFT LOADS

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Abstract

This paper aims to compare the behavior and design limit parameters of rammed aggregate piers (RAPs) and of cast-in-place drilled concrete piers (CPs) under in situ uplift loading. Usually, RAPs and CPs are two new and common systems for strengthening foundations against uplift loads used in buildings with braced frames. In this research project, two groups of small scale RAPs and CPs were constructed and tested on site. The single piers had a fixed diameter of 135 mm and variable lengths of 300, 550, 650 and 850 mm. The test site was the Bushehr Special Economic Zone, where the testing area was made up of a uniform layer of moist silt; 1.2 meters thick and stiff. The trial piers were constructed and loaded in a linear row at a safe distance from each other. For uplift loading, a mobile reaction beam system, made up of a heavy cart, modular rails and an uplift loaded frame, was utilized. Results show that on average, the measured load and pier deflection at the design limit of RAPs were 1.36 and 1.32 times the corresponding values in CPs, respectively. The behavior of CPs was rigid at various lengths. The behavior of RAPs with slenderness ratios of less than 4 was similar to that of the CPs, and the behavior of RAPs with slenderness ratios of higher than 4 was ductile. There was better agreement between the results of the calculated and measured uplift loads in CPs than in RAPs. The stiffness modulus of both types of pier was the same at different lengths under uplift loads. In general, it seems that these technical merits, including the fact that RAPs (unlike CPs) do not need cement, has convinced engineers to use RAPs under uplift loading and do more research in this area.

Key Words: Rammed aggregate piers, cast-in-place drilled concrete piers, uplift load test, design limit load, pier deflection.

EFFECT OF WEIGHT COMPACTION AND PERCENTAGE OF FLY-ASH ON SELF-COMPACTING CONCRETE STRENGTH, AT DIFFERENT LEVELS

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Abstract

Despite the fact that self-compacting concrete has been used for many years, until now, no-one has carried out any research on the strengthening effect of the weight of concrete at any level. For this reason, employing concrete columns made out of different mixes of self-compacting concrete, a research is conducted. In order to measure the concrete strength at any level, the in-situ friction-transfer method was used. Having examined over 50 mix designs, nine mixes were proved to be self-compacting concrete and, therefore, were used for this investigation. In order to see the effect of the weight of the concrete above the level considered, concrete columns were cast using self-compacting concrete without giving any form of compaction. At specified ages, the hardened concrete columns were cut at 150 mm height intervals. Using the Friction-transfer method, the strengths of concrete at different levels were obtained. In the friction-transfer method, a 50 mm diameter partial core is made using a diamond tipped coring drill. A

Abstracts of Papers in English

INFLUENCE OF SURFACE BUILDINGS AND GROUND STRATIFICATION ON LINING LOADS, APPLYING THE NUMERICAL FINITE ELEMENT METHOD

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Abstract

Urban development and increasing population growth have been accompanied by a considerable growth in mechanized shield tunneling. Commonly, precast concrete segments are used as a tunnel lining, which constitutes the largest portion of tunneling costs. The optimum design of lining that decreases tunneling costs requires an accurate evaluation of loads acting on the lining. In this paper, the effects of ground stratification and geometry, position and weight of the buildings on lining loads are studied. For this purpose, a 3D finite element model is used employing ABAQUS software (Ver. 6.10). The main construction aspects and all main elements of the mechanized excavation are modeled: TBM shield, concrete tunnel lining, support of excavation face, overexcavation, tail gap grouting and progressive hardening of the cement based grout. The geometry of the tunnel, lining segments, the injection grout and surrounding soil properties are adapted from the (under construction) Tabriz urban railway, line 2, project. The results show that ground stratification and building properties have a considerable effect on lining loads, and this effect should be taken into consideration in the design. Based on obtained results for the mentioned case study, surface buildings with 5 and more storeys have a considerable effect on lining loads, especially for shallow tunnels. Also, the geometry of surface buildings influences the internal forces of the lining; increasing both building width and length increases the lining loads. The building width is the most important parameter of the tunnel and surface building interaction; by increasing this parameter, the influence of other parameters increases. Also, by com-