Προς την αναθεώρηση του Ευρωκώδικα 8: Πρόταση νέου συστήματος εδαφικής κατηγοριοποίησης και κατάλληλων συντελεστών ενίσχυσης

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ΠΕΡΙΛΗΨΗ

Η παρούσα έκδοση του Ευρωκώδικα 8 λαμβάνει υπόψη την επιρροή των τοπικών εδαφικών συνθηκών μέσω της χρήσης κατάλληλων φασμάτων ελαστικής απόκρισης που εξαρτώνται, εκτός άλλων, από την εδαφική κατηγορία. Ως κύρια παράμετρος εδαφικής κατηγοριοποίησης χρησιμοποιείται η μέση ταχύτητα στα ανώτερα 30 μέτρα της εδαφικής στήλης ($V_{s,30}$), η οποία, παρά τα πλεονεκτήματα της, έχει αμφισβητηθεί από πολλές πρόσφατες έρευνες. Επιπλέον, ως μοναδική παράμετρος σεισμικής επικινδυνότητας χρησιμοποιείται η ενεργός σεισμική επιτάχυνση σε εδαφικές συνθήκες βράχου, ενώ η μη γραμμικότητα του εδάφους λαμβάνεται υπόψη μόνον για την χρήση διαφορετικών τύπων φάσματος για δύο κατηγορίες σεισμικής δράσης που αντιστοιχούν σε περιοχές χαμηλής και υψηλής σεισμικότητας.

Στην παρούσα εργασία αξιοποιήθηκε μια εκτεταμένη βάση σεισμικών καταγραφών από θέσεις για τις οποίες υπάρχει πολύ καλή γεωτεχνική τεκμηρίωση ως και το σεισμικό υπόβαθρο ($V_s > 800$ m/s), με στόχο την πρόταση ενός νέου συστήματος εδαφικής κατηγοριοποίησης και κατάλληλων συντελεστών εδαφικής ενίσχυσης για κάθε κατηγορία, οι οποίοι εξαρτώνται από την σεισμική ένταση. Το προτεινόμενο σύστημα εδαφικής κατηγοριοποίησης χρησιμοποιεί ως βασικές παραμέτρους το πάχος της εδαφικής απόθεσης και την $V_{s,30}$, ενώ εισάγεται ως συμπληρωματική παράμετρος το σημείο της εδαφικής επιτάχυνσης $V_s$. Προτείνεται η εστίαση στις μικρές ($0.2-0.3s$) και μεσαίες ($1s$) περιόδους και αντίστοιχους συντελεστές εδαφικής επιτάχυνσης για αυξανόμενα επίπεδα σεισμικής έντασης, ώστε να λαμβάνεται υπόψη η μη γραμμικότητα του εδάφους. Η παρούσα εργασία έχει στόχο να συνεισφέρει στην υπό εξέλιξη αναθεώρηση του Ευρωκώδικα 8, καθώς και του αντίστοιχου ελληνικού προσαρτήματος.

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Towards the revision of EC8: Proposal for an alternative site classification scheme and associated site amplification factors

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ABSTRACT

The paper presents an alternative site classification scheme and associated design response spectra, aiming to contribute to the ongoing revision of Eurocode 8 (EC8). The new classification scheme introduces the approximate depth to seismic bedrock, HB, and the fundamental period, \(T_0\), as classification parameters for the estimation of seismic actions in addition to \(V_{s,30}\). The main features of the new seismic design actions are summarized in the use of two anchoring spectral values, for short and intermediate periods, instead of only one of the present version of Eurocode 8 (i.e. PGA), and the scalar intensity variation of site amplification factors to account for soil nonlinearity.

1 INTRODUCTION

Eurocode 8-Part 1 [1] accounts for site effects through the suggestion of appropriate site-dependent elastic design spectra based on different soil classes. The main adopted parameter for site classification in the current version of Eurocode 8 (EC8) is \(V_{s,30}\), i.e. the average shear wave velocity of the upper 30m of the soil profile, calculated from the total time needed for a shear wave to travel these 30m. \(V_{s,30}\) is used along with NSPT blow count, plasticity index PI and undrained shear strength \(S_u\) to define five soil types (A to E), while two extra special ground types (S1 and S2) are also proposed for special soils (i.e. liquefaction prone sites etc). The seismic hazard parameter used in the current version of EC8 to define the elastic response spectra is the effective ground acceleration at rock site conditions (\(V_s\geq800\text{m/s}\)), \(a_g\), amplified by a soil amplification factor, \(S\), which is dependent on the site class to account for local soil and site effects. Elastic response spectra are anchored to \(S\cdot a_g\), and their shapes, defined by the corner periods \(T_B\), \(T_C\), \(T_D\) are controlled by the site classes.

To indirectly account for soil nonlinearity, EC8 proposes different elastic response spectra for two different levels of seismicity and seismic action, Type 1 and Type 2. Type 1 spectra have more energy in long-period motions and are proposed for use in regions having high seismic

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activity and stronger earthquakes ($M_s > 5.5$), while Type 2 spectra are recommended for $M_s \leq 5.5$, having larger normalized spectral amplitudes at short periods.

The use of $V_{s,30}$ as a proxy to seismic amplification has been questioned by several recent works and more specifically for cases of deep, low damping stiff deposits lying on much harder rock [2], for cases of a shallow velocity inversion [3], for sites with velocity profiles which are not monotonically increasing with depth or do not exhibit a strong impedance contrast in the first dozen meters [4] or in basin type structures like Adapazari basin in Turkey [5]. It is therefore more and more being argued that $V_{s,30}$ is not in all cases and site conditions the most appropriate indicator of soil amplification, resulting in the suggestion of alternative or supplementary indicators, such as depth-to-basement (e.g. [6]), average shear wave velocity over depths other than 30 m (e.g. 10-20 m) (e.g. [7]) or predominant site period/ frequency (e.g. [8]), as well as the proposal of alternative site classification schemes (e.g. [8]). Within this context, Pitilakis et al. (2013) [10] proposed a new soil classification scheme appropriate for EC8, based on a comprehensive analysis of a worldwide database of strong ground motion records from sites which dispose a very well documented soil profile (SHARE-AUTH database). The main parameters considered for site classification are the average shear wave velocity of the entire soil deposit, $V_{s,av}$, the approximate thickness of the soil deposit above the seismic bedrock, $H_b$ and the fundamental period of soil deposit, $T_0$, together with appropriate descriptive parameters of the geotechnical conditions. Moreover, following the basic rationale of the current version of EC8, i.e. the use of Type 1 and Type 2 elastic response spectra anchored to effective ground acceleration, Pitilakis et al. (2013) [10] proposed accompanying elastic response spectra for the soil classes of their soil classification scheme based on the conceptual assumption that the general spectral equations of the code should be higher than the median value and closer to the 84th percentile of the spectra of the strong-motion records of the SHARE-AUTH database, in order to account as much as possible for the uncertainties associated with the nature of the problem.

However, the most recent international seismic codes, as NEHRP 2015 [11] in U.S.A., have moved to a more refined definition of elastic response spectra, where seismic hazard is introduced with two parameters, namely $S_s$ (i.e. reference spectral acceleration at short periods) and $S_1$ (i.e. reference spectral acceleration at the vibration period $T = 1$ s), instead of only one (effective ground acceleration) and nonlinearity in ground response is accounted for through a scalar variation of the site amplification factors $F_s$ (for short periods) and $F_v$ (for 1 s) for increasing seismic intensities. Reference national seismic hazard maps in U.S.A. have historically been produced for a site condition of $V_{s,30} = 760$ m/s, a practice which is currently under debate.

In line with the current version of NEHRP, which is summarized in (i) the use of two anchoring spectral values instead of only one (effective ground acceleration) and (ii) the scalar intensity variation of site amplification factors to account for soil nonlinearity, the present study presents a proposal for a new classification scheme and amplification factors, which is an evolution of the recent work by Pitilakis et al. (2013) [10], aiming to contribute to the ongoing revision of Eurocode 8.
2 PROPOSED SOIL CLASSIFICATION SCHEME

Largely inspired from the soil and site characterization scheme initially proposed by Pitilakis et al. (2013) [10], the proposed classification scheme comprises six main soil classes, i.e. A, B, C, D, E and X, with sub-classes for site class B and C according to Table 1. The main classification parameters are the average shear wave velocity of the upper 30 m of the soil profile, $V_{s,30}$, the thickness of the soil deposit, i.e. approximate depth to “seismic” bedrock, $H_b$, and the fundamental period of soil deposit, $T_0$, along with the dominant soil profile description, average shear wave velocity of the entire soil deposit, $V_{s,av}$, and average values of standard penetration test blow count, N-SPT, plasticity index, PI and undrained shear strength, $S_u$. Depth of “seismic bedrock”, $H_b$, is generally defined as the depth below which $V_s$ exceeds 800 m/s. In most cases this is quite difficult to accurately estimate and hence we are referring to “approximate” values. Moreover, for deep rather soft soil deposits, the horizon of an “equivalent” seismic bedrock may be defined with a lower $V_s$ threshold, e.g. 600 m/s. Parameters derived from other field tests like the cone penetration test CPT or pressuremeter may be also used. To obtain $T_0$ and $V_{s,30}$ or $V_{s,av}$, invasive (in-hole measurements) or non-invasive (e.g. surface-waves analysis) techniques at small shear strains are suggested. In case of absence of direct measurement parameters, adequate correlations with SPT and CPT may be applied.

Ranges of $H_b$, $V_{s,30}$, $T_0$ and $V_{s,av}$ for site classes of Table 1 were derived based on statistics from good quality experimental data from the SHARE-AUTH database and when needed from theoretical analyses of representative models of realistic soil conditions [12-13] applying classical statistics. The distribution of moment magnitude $M_w$ and of the geometric mean of the peak ground acceleration values (PGA) of the two horizontal components with epicentral distance $R$ for the records of SHARE-AUTH database used in this study is illustrated in Figure 1a and 1b respectively.
<table>
<thead>
<tr>
<th>Site class</th>
<th>Description</th>
<th>$H_0$ (m)</th>
<th>$V_{s,30}$ (m/s)</th>
<th>$T_0$ (s)</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| A         | - Rock formations  
- Slightly weathered/ segmented rock formations with thickness of weathered layer <5.0 m  
- Geologic formations resembling rock formations in their mechanical properties and their composition (e.g. conglomerates)                                                                                                                                                                                                 | ≥ 800    | ≤ 0.2           |          | For a surface weathered layer with $H$<5m: $V_{s,av} \geq 300$ m/s                                                                                                                                 |
| B1        | - Soft rock formations  
- Formations which resemble soft rock in their mechanical properties (e.g. stiff marls)  
- Very dense sands and gravels  
- Hard and very stiff clays                                                                                                                                                                                                                                                                                  | ≤ 30     | 400-800         | 0.1-0.3  | $V_{s,av} : 400 - 800$ m/s  
N-SPT > 50  
$S_u > 150$ kPa                                                                                                                                                                                   |
| B2        | Formations of very dense sands and gravels and/or very stiff to hard clay, whose mechanical properties increase with depth                                                                                                                                                                                                                                           | 30-60    | 350-500         | 0.3-0.6  | $V_{s,av} : 400 - 600$ m/s  
N-SPT > 50  
$S_u > 150$ kPa                                                                                                                                                                                   |
| C1        | Formations of dense sand and gravels and/or stiff clays, of great thickness                                                                                                                                                                                                                                                                                                                   | > 60     | 350-500         | 0.6-1.0  | $V_{s,av} : 250 - 400$ m/s  
N -SPT > 20  
150 kPa>$S_u>70$ kPa                                                                                                                                                                           |
| C2        | Formations of medium dense sand and gravels and/or medium stiffness clays (PI > 15, fines percentage > 30%) of intermediate thickness                                                                                                                                                                                                                                           | 30-60    | 250-400         | 0.3-1.0  | $V_{s,av} : 300 - 400$ m/s  
N -SPT > 20  
150 kPa>$S_u>70$ kPa                                                                                                                                                                           |
| C3        | Formations like C2 of great thickness                                                                                                                                                                                                                                                                                                                                                 | > 60     | 250-400         | 0.6-1.4  | $V_{s,av} : 200 - 400$ m/s  
N -SPT < 20  
$S_u < 70$ kPa  
The dominant soil formations may be interrupted by layers of very soft clays ($S_u<25$ kPa, $W>40\%$, PI>25) or sands and sandy clays of relatively small thickness (<10m) |
| D         | Recent soil deposits of great overall thickness with prevailing formations being soft to medium thickness clays and/or loose sandy to sandy-silt formations with substantial fines percentage (not susceptible to liquefaction)                                                                                                                                                             | > 60     | 150-300         | 1.4-3.0  | $V_{s,av} : 150-300$ m/s  
N-SPT < 20  
$S_u < 70$ kPa  
The dominant soil formations may be interrupted by layers of very soft clays ($S_u<25$ kPa, $W>40\%$, PI>25) or sands and sandy clays of relatively small thickness (<10m) |
| E         | Shallow soil formations of small thickness, small strength and stiffness, generally classified as category C and D according to its geotechnical properties, which overlie category A formations                                                                                                                                                | < 20     | not applied     | ≤ 0.5    | $V_{s,av} : 150-300$ m/s  
N-SPT < 20  
$S_u < 70$ kPa  
The dominant soil formations may be interrupted by layers of very soft clays ($S_u<25$ kPa, $W>40\%$, PI>25) or sands and sandy clays of relatively small thickness (<10m) |
| X         | Loose fine sandy-silty soils beneath the water table, susceptible to liquefaction (unless a special study proves no such danger, or if the soil’s mechanical properties are improved). Soils near obvious tectonic faults. Steep slopes covered with loose soil deposits. Loose granular or sot silty-clayey soils, provided they have been proven to be hazardous in terms of dynamic compaction or loss of strength. Recent loose landfills Soils with a very high percentage in organic material. Peat and/or highly organic clays (H>3m) and/or very high plasticity clays (H>8m) and/or very thick. soft/medium stiff clays (H>30m). Special soils requiring site-specific evaluations |
Figure 1: Data coverage of SHARE-AUTH database records in terms of (a) Moment Magnitude $M_w$ - Epicentral distance $R$ and (b) Peak Ground Acceleration (PGA) - Epicentral distance $R$. Different colours are representative for different station countries.
3 ELASTIC RESPONSE SPECTRA

In line with the present practice in modern international seismic codes, the seismic hazard is proposed to be described in terms of two parameters, namely $S_{sRP}$ (i.e. the reference maximum spectral acceleration, corresponding to the constant acceleration branch of the horizontal 5% damped elastic response spectrum on site class A) and $S_{1RP}$ (i.e. the reference spectral acceleration at the vibration period $T = 1$ s of the horizontal 5% damped elastic response spectrum on site class A) instead of only one, $a_g$ (i.e. the effective ground acceleration on site class A). $S_{sRP}$ and $S_{1RP}$ should be provided in the National Annex of each European country for the reference return period $T_{ref}$ (e.g. 475 years), depending also on the local seismic hazard. For the horizontal components of the seismic action, the elastic response spectrum $Se(T)$ for 5% damping is defined by the following expressions:

\[
0 \leq T \leq T_A: S_e(T) = \frac{S_S}{F_0} \tag{1}
\]

\[
T_A \leq T \leq T_B: S_e(T) = \frac{S_S}{T_B-T_A} \left[ n \cdot (T - T_A) + \frac{T_B-T}{F_0} \right] \tag{2}
\]

\[
T_B \leq T \leq T_C: S_e(T) = n \cdot S_S \tag{3}
\]

\[
T_C \leq T \leq T_D: S_e(T) = n \cdot \left[ \frac{S_1 T_1}{T} \right] \tag{4}
\]

\[
T \geq T_D: S_e(T) = n \cdot \left[ \frac{S_1 T_1}{T^2} \right] \tag{5}
\]

where $T$ is the vibration period of a linear single-degree-of-freedom system; $S_S$ is the maximum response spectral acceleration (5% damping) corresponding to the constant acceleration range of the elastic response spectrum; $S_1$ is the 5% damping response spectral acceleration at the vibration period $T_1=1$ s; $T_A$ is the short-period cut-off associated to the effective ground acceleration; $F_0$ is the ratio of $S_S$ with respect to the effective ground acceleration; $T_C=S_1 T_1/S_S$ is the upper corner period of the constant spectral acceleration range; $T_B=T_C/\kappa$ is the lower corner period of the constant spectral acceleration range, with $0.05 \leq T_B \leq 0.1$ s, whatever value of $T_C$; $\kappa$ is the ratio of $T_C$ and $T_B$; $T_D$ is the corner period at the beginning of the constant displacement response range of the spectrum; $\eta$ is the damping correction factor, with a reference value of $\eta = 1$ for 5% viscous damping.

Table 2 presents generic values for parameters $T_A$, $\kappa$, $F_0$ and $T_D$. These values are still debated in the sense that for example $F_0$ could be higher (e.g. 2.75) for lower seismicity countries and slightly lower (e.g. 2.3) for the high seismicity ones.

<table>
<thead>
<tr>
<th>$T_A$ (s)</th>
<th>$\kappa$</th>
<th>$F_0$</th>
<th>$T_D$ (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>5</td>
<td>2.5</td>
<td>2 if $S_{1RP} \leq 0.1$ g</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1+10·$S_{1RP}$ if $S_{1RP} &gt; 0.1$ g</td>
</tr>
</tbody>
</table>

The spectral accelerations $S_S$ and $S_1$ are defined as follows:
\[ S_s = F_T \cdot F_B \cdot F_s \cdot S_{SRP} \]  \hfill (6)

\[ S_1 = F_T \cdot F_B \cdot F_1 \cdot S_{1RP} \]  \hfill (7)

where \( F_s \) is the short period site amplification factor, \( F_1 \) is the intermediate period (\( T_1=1s \)) site amplification factor, \( F_T \) is an amplification factor related to topography and \( F_B \) is an aggravation factor related to basin effects (see Section 4).

To account for soil nonlinearity, site amplification factors \( F_s \) and \( F_1 \) for the different soil classes are proposed for distinct values of \( S_{SRP} \) (reference maximum spectral acceleration at rock site conditions). Following the rationale of the Boore et al. (2014) GMPE [14], amplification factors \( F_i \) \( (i=s,1) \) are considered to comprise two additive terms, i.e. a linear component, \( F_{i,lin} \), which is practically independent of the amplitude of shaking, and a nonlinear component, \( F_{i,nl} \), which modifies the linear term in order to decrease amplification for increasing shaking intensity:

\[ F_i = \ln(F_{i,lin}) + \ln(F_{i,nl}), i = s, 1 \]  \hfill (8)

For the linear component, \( F_{i,lin} \), soil amplification factors proposed in [10] for Type 2 (low seismicity) were adopted, which were estimated using a subset of the SHARE-AUTH database, consisting of 715 strong-motion records with surface wave magnitude \( M_s\geq4 \), PGA\( \geq20cm/s^2 \) and usable spectral period \( T\geq2.5s \). For the nonlinear term, \( F_{i,nl} \), we used the nonlinear site amplification model developed by Seyhan and Stewart (2014) [15] and adopted in the Boore et al. (2014) [14] GMPE.

Site amplification factors \( F_s \) and \( F_1 \) were finally estimated for distinct values of \( S_{SRP} \), equal to 0.125, 0.25, 0.5, 0.75, 1.0 and 1.25g as the sum of the linear and nonlinear components. The proposed values for \( F_s \) and \( F_1 \) (Tables 3 and 4) were obtained after adequate rounding. For intermediate values of \( S_{SRP} \), straight line interpolation of the values of \( F_s \) and \( F_1 \) of Tables 3 and 4 is suggested. For the computation of site amplification factors of site class X and for buildings of importance classes III or IV based on the current version of EC8 [1] located on sites classified as D or E, site-specific geotechnical investigation and dynamic site response analyses should be performed.

<table>
<thead>
<tr>
<th>Site class</th>
<th>( S_{SRP} &lt; 0.25 )</th>
<th>( S_{SRP} = 0.25 )</th>
<th>( S_{SRP} = 0.5 )</th>
<th>( S_{SRP} = 0.75 )</th>
<th>( S_{SRP} = 1.0 )</th>
<th>( S_{SRP} \geq 1.25 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>B1</td>
<td>1.30</td>
<td>1.30</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>B2</td>
<td>1.40</td>
<td>1.30</td>
<td>1.30</td>
<td>1.20</td>
<td>1.10</td>
<td>1.10</td>
</tr>
<tr>
<td>C1</td>
<td>1.70</td>
<td>1.60</td>
<td>1.40</td>
<td>1.30</td>
<td>1.30</td>
<td>1.20</td>
</tr>
<tr>
<td>C2</td>
<td>1.60</td>
<td>1.50</td>
<td>1.30</td>
<td>1.20</td>
<td>1.10</td>
<td>1.00</td>
</tr>
<tr>
<td>C3</td>
<td>1.80</td>
<td>1.60</td>
<td>1.40</td>
<td>1.20</td>
<td>1.10</td>
<td>1.00</td>
</tr>
<tr>
<td>D</td>
<td>2.20</td>
<td>1.90</td>
<td>1.60</td>
<td>1.40</td>
<td>1.20</td>
<td>1.00</td>
</tr>
<tr>
<td>E</td>
<td>1.70</td>
<td>1.60</td>
<td>1.60</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 4: Proposed values for intermediate period site amplification factor $F_1$.

<table>
<thead>
<tr>
<th>Site class</th>
<th>$S_{sRP}$ (maximum response spectral acceleration at short period on site class A in g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_{sRP}&lt;0.25$</td>
</tr>
<tr>
<td>A</td>
<td>1.00</td>
</tr>
<tr>
<td>B1</td>
<td>1.40</td>
</tr>
<tr>
<td>B2</td>
<td>1.60</td>
</tr>
<tr>
<td>C1</td>
<td>1.70</td>
</tr>
<tr>
<td>C2</td>
<td>2.10</td>
</tr>
<tr>
<td>C3</td>
<td>3.20</td>
</tr>
<tr>
<td>D</td>
<td>4.10</td>
</tr>
<tr>
<td>E</td>
<td>1.30</td>
</tr>
<tr>
<td>X</td>
<td>-</td>
</tr>
</tbody>
</table>

The values for $F_s$ and $F_1$ proposed in the present study follow in general the same trend as the respective site amplification factors $F_a$ and $F_v$ of NEHRP [11] with the discrepancies between most of the respective soil classes not exceeding 10%. An important exception however is observed for the wide soil class D in NEHRP corresponding to soil classes C1, C2 and C3 in the present proposal; for example, the intermediate-period site amplification factor $F_v$ in NEHRP (equal to 2.4) is about 40% higher than the respective amplification factor $F_1$ for soil class C1 and 25% lower than the one for soil class C3 for $S_{sRP}=0.25g$. This observation further emphasizes the need for a more refined soil classification system than the ones adopted in the current seismic codes including NEHRP.

Figure 2 presents examples of the proposed elastic design response spectra for two different $S_s$, $S_1$ pairs corresponding to $S_{sRP}$ equal to 0.25g and 0.75g (corresponding to $a_g$ equal to 0.1g and 0.3 respectively) for all site classes.

Figure 2: Elastic response spectra for the proposed site classes of Table 1 and two different $S_s$, $S_1$ pairs corresponding to $S_{sRP}$ equal to 0.25g (left) and 0.75g (right).
4 CONCLUSIONS

The paper presents an updated site classification scheme and associated spectral amplification factors aiming to contribute to the ongoing revision of Eurocode 8 Part 1 concerning the evaluation of seismic action. The study is based on a statistical analysis of a comprehensive worldwide database of strong ground motion records from sites which dispose a very well-documented soil down to seismic bedrock ($V_s > 800$ m/s). The proposed classification scheme introduces among the main classification parameters the fundamental period $T_0$ of the site, as it is suggested in several recent works and it has been proposed in the recent work by Pitilakis et al. (2013) [10]. Another important difference from current classification schemes is the introduction of sub-classes, in particular for the general soil category C, which in its current form is too broad representing a wide spectrum of different soil conditions and ground amplification potential. The main features of the proposed amplification factors for the evaluation of the seismic design actions are summarized in the following: (a) use of two anchoring spectral values, for short and long periods, instead of only one of the present version of Eurocode 8 (i.e. peak ground acceleration) and (b) scalar intensity variation of site amplification factors, for each soil and site category, to account for soil nonlinearity. The proposal is in line with the most recent advances in the field and reflects the state-of-art knowledge. Improvement of some points should be expected during the ongoing official discussion at European and National Member States level.

5 ACKNOWLEDGEMENTS

This research has been funded by the European Community’s FP7 Program [FP7/2007-2013] under grant agreement no. 226967 SHARE (http://www.share-eu.org/) and by the project “HELPOS - Hellenic Plate Observing System” (MIS 5002697) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Program "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund). The authors would like to thank all the members of CEN/TC250/SC8 Working Group 4 “Seismic action and site classification” for the fruitful discussions held within this working group.

6 REFERENCES