Amendment No. 5

Israeli Standard SI 413
June 1995
Amendment No. 5
December 2013

Design Provisions for Earthquake Resistance of Structures

The Standards Institution of Israel

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The changes between the SI 413 standard of 1995 including amendments 1, 2 and 3 and between amendment 5 are presented in this document.

The additions are marked in yellow.
The removed text is marked in blue
The explanations are marked in italic

List of Tables

The following was added to the list of tables

<table>
<thead>
<tr>
<th>Number of Table</th>
<th>Name of Table</th>
<th>Clause</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classification of the Soil On-site</td>
<td>202.2.1</td>
<td>23</td>
</tr>
</tbody>
</table>

Table 6 was removed from the list of tables

List of Drawings

Drawing 3 was removed from the list
Amendment No. 5

Foreword

This sentence was added at the end of the first paragraph

The purpose of this standard is to improve the chance, of the structure to which it applies, for adequate resistance, in the following manner:

101. Scope

At the end of the paragraph was added

Note:

As of the day this amendment of published, amendment # 5, in the "Records", the following documents shall be in affect for 2 years:

also

The Israeli Standard SI 413 of the year of 1995, including it amendment no. 1, of the Month of December 1998 and its amendment no. 2 of the Month of May 2004,

also

The Israeli Standard SI 413 of the year of 1995, including it amendment no. 1, of the Month of December 1998, its amendment no. 2 of the Month of May 2004 and its amendment no. 3 of the Month of September 2009,

also

The Israeli Standard SI 413 of the year of 1995, including it amendment no. 1, of the Month of December 1998, its amendment no. 2 of the Month of May 2004, its amendment no. 3 of the Month of September 2009 and its amendment no. 5 of the Year of 2013.

I.e. this amendment enables transition period. In this period the designers will be able to design the seismic resistance of structures, in accordance with SI 413 of the Year if 1995 and its amendments 1, 2, 3 and 5,

Or in accordance with SI 413 of the Year if 1995 and its amendments 1, 2 and 3,

Or in accordance with SI 413 of the Year if 1995 and its amendments 1 and 2,

By the discretion of the design engineer of the structure skeleton.

The previous note at the end of this paragraph was removed

102. References

Was added

Israeli Standards
Amendment No. 5

SI 413, Part 2 - Design for Earthquakes resistance: nonbuilding Structures – General
SI 413, Part 2.1 - Design for Earthquakes resistance: nonbuilding Structures – Steel Storage Shelves Systems
SI 413, Par 2.4 - Design for Earthquakes resistance: nonbuilding Structures – Aboveground Pipes in Industrial Facilities

Was removed from the list:
SI 739 Steel for concrete reinforcement:
SI 893 Round smooth steel bars for concrete reinforcement

Israeli Laws, Regulations and Documents
GSI/15/2009 - Maps of Zones with Potentially High Ground Motions and Amplification: Explanatory Notes
Regulations of Design and Construction (Application for Permits, Conditions and Tolls), 1970 and all their Updates

Foreign Documents
ASCE - 7 – 10: Minimum Design Loads for Buildings and Other Structures

103.6 Low Structure
Defined as one of the following types of structures:

103.6.1 New Low Structure (until otherwise defined in the Design and Construction Regulations)
New, one story or 2 stories residential building in which total built area is smaller than 400 sq. meters and which is located in a region in with \( Z \leq 0.075 \), and which is not built with a soft story made of concrete skeleton or steel skeleton.

103.6.2 Existing Low Structure (until otherwise defined in the Design and Construction Regulations)
One story or 2 stories existing residential structure, the total built area of which is smaller than 400 sq. meters and which is located in a region in with \( Z \leq 0.06 \), which is not built with a soft story and made of concrete skeleton or steel skeleton.

103.15 Response Modification Factor (RMF)
This paragraph added:
The designed level of ductility shall be achieved by a static scheme and reinforcement details that shall ensure the ductile behavior of the structure.
The usage of the RMF is based on the ability of the structure to develop plastic hinges and to maintain all of them together, in a manner that will prevent brittle failure, which may endanger its stability.

103.16 was removed

103.36 Active Fault
Replaces the previous definition

A fault that was defined by the Institution of Geology as an active fault and appears in the updated map of active faults and faults that are suspected as potentially fault active in Israel\(^1\) (see Appendix G).

103.37 Suspected Active Fault
Replaces the previous definition

A fault that is suspected as active according the definition of the Geological Survey of Israel (GSI) but there is no proof that is active and it appears in the updated map of active faults and suspected active faults (see Appendix G).

103.38 Zone of Active Faulting
Replaces the previous definition

A zone of 200 meters on each side of the trace of the fault ('Active Fault' and 'Potentially Fault Active'). This is a zone for which there is a high probability of repeated activity of one of the fault's branches or secondary faults, which were not yet detected.

104. List of Symbols

- **PGA** - The expected horizontal peak acceleration on the ground surface (in units of the gravitational accelerations, g)
- **S\(_a\)** - The spectral design acceleration (in units of the gravitational accelerations, g) (Clause 202.3)
- **S\(_{DS}\)** - The spectral design acceleration considering the influence of the soil conditions on-site in short periods (in units of the gravitational accelerations, g) (Clause 202.2)
- **S\(_{D1}\)** - The spectral design acceleration considering the influence of the soil conditions on-site in period of one second (in units of the gravitational accelerations, g) (Clause 202.2.2)
- **S\(_S\)** - The spectral horizontal acceleration on a rock (Type B soil) for short periods (in units of the gravitational accelerations, g) (Clause 202.1.1)

\(^1\) The definition of the Institution of Geology for an active fault, for the purpose of this standard: a fault that has cut the surface at least once in the last 13,000 years.

Replaces the old footnote
Amendment No. 5

$S_1$ - The spectral horizontal acceleration on a rock (Type B soil) for period of one second (in units of the gravitational accelerations, g) (Clause 202.1.1)

$Z$ - The expected peak acceleration on the face of an exposed rock, which is classified as soil Type B (in units of gravitational acceleration, g)

Replaces the old definition

$\gamma_{rd}$ - Over strength factor due to strain hardening of the steel

$\varepsilon_{eq}$ - Dynamic amplification factor for shear in walls

Standards and documents that are referenced in this standard:

105.1.3 Industrial and storage buildings except for low building and except for those that are discussed in SI 413, Part 2 and all its branches;

105.1.5 Silos (except for the issues that are discussed in SI 413, Part 2 including its branches);

105.1.6 Tanks Removed

105.2.4 Tanks and other nonbuilding structures (to which the branches of SI 413, Part 2 apply);

108 Instruction for additions, for structural changes (structural) and change of purpose for buildings

Replaces the old clause

108.1 General

The instructions in this Clause apply to the design of additions to an existing structure and to the design of a structure, whose purpose was changed (factor of importance and/or loads).

Design of changes in existing structure whose its area was not increased and/or its purpose was not changed, shall be done in accordance with Clause 108.5.

Replaces the old clause

108.2

The design of an addition that is not structurally connected to an existing structure shall be done so that the addition shall meet all the requirements of this standard.

Replaces the old clause

108.3 Additions which are not structurally independent

Replaces the old title

108.3.1 Loads and displacements

The existing structure and the addition to it (hereinafter: "The Entire Structure") will meet the loads and the displacements limits that are required in this standard.

Replaces the old clause
108.3.2 Design

Replaces the old clause and sub clauses

108.3.2.1 The Structural Model

The analysis of the entire structure shall consider the rigidity and strength of the new members as well as the existing members, which participate in the resistance to the seismic load. The analysis will consider structural members, or members which are not structural, which participate in the resistance to the load, even if they were not designed for it. The rigidity and strength of masonry walls, prefabricated members or others, shall be calculated in accordance with the recommendations of the updated professional literature and/or the relevant standardization (Israeli, American or European).

108.3.2.2 Members of the Existing Structure which do not form Part of the Seismic Hardening System

The capability of the structure's members to carry the gravitational loads, combined with the stresses that are developed in them under the influence of the maximum expected movements, in accordance with Clause 403.2.4, while preventing brittle fracture, shall be assured.

108.3.2.3 Design of the Members of the Addition

The design of the members of the addition shall meet the requirements of this standard and the requirements of the relevant standards for the design of new buildings.

108.3.2.4 The Members of the Existing Structure, Which Form Part of the Seismic Hardening System

The members of the existing structure shall endure the loads that are developed in them. In the absence of reinforcement details, which provide sufficient ductility, in order to prevent brittle failure, the bearing capacity of those members shall be assured to carry the stresses that develop in them, without considering the response modification factor (i.e. K=1.0).

108.5 Changes in an Existing Structure without Enlarging its Area and/or Changing of Purpose

108.5.1 General

A change in an existing structure is allowed, as detailed in Clause 108.5.2, without meeting the requirements in Clause 108.3, except for the requirements for the related to the structural model, which are detailed in Clause 108.3.2, provided it was proven by calculation that the change does not reduce the seismic resistance of the original structure.

108.5.2 Allowed Changes

The changes that are allowed in an existing structure, without meeting the requirements of Clause 108.3 are: addition of elevator shafts, improvement of accessibility for handicapped, improvement of anti explosion protection and/or seismic (for the purpose of partial improvement of the resistance of the structure to earthquake, without adding area and without changing the purpose of the structure), improvement of sanitary conditions, improvement of fire safety, addition of light construction, provided its mass does not exceed 2% of the mass of
the original structure\(^2\) and which does not enlarge the eccentricity between its shear center and its center of mass.

Chapter B – Data and Characteristics of the Seismic Action

201. General

201.1 was removed

202.1.1 The Parameters of Seismic Accelerations

Replaces the old clause

The parameters \(Z\), \(S_s\) and \(S_1\) of the response spectrum characterize the responses of structures that are located on soil Type B, due to earthquake with given probability (for example: 2\%, 5\% or 10\%) that stronger earthquake will occur within a period of 50 years.

\(Z\) – The expected peak horizontal acceleration on an exposed rock that is classified as soil type B (in units of gravitational acceleration, \(g\)) (see Clause 202.2.1, Table 1).

\(S_s\) - Horizontal spectral acceleration coefficient of, for 5% damping systems, over exposed rock (type B soil) for short period, but not shorter than \(T_0\), as defined in Clause 202.3

\(S_1\) - Horizontal spectral acceleration coefficient, for 5% damping over an exposed rock (type B soil) for period of one second.

These values are brought in units of gravitational acceleration, \(g\).

These values shall be determined, according to the location of the construction site and the desired probability, out of the acceleration maps (see Appendix H), or the list of cities (see Appendix C). The auxiliary tool described in the web site of The Standards Institution of in Israel can also be used for this purpose.

The design shall be based on the values that relates to the probability of 10\% in 50 years (Return Period of 475 years).

Structures that belong to the importance group A (according to Table 4) shall be analyzed in accordance with the most severe of the following cases (see equation 3 (a – g)):

- \(S_s\) based on probability of 10\% in 50 years (Return Period of 475 years);
- \(S_s\) based on probability of 2\% in 50 years (Return Period of 2,475 years), divided by factor of 1.4.

Structures that belong to the importance group B (according to Table 4) shall be analyzed in accordance with the most severe of the following cases:

\(^2\) The calculation of the mass of the original structure shall be done for the parts of the structure that are above the altitude of the entrance level (i.e.: not including basements, underground parking lots and shelters) and shall include the construction material and the cover.
• $S_a$ based on probability of 10% in 50 years (Return Period of 475 years);
• $S_a$ based on probability of 5% in 50 years (Return Period of 975 years), divided by factor of 1.2.

202.1.2 Proximity to an active fault

Replaces the old clause

a. Structure to which this standard applies shall not be built on a trace of an active fault and 15 meters on its both sides. Geological investigation shall be conducted, the purpose of which is to accurately locate the location of the fault and traces of additional faults, if such exist, up to the border of ‘Region of Active faulting’.

b. Building of structures in the area of ‘zone of active faulting’ shall be accompanied with reasoned geotechnical and geological report which shall clarify that there are no traces of active fault in the building and up to 15 meters from it.

c. Prohibition of construction on a trace of active fault shall not apply to low structures, which are not residential structures, as defined in Clause 103.6, and not to cases in which the ground on-site is not classified as Type A, B or C ground in accordance with Clause 201.2.1. In cases in which the ground is classified as Type D, E or F, except for structures as defined in Clause 103.6 and which are not populated, it shall be proven by a detailed calculation that the structure will meet the requirements of this standard, considering the relative movement that originate in a rock. In addition, it shall be proven that the region / strip of shear in the ground is not in the area of the structure, including its foundation members.

d. All the reports shall be attached to the documents that are submitted to the local authority in order to obtain building permit.

e. Geological investigation shall be conducted for each outline development plan, or to a detailed development plan subjected to the design requirements for earthquakes. The objective of the investigation is to review the existence of active faults and faults that are suspected as active their conclusions shall be an inseparable part of the design documents.
202.1.3 Proximity to suspected active fault

This clause replaces the older one

Construction on a trace of a fault that appears in the faults map of the GSI, as suspected active or in its proximity (see Appendix G), up to distance of 200 meters from each side, requires geological investigation, the objective of which is to accurately locate the location of the fault and to verify that it is not an active Fault. If proofs that the fault is not active are found, the investigation report shall be submitted to the GSI, for approval of the findings.

If the findings are not approved, or in the case that a geological investigation was not conducted, the restrictions that are presented in Clause 202.1.2, regarding an active fault shall apply to the construction in the proximity of the fault.

202.1.4
the number of the clause about slope stability was changed

202.2 Influence of the Ground sections

... and the underground ...³

was added after "soil conditions"

³ according to the soil section" was removed

202.2.1
Sub clause C-5 was removed

D. When the soil profile does not fit exactly to one of the soil types in the table, Soil profile which is the closest to one of them shall be used

Table 1 – Classification of the Ground On-site

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F 202.2.2 was replaced by 202.2.3

Notes to the table:

³ Weighing the parameters that characterize the ground in the top 30 meters shall be in accordance with the formula \( \bar{x} = \frac{\sum_i d_i x_i}{\sum_i d_i} \), where \( d_i \) is the thickness of the layer, \( x_i \) is the parameter that characterize the layer (i.e. \( S_u \), \( N \) or \( V_s \)) and \( \sum_i d_i = 30m \). For example, the velocity of the shear wave in the top 30 meters is \( \bar{V_s} = \frac{\sum_i d_i \bar{V}_{s,i}}{\sum_i d_i \bar{V}_{s,i}} \), where \( V_{s,i} \) is the value of the velocity of the shear wave in sub-layer \( i \) at thickness \( d_i \).
(b) In structures included in importance groups B and C, which are located in a region suspected for exceptional amplifications, as presented in the map of regions suspected in exceptional amplifications (Appendix I) and site specific survey was not conducted, the ground rigidity shall be classified one level higher than the one derived according the criteria in the table (for instance, soil type C shall be classified as soil type D).
Replaces the older table

Table 2 – The factor of The Site in Short Period, $F_s$

<table>
<thead>
<tr>
<th>Type of Soil On-site</th>
<th>Spectral Horizontal Acceleration on Rock (Type B Ground) for Short Period, $S_s$ (Clause 202.1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_s \leq 0.25$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.2</td>
</tr>
<tr>
<td>D</td>
<td>1.6</td>
</tr>
<tr>
<td>E</td>
<td>2.5</td>
</tr>
<tr>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

Replaces the older table

Table 3 – The factor of The Site in Long Period, $F_v$

<table>
<thead>
<tr>
<th>Type of Soil On-site</th>
<th>Spectral Horizontal Acceleration on Rock (Type B Ground) for Period of one Second, $S_1$ (Clause 202.1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_1 \geq 0.1$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.7</td>
</tr>
<tr>
<td>D</td>
<td>2.4</td>
</tr>
<tr>
<td>E</td>
<td>3.5</td>
</tr>
<tr>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

202.2.3 Site Specific Response Survey

Instructions and restrictions about conducting site specific survey are provided in Appendix E.

Site specific survey should be conducted in the following cases:

a. When the soil type was classified as F, according to Clause 202.2.1.

b. For buildings of importance group A (see Table 4) which are located in regions in which, according the map of "Regions that are Suspected for Exceptional Amplifications of Sub-soil" (see Appendix I), exceptional amplifications of sub-soil can be expected due to the existence of very hard base rock or due to basin effect.
Site specific survey can also be conducted in cases in which the soil is classified among A to E soil types. If so, the spectrum shall be determined according to the survey and not according to the tables, provided it meets the restrictions of Appendix E, regarding the reduction of spectral values.

202.3

In clause c. … (see Appendix H) is added after the “the third and the fourth”(…)

202.4

"in percent" was removed

The damping ratio for the calculation of the correction factor $\eta$ for structures higher than 50 meters, with masonry perimeter walls less than 15 cm thick shall not be higher than 3%.

202.5 PGA - Peak Ground Acceleration

If site specific is not conducted in order to define the peak acceleration on the surface, the peak acceleration shall be calculated in accordance with the value of the spectrum at 0 period (intersection with the vertical axis), or according to the following formula:

\[ \text{PGA} = F_a \times Z \]

Where:

- $F_a$ - The site's factor in short periods, as defined in Table 2 (according to the value $S_s$)

203.1

5th bullet - … shall not exceed in more than …50% of the drift…

203.4

To the sentence ended with cracked components will be added "reinforced concrete"

After the paragraph ending with "updated current literature" shall be added:

The rigidity can be determined considering half of rigidity of the non-cracked cut.

If the total contribution of the members that are not part of the designed seismic load carrying system (such as masonry walls or screen walls made of prefabricated concrete) to the horizontal rigidity of the structure is higher than 15% of its rigidity without those members, their contribution to the rigidity of the structure shall be taken into account only in the calculations of its period.

To the sentence "in equivalent static analysis was added:

In equivalent static analysis if the period $T$ was calculated by dynamic analysis the period for the purpose of calculation shall not exceed the value derived for equations 6a, 6b, 6c multiplied by a factor whose value is:

\[ 1.4 \leq (1.8-1.5S_{D1}) \leq 1.7 \]

Note:
The rigidity of masonry walls shall be calculated in accordance to Israeli Standard SI 2413 in the clause that deals with masonry walls (4.4.1), or according to other updated professional literature.

203.5

"According to equation (3)" was replaced by "According to equation (4)"

Foot note 5 was removed

204.1.1

Was added

a. ... the most severe loading

204.2

Was added

b. \( C_d \geq 0.015l \)

\( K \) was added... in accordance with Clause 204.4 was removed

* for structures made of reinforced concrete as presented in table 5. And for steel structures as presented is SI 1225 part 4 standard.

\( S_1 \) - 202.1.1 was updated

If the calculated value of \( C_d \) according to the restriction A, B, C above, is larger than \( \frac{S_d}{K} \) the displacements shall be calculated based on the forces obtained from the calculations according to Clause 302 or 303 and not directly from the values of \( S_d \) in the spectrum.

204.3

Table 4 – Importance factors, \( I \), (Until Otherwise Defined in the Regulations of Design and Construction)

<table>
<thead>
<tr>
<th>A</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Added ... as set by the authorized authority removed &quot;250 people and more ...&quot; 1.2</td>
</tr>
</tbody>
</table>

... 202.1.1 replacing 204.5.1

204.4

For steel structures ... specified in The Israeli Standard SI 1225, Part 4.
Table 5 – Maximum Values...was added....

The table replaces the old table.

<table>
<thead>
<tr>
<th>No.</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>3.0</td>
<td>4.5</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td><strong>removed</strong></td>
</tr>
</tbody>
</table>

**Notes for the Table:**

(a) In irregular structures, with medium and high levels of ductility, the value of the response modification factor shall be reduced by 20%.

(b) Existing structures shall be handled in accordance with the instructions of Clause 108.

Table 6 was removed and replaced by

Values of steel structure see SI 1225, Part 4

Table 7

<table>
<thead>
<tr>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Tanks and water towers was removed 2.0

Unique structures that are discussed in the subdivision of the Israeli Standard SI 413, Part 2 – nonbuilding Structures

As detailed in the tables for reduction factor of in the series parts

Paragraph 204.5.2 was removed

Paragraph 204.5.3 was removed

Chapter C

Table 8: "tanks" was removed
301.3 Analysis types

| Table 9
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a.</strong> &quot;groups&quot; was replaced by &quot;group&quot; importance A, B, C was replaced &quot;C&quot;. … 80 m was replaced by 42m</td>
</tr>
<tr>
<td>T ≤ (3.5T_s ; 2 sec) replaces the old period restriction</td>
</tr>
<tr>
<td><strong>b.</strong> replaces d</td>
</tr>
<tr>
<td>old b removed</td>
</tr>
<tr>
<td>Modal analysis</td>
</tr>
<tr>
<td>Advanced analyses</td>
</tr>
</tbody>
</table>

302.0 Analytical Model

The structure and its members shall be designed to endure forces and displacements that meet the following combinations of loads:

a. 100% of the design seismic forces in direction X with 30% of the design seismic forces in direction Y and 30% of the design seismic forces in direction Z.

b. 30% of the design seismic forces in direction X with 100% of the design seismic forces in direction Y with 30% of the design seismic forces in direction Z.

c. 30% of the design seismic forces in direction X with 30% of the design seismic forces in direction Y with 100% of the design seismic forces in direction Z.

Where directions X and Y are horizontal and perpendicular to each other and direction Z is the vertical axis.

The shaking in direction Z shall be considered only in the required cases, in accordance with Clause 204.1.2.

302.4

The following equations replace the older once:

(15) \[ P_v = \pm \frac{2}{3} \times \text{PGA} \times W \]

(16) \[ P_v = W_{\text{min}} (1 - 1.5 \times \text{PGA}) \geq 0.5 \times W_{\text{min}} \]

(17) \[ P_v = W[1 \pm \frac{2}{3} \times \text{PGA}] \]

Remove - S

Remove - Z

PGA - The expected peak horizontal acceleration on the surface (in gravitational acceleration units g).

302.6
Amendment No. 5

**e - Before eccentricity was added "accidental"**

"According to equation (18)" was replaced by "(d and e)"

"movement" was replaced by "accidental eccentricity"

**In equation (19) was added**

In this equation:

302.7

$\Delta_{el,1} -$ after seismic elastic calculation was added "including the influence of torsion"

K - at the end of the sentence was added "or in accordance to SI 1225, Part 4"

at the end of the clause

The story's stability factor $\delta_i$ shall not be larger than 0.2 in any story. **Replacing the older sentence**

303.2

**The end of the paragraph was replaced by:**

When the uncoupling condition does not exist the spatial movements (3 dimensional) of the structure shall be considered.

The structure and its members shall be designed to resist forces and movements that meet the following combinations of loads:

a. 100% of the design seismic forces in direction X with 30% of the seismic design seismic forces in direction Y with 30% of the design seismic forces in direction Z.

b. 30% of the design seismic forces in direction X with 100% of the design seismic forces in direction Y with 30% of the design seismic forces in direction Z.

c. 30% of the design seismic forces in direction X with 30% of the design seismic forces in direction Y with 100% of the design seismic forces in direction Z.

Where directions X and Y are horizontal and perpendicular to each other and direction Z is the vertical axis.

Consideration of shaking in direction Z shall be done only in the required cases, in accordance with Clause 204.1.2.

303.4 **Equations 26 and 27 were removed**

$C_{dm} -$ ... with the restrictions in Clause 204.2 was added at the end of the sentence.

The last paragraph was replaced by:

For additional information regarding the inspection of the analytical model for of the designed structure, see Appendix F.
Amendment No. 5

µ ... was removed

303.5
"as explained in the monoculture" was removed

303.6
At the end of the paragraph was added: "In non-planar model, in which the mass of the story was modeled in a manner that considers the rotational inertia around a vertical axis, the accidental eccentricity shall not be multiplied by the factor $A_T$.

303.7
Are calculated according to clause 302.7 but drift capacity the story's stability factor $\theta_i$ shall be calculated .... K – Response modification factor as it appears in the suitable table 5, 6, 7 add detailed in SI 1225, Part 4

The last line in the paragraph was replaced by

The story's stability factor $\theta_i$ shall not exceed 0.2 in any story.

304 in the last sentence "recommended that" was removed

305.1
At the end of the second paragraph was added: "(see details in Clause 108.3.2.2)".

306.
After "in this structure" was added "in the flexible or weak story"

The "load carrying elements" was replaced by "the columns"

"designed to transfer seismic loads" was removed

After "amplified design force" was added:

"which is multiplied by 1.0*K. The design and the reinforcement detailing shall be done according to the instructions of Clause 403.4. The design of the walls structure shall include the adequate reinforcement suitable to the sensitive region in those stories."

Chapter D

401
After "and equations" (5), (6) was removed

402.1
In the first sentence "concrete with light aggregate" was removed
Table 10 - ... in the various ductility levels

<table>
<thead>
<tr>
<th>removed</th>
<th>removed</th>
<th>removed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least by B-30 replaces &quot;B20&quot;</td>
<td>At least B20 replaces &quot;B15&quot;</td>
</tr>
</tbody>
</table>

Footnote 7 is missing

403.2.2
K- "or table 6" was removed

403.2.3
"not cracked concrete section" was replaced by "cracked concrete section"

403.2.7
Limited absolute horizontal acceleration
In structures that belong to importance group A, in which there are systems that are sensitive to accelerations and are supposed to function after earthquake, it is recommended to limit the absolute accelerations in the structure in accordance with the limitations of the sensitive equipment, in accordance with the requirements of the purchaser / manufacturer of the equipment.

403.3.2.3
Before "the part of the concrete in carrying the shear" shall be added
- When the columns are in compression, the concrete part in carrying the shear...

404.1
In table 17 in the row "the upper levels", "404.2.2" was removed

404.2.1
In sub clause (a) "(redistribution)" was removed
After sub clause (b) "when the structure is calculated using equivalent static analysis" will be removed
After "drawing straight line between the maximum moment at the base of the wall (A)", "based on M_d," shall be added
At the end of the clause shall be added:

Note:
If the bending capacity, M_u, at the base of a given wall that is designed to develop plastic hinge is larger by more than 25% of it's design moment, M_d, it should be verified that other plastic hinges shall not develop along
Amendment No. 5

its height in section that were not designed for it. Alternatively, one can carry out repeated design with new response modification factor, which is valid only for the wall and its base, which has the value: \( k \frac{M_d}{M_{d0}} \geq 1 \).

404.2.2

The second and the third bullets shall be replaced by

- When a structure is calculated by equivalent static analysis at low level of ductility, the calculated shear force in the hardening shear wall should be amplified as follows:

In a building up to 5 stories, it should be multiplied by dynamic amplification factor according to equation (70) below:

\[
\omega = 0.9 + 0.1n
\]

(70)

In a building higher than 5 stories, it should be multiplied by dynamic amplification factor according to equation (71) below:

\[
\omega = 1.2 + 0.04n
\]

(71)

Subject to the constraint: \( \omega \leq 1.5 \)

Where:

- \( \omega \) - dynamic amplification factor
- \( n \) - number of the stories

The shear force that acts on the wall in the higher ductility levels should be multiplied by the dynamic amplification factor of \( \epsilon_{eq} \) according to the equation:

\[
\epsilon_{eq} = k \left[ \frac{(\gamma_{RD} M_u)}{R M_d} \right]^2 + 0.1 \left( \frac{S_{DS}}{S_a(T)} \right)^2 \leq K ; \geq 1.5
\]

(72)

In which:

- \( K \) - Response modification factor
- \( \gamma_{RD} \) - Over strength factor due to strain hardening of the steel: in absence of accurate data, the value of 1.2 can be used.
- \( M_u \) - Bending capacity moment at the base of the wall, considering the actual pressure force and the reinforcement (according to the Israeli Standard SI 466, Part 1)
- \( M_d \) - The Calculated design moment in the base section of the wall (including multiplication by the factor \( \nu \) if required)
- \( S_{DS} \) - Spectral design acceleration coefficient considering the influence of the ground conditions on-site in short period
- \( T \) - Basic period of the structure in the considered direction
- \( S_a(T) \) - Spectral design acceleration coefficient at the basic period of the structure

Note:
When the walls in the direction of the load are not similar, then the more flexible walls (for bending) tend – after yielding of the other walls – to carry larger shear forces than the expected according to their rigidity or relative strength.

Foot note 9 is missing

404.2.4.3

After the sentence "..to each side of the wall (figure 16)"; "without participation of the reinforcement section and cracking and the concrete" was removed

After Figure 16 was added

The length of the sensitive region shall not be less than 15% of the length of the wall (l_w) and will be greater than 1.5 times its thickness

The thickness of the wall in the sensitive region shall not be less than 200 mm and not less than the height of the story divided by 15.

404.2.5.1

Replacing the older equation:

\[ V_d \geq b \cdot d \cdot f_{cd} \]

\( f_{cd} \) - was removed

\( f_{cd} \) - the design strength of the concrete in tension

\( d \) - the active height of the section of a tie beam

Chapter E

Seismic design of steel skeleton systems shall be made according to the Israeli Standard SI 1225.

Chapter F

602.1

"(… 202.1.4) replaces "202.1c"

603.1

\( \frac{K_h}{PGA} = 0.86 \left( \frac{PGA}{D} \right)^{1.5} \leq 1.5 \) replaces the older one

PGA replaces \( Z \)

603.2

Added at the end of the paragraph… \( k_h = 1.5 \cdot PGA \)
Amendment No. 5

603.4

\[ \theta - \text{Calculated according to equation (87), which considers } k_h = 1.5 \text{ PGA (replaces 1.5Z)} \]

604.1

Replaces the old equation

\[ F_p = R_p \times \text{PGA} \times W \times I \]

PGA – replaces \( Z \)

Added:

\( I \) - Importance Factor of the structure

Chapter H

803.

In the sentence after: "\( h_w \) – the wall height":

"using elastic linear calculation" shall be replaced by: "as linear strain"

Following …(figure 16). "without participation of the reinforcement section and without considering the concrete cracking" shall be removed

Appendix B – Map of Horizontal ground accelerations

Horizontal ground accelerations according to their location on the map of Israel appear in Appendix H and for information only in the web site of the Standards Institution of Israel. A list of the ground accelerations of the cities in the country appears in Appendix C.

Appendix C – List the Israel cities and their Ground Accelerations (the list was updated)

(Normative)

<table>
<thead>
<tr>
<th>City</th>
<th>2@5@50years</th>
<th>5@5@50years</th>
<th>10@5@50years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S(_1)</td>
<td>S(_s)</td>
<td>Z</td>
</tr>
<tr>
<td>Haifa</td>
<td>0.13</td>
<td>0.70</td>
<td>0.28</td>
</tr>
</tbody>
</table>
Appendix D – Values of Design Shear Strength to be used in equations (73), (74), (75)

(normative)

Table D-1 – Values of $\tau_{dl}$ (MPa)

<table>
<thead>
<tr>
<th>Longitudinal reinforcement ratio</th>
<th>Values of Strength $\tau_{dl}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type of Concrete</td>
</tr>
<tr>
<td></td>
<td>C-20</td>
</tr>
<tr>
<td>$\leq 0.005$</td>
<td>0.8</td>
</tr>
<tr>
<td>0.01</td>
<td>1.0</td>
</tr>
<tr>
<td>$\geq 0.01$</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Appendix E – Instructions for Performing Site Specific Response Survey as required by Clause 202.2.3

(Normative)

E-1. Analysis of the Site's Response

The requirements of Clause E-1 should be met when conducting a site specific response analysis as required by Clause 202.2.3. The results of the analysis shall be documented in a report.

E-1.1. Bedrock shaking

The response spectrum of the bedrock shall be created for earthquake with the required probability (for instance 2% or 10% probability in 50 years), considering the requirements presented in the body of this standard or in Clause E-2. If the analysis described in Clause E-2 is not conducted, the bedrock response spectrum at the required probability shall be derived based on the assumption of a site with soil type B (Table 1). If the rock on-site is of Type A ground, the bedrock spectrum response shall be adjusted, using the site’s coefficients, which appear in tables 2 and 3 in the standard, unless the usage of other site factors can be justified. At least five time histories of horizontal ground motion acceleration, which document actual seismic events, or at least 15 time histories that document simulated events shall be selected among the events that have magnitude and distance from a fault that fit the magnitude and the distance from the fault of the event that dominate the site. For each record the accelerations shall be scaled, such that in average, the response spectrum for each of the documented events shall be, approximately, at the level of the response spectrum as defined above, for the range of the substantial periods for the response of the structure on-site.

E-1.2. Creating Model for the site conditions
A site response model shall be created, based on the waves shear velocities at low strain level, equivalent nonlinear relations or linear relations between the shear stress and the strain and the specific gravity of the ground's samples. The shear waves velocities shall be determined based on measurements in the inspected site, or according to measurements of similar ground samples at the vicinity of the site. The equivalent nonlinear or linear relations between the shear stress and the strain and also the specific gravity shall be chosen based on laboratory tests or according to known relations for similar ground samples. Estimation of the uncertainties regarding the characteristics of the ground shall be carried out.

The soil model that will be used in the site response survey shall include all the layers from the surface to the hard bedding that characterize the investigated region (bedrock). The accurate definition of this hard bedding (limestone, dolomite, basalt, etc.) varies in accordance with the various geologic conditions of Israel and its depth can reach hundreds of meters. When conducting the investigation, a geologist, who is familiar with the geologic structure of the underground in the area should be consulted. For regions that are suspected for exceptional sub-soil amplifications, the hard bedding that may create exceptional amplifications is defined in the report of the Geological Institute (GSI) (GSI/15/2009).

When the hard bedding is too deep to obtain information on the thickness of the layers and retrieving their physical characteristics in the bottom part of the soil section is not practical, information from close-by drills can used to estimate the thickness of the layers that were not drilled and their composition and accordingly assess their physical characteristics. In that case estimation of uncertainties of the layers thickness shall be carried out. The response spectrum and the ground shaking records created according to Clause E-1 shall be adjusted to the type of ground that was set as the hard bedding, using the site's coefficient listed in Tables 2 and 3 in this standard.

**E-1.3. Analysis of the site response and the calculations results**

The bedrock shaking records shall be used as input for the ground profile, assuming that they are vibration of the outcrop. The ground profile response and the shaking records at the ground surface shall be determined using adequate calculation method, which relates to the nonlinear characteristics of the ground in nonlinear manner or in equivalent linear manner. The relations between structure response spectrum (with 5% damping) at the ground surface shaking and the outcrop shaking which is used as input to the soil section(with 5% damping) shall be calculated as well. The design spectrum on the surface of the ground shall not be lower than the response spectrum of the outcrop multiplied by the average of the spectral relations between the ground surface response spectrum of the bedrock response spectrum (for each period separately), which is retrieved from the site's response analyses. The recommended ground surface shaking obtained from the analysis, shall relate to the sensitivity of the response to the uncertainty of the characteristics of the soil, the depth of the model and the motions that serve as input.

**E-2. Analysis of the Influence of the ground motions**

The requirements of Clause E-2 shall be met when analysis of the influences due to ground motions is carried out. In the framework of the
analysis, the regional tectonic characteristics, geologic data and the seismic activity, the expected rate of return of earthquakes in the faults and in known source regions and their maximum expected magnitudes, the attenuation characteristics of the ground motions, the influence of ground motion close to their source regions – as much as such that influences exist – on the ground motions as well as the influences of the subsoil conditions on-site shall be considered. The characteristics of the subsoil conditions on-site shall be considered either by using attenuation relations that represent the local and regional geologic conditions or by implementing the requirements of Clause E-1. The analysis shall include updated interpretation of seismic activity, including uncertainties in using model and parameters for sources of seismic activity and soil shaking. The analysis shall be documented in a report.

E-3. The design response spectrum limitations

For each required probability, the spectral acceleration $S_a$, which is obtained from the analysis of the site response at any period, shall not be smaller than 80% of the one that is calculated in accordance to Clause 202.

In sites in which the soil is of type $F$, for which site's analysis response is required according to Table 1, the spectral acceleration for design, at any period, shall not be smaller than 80% from the one which is required for sites that are classified as soil type $E$.

E-4. Parameters of the Design Acceleration

When site response analysis is conducted, in order to determine the the ground vibrations, in accordance with Clause E-3, $S_{DS}$ shall be taken as the spectral acceleration $S_a$ that is obtained from the response spectra that are specific to the site at period of 0.2 seconds, provided that this value shall not be smaller than 90% of the value of the peak of the spectral acceleration $S_a$ at any period that is longer than 0.2 seconds. The value of $S_{D1}$ shall be taken as equal to the higher between the values of the spectral acceleration $S_a$ at period of one second, or twice the value of the spectral acceleration $S_a$ at period of 2 seconds.

Appendix F – Checking the Analytical Model of the Designed Structure

(For information only)

In case when the total shear force at the base obtained from a modal analysis, is smaller than $0.85F_H$, it is recommended to reconsider the adequacy of the analytical model for the designed structure.

$F_H$ - Total horizontal design load, which is obtained by equivalent static analysis using equations (7) and (12) in this standard considering the limitations of Clause 204.2
Appendix G – Map of Active Faults and Suspected Active Faults (Normative)

Appendix H – Maps of the Parameters of the Seismic Accelerations (Normative)

Figure H-1. Map of $S_1$ for return period of 475 Years (10% in 50 years), $V_{S30}=760$ m/s Type B ground
Amendment No. 5

Figure H-2. Map of $S_S$ for return period of 475 Years (10% in 50 years), $V_{s30}=760$ m/s Type B ground

Figure H-3. Map of $Z$ for return period of 475 Years (10% @ 50y)

Figure H-4. Map of $T_L$ for return period of 475 Years (10% @ 50y)

Figure H-5. Map of $S_1$ for return period of 975 Years (5% in 50 years), $V_{s30}=760$ m/s Type B ground

Figure H-6. Map of $S_S$ for return period of 975 Years (5% in 50 years), $V_{s30}=760$ m/s Type B ground

Figure H-7. Map of $Z$ for return period of 975 Years (5% @ 50y)

Figure H-8. Map of $T_L$ for return period of 975 Years (5% @ 50y)

Figure H-9. Map of $S_1$ for return period of 2,475 Years (2% in 50 years), $V_{s30}=760$ m/s Type B ground

Figure H-10. Map of $S_S$ for return period of 2,475 Years (2% in 50 years), $V_{s30}=760$ m/s Type B ground

Figure H-11. Map of $Z$ for return period of 2,475 Years (2% @ 50y)
Figure H-12. Map of $T_L$ for return period of 2,475 Years (2% @ 50y)

Appendix I – Map of Regions that are suspected for Exceptional Amplifications of Sub-soil
(Normative)