TECHNICAL CHAMBER OF CYPRUS

DATE OF ORIGINAL PUBLICATION: APRIL 2021
Edition: **OCTOBER 2023 (REV 05)**

RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS

(R.A.V.I.F.)

ISBN 978-9925-8078-1-9

1. INTRODUCTION

Following the latest amendment of the "Regulation of Energy Performance of Buildings Law", article 4-(2)(b) has been added, which for the first time, introduces the obligation of a building's owner to appoint a licensed designer (Engineer) to prepare a report on the assessment of the building's load-bearing structure for the cases described below. This paragraph is quoted in full below, translated in English.

"(b) For the purposes of addressing issues related to intense seismic activity prior to a major scale renovation, the owner of a building or building unit whose building permit was issued before 1994 shall appoint a licensed designer (Engineer) who shall prepare a structural assessment report, in accordance with the Eurocodes in force, on the state of the load-bearing structure of the building and its estimated life cycle, accompanied by any recommendations regarding the building's structural upgrading."

Based on the above provision of the Law, the owner is subject to the specific obligation if:

1. The building permit was issued before 1994.

2. The building will undergo a major scale renovation.

"Major scale renovation" is defined in the Regulation of Energy Performance of Buildings Law and *means the renovation of a building where more than 25% of the surface of the building envelope undergoes renovation.*

In addition, according to the Regulation of the Energy Performance of Buildings (Minimum Energy Performance Requirements) Decree of 2020 (A.R. 121/2020), ***"renovation of the building envelope"*** *means the replacement of a building's element that is part of the building envelope.*

Based on the above, ETEK has proceeded to the preparation of the **Rapid Assessment and Visual Inspection Form for the Load-bearing Structure of Existing Buildings (R.A.V.I.F.)**. Particularly, R.A.V.I.F. can be utilised for the carrying out of visual checks and rapid base shear check for buildings, as part of the above requirement of the Regulation of the Energy Performance of Buildings Laws of 2006 up to 2020 (Article 4.(2)(b)) and the relevant requirement of the "Save - Upgrade for Households" Grants Scheme, for cases that concern up to two-storey buildings (including the "pilotis" (ground level with significantly less infill walls than the floors above usually used for parking)).

It is emphasised that this form does not apply to buildings with more than two storeys (including the "pilotis"). It also does not apply to Public Use buildings, regardless of the number of floors of these buildings.

In cases of buildings with more than two storeys (including the "pilotis"), but also in the case of all Public Use buildings, it is compulsory to implement the relevant provisions of Eurocode 8: Part 3 and of the corresponding National Annex. For the determination of the reference peak ground acceleration value, the values provided in Tables A1-3 of Cyprus National Annex of Eurocode 8-Part 3 shall be used.

It is highlighted that carrying out inspections and visual checks on the load-bearing structure of a building and or the carrying out a base shear check is not equivalent to assessing the load-bearing capacity and/or structural capacity of the building, which, if required, should be carried out according to the requirements of Eurocode 8, Part 3 (CYS EN 1998- 3:2005).

It is noted that, although the relevant provision of the "Regulation of the Energy Performance of Buildings Law" applies only to buildings whose building permit was issued before 1994 and which are subject to major scale renovation, ETEK recommends that it is implemented to all buildings whose building permit was issued before 1994, regardless of whether they are subject to a major scale renovation.

The present form (R.A.V.I.F.) has been proposed by the Ad-hoc Working Group for the preparation of a report for the assessment of the load-bearing structure of buildings within the scope of Article 4(2)(b) of the Regulation of the Energy Performance of Buildings Laws of 2006 up to 2020, for up to two-storey buildings (including the "pilotis").

The development of the form is intended to serve as a tool for ensuring the minimum basic requirements for the protection of the safety of buildings' users and the public, in the context of the aforementioned framework.

Members of the Working Group, Civil-Structural Engineers, who have prepared the Rapid Assessment and Visual Inspection Form for the Load-bearing Structure of Existing Buildings (R.A.V.I.F.):

- **Platonas Stylianou (Coordinator)**
- **Andreas Theodotou (Member)**
- **Nikolas Kyriakidis (Member)**
  Working Group Support and Editing: Lydia Mina

The Working Group used the Visual Inspection Form (V.I.F.) as a basis for its work, which is part of the "Methodology for the Regular Inspection of Buildings", which has been developed and published by ETEK.

For the purpose of its revision (September 2022 and January 2023), the form has been processed and revised by the ETEK "Regular Inspection of Structures" Scientific Committee (2020-2023).

2. CARRYING OUT BUILDING INSPECTIONS BASED ON THE RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS

Guidelines for the completion of the Rapid Assessment and Visual Inspection Form for the Load-bearing Structure of Existing Buildings (R.A.V.I.F.) are given in Annex 1 of this document.

Note: If it is concluded that identified damages/issues are deemed to be of concern and that inclusion to the Grant Scheme is not recommended, then the carrying out of second-level preliminary assessment of the seismic vulnerability of the building and possibly tertiary assessment (assessment and retrofitting of building in accordance to Eurocode 8 Part 3) is required. It is also recommended that in the aforementioned cases, the necessary remedial measures are taken prior to the carrying out any work for the upgrading of the energy performance of the building.

FORM No.: .....
(R.A.V.I.F.)

RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

(October 2023 - Rev 05)

SECTION A: BUILDING IDENTITY

1. DISTRICT: .....
2. MUNICIPALITY/COMMUNITY: .....Sheet/Plan: ..... Block: ..... Parcel: .....
3. ADDRESS: .....
..... P.C. ..... Tel.: .....
4. COMPLEX: ..... 4a. BUILDING: .....
4b. GEOGRPAPHICAL POSITION OF BUILDING (COORDINATES): X:..... Y:.....
5. BUILDING USE: Initial ..... Current .....
6. USER: .....
7. OWNER: .....
8. CONTRACTING AUTHORITY: .....

SECTION B: TECHNICAL INFORMATION OF THE BUILDING

9. NUMBER OF FLOORS: ..... NUMBER OF BASEMENTS: .....
10. FLOOR PLAN AREA: .....
11. TOTAL BUILT AREA: .....
12. YEAR OF DESIGN: .....
13. YEAR OF CONSTRUCTION: ..... 14. YEAR OF LAST ADDITION/ EXTENSION: .....
15. AVAILABILITY OF STRUCTURAL DESIGN / STRUCTURAL DRAWINGS.... YES ☐ NO ☐ *
15a. AVAILABILITY OF GEOTECHNICAL STUDY
OR THE GEOTECHNICAL CHARACTERISTICS OF THE SUBSOIL ..... YES ☐ NO ☐
16. IS THE BUILDING CLASSIFIED AS LISTED? ..... YES ☐ NO ☐
17. HAS THE BUILDING BEEN REPAIRED/STRUCTURALLY UPGRADED? ..... YES ☐ NO ☐
17a. IF YES, FOR WHAT REASON AND WHEN: .....
.....
18. IMPACT IN RELATION TO ADJACENT STRUCTURES: YES ☐ NO ☐
IF YES, PLEASE SPECIFY: .....

*Additional inspection is required using the V.I.F. and R.V.S.B. forms.

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RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

SECTION C: ELEMENTS OF ISNPECTION

19. EXTERIOR

		YES	NO	IF YES, PLEASE ASSESS ** I	II	III
i.	Damage to beams, slabs, cantilevers	☐	☐	☐	☐	☐
ii.	Deflection of beams, slabs, cantilevers	☐	☐	☐	☐	☐
iii.	Damage to columns / shear walls	☐	☐	☐	☐	☐
iv.	Severe damages to walls	☐	☐	☐	☐	☐
v.	Settlement /Displacement	☐	☐	☐	☐	☐
vi.	Condition of Concrete	Good ☐	Moderate ☐	Poor ☐ *		

Comments/Observations:

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20. INTERIOR

		YES	NO	IF YES, PLEASE ASSESS ** I	II	III
i.	Damage to beams, slabs, cantilevers	☐	☐	☐	☐	☐
ii.	Deflection of beams, slabs, cantilevers	☐	☐	☐	☐	☐
iii.	Damage to columns / shear walls	☐	☐	☐	☐	☐
iv.	Severe damages to walls.....	☐	☐	☐	☐	☐
v.	Settlement /Displacement	☐	☐	☐	☐	☐
vi.	Condition of Concrete	Good ☐	Moderate ☐	Poor ☐ *		

Comments/Observations:

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Note: In cases where damages identified and deemed to be concerning (III), it is required that further inspections, as well as a new study, are carried out, or it is recommended that the necessary measures are taken before the execution of any work for the upgrading of the energy performance of the building.

* Additional inspection is required using the R.V.S.B. form.

**** I: Insignificant II: Not concerning III: Concerning**

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RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

SECTION D: STRUCTURAL ELEMENTS OF STOREY LEVELS /ROOF STRUCTURE **

21. TYPE OF STOREY LEVEL/ROOF STRUCTURE — Timber ☐ Steel ☐ Reinforced Concrete ☐ Other ☐

22. BEARING OF STOREY/ROOF STRUCTURE — Satisfactory ☐ Unsatisfactory ☐ *

23. NODES / CONNECTIONS / DIAPHRAGM FUNCTIONALITY — Satisfactory ☐ Unsatisfactory ☐ *

24. DEFLECTION — NO ☐ YES ☐ *

* There are visually apparent problems and the carrying out of structural assessment is required.

** Ensure that adequate and safe access is provided to the Inspecting Civil Engineer.

SECTION E: CHECKS

25. Rapid base shear check - the check should be performed in both horizontal directions of the structure.

A. Determination of seismic demand V_{req}

$$V_{req} = M \times S_d(T)$$

M: calculated mass of the structure for seismic load combination

S_d (T): to be calculated from the corresponding design spectrum of EC8-1 selected on the basis of ground type classification and calculated for behaviour factor of q=2.0. Note that for buildings whose building permit was issued after 1986, the value of the behaviour factor may be higher than 1.5 (up to 2.0) based on the Engineer's judgement. For the calculation of the fundamental period of vibration T of a single-degree-of-freedom linear oscillator, use the relationships given in EC8-1. The value of reference peak ground acceleration shall be selected from Tables A1-3 of Annex A of National Annex of EC8, Part 3.

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RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

SECTION E: CHECKS (Continued)

25. Rapid base shear checks (Continued)

B. Determination of shear resistance V_{R0}

$$V_{R0} = 0.8 \times \sum V_{R,column}$$

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$$V_{R0} = 1.0 \times \sum V_{R,shear\ wall}$$

$$V_{Rc,s} = \frac{A_{sw}}{s} \times z \times f_{ywd}$$

$$V_M = \frac{2M_R}{L_{cl}},\ M_R = \mu b h^2 f_{cd}$$

(μ from a corresponding interaction diagram)

$$V_{R,column} \text{ή } V_{R,shear\ wall} = \min(V_{RC,s}, V_M)$$

Is the base shear check $\boldsymbol{V_{R0} > V_{req}}$ satisfied? YES ☐ NO ☐

FORM No.: .....

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RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

SECTION F: OBSERVATIONS/GENERAL COMMENTS/TECHNICAL REPORT

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Disclaimer:

Completion of this form and recording of data and/or results, should be carried out with the required care and/or ordinary due diligence. The form and/or its contents are the sole responsibility of the individual on behalf of which they are recorded and their validity and/or legality is not checked by the Scientific and Technical Chamber of Cyprus (ETEK).

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(R.A.V.I.F.)

RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

SECTION G: FINDINGS *(Delete as applicable)*

Based on all of the above sections, there are apparent / there are no apparent areas of concern in the building and it meets / it does not meet the requirements for inclusion in the Grant Scheme and it is recommended / it is not recommended that measures are taken prior to carrying out any work for upgrading the energy performance of the building and that further inspections are carried out at the building.

Note: It is highlighted that carrying out inspections and visual checks on the load-bearing structure of a building and carrying out a base shear check is not equivalent to assessing the load-bearing capacity and/or structural capacity of the building, which if required should be carried out in accordance with the requirements of Eurocode 8, Part 3 (CYS EN 1998-3:2005).

27. INFORMATION OF INSPECTING CIVIL ENGINEER:

1. SIGNATURE: .....
2. NAME: .....
3. ETEK Member Register Number: .....

28. DATE OF INSPECTION: .....

SECTION H: DECLARATION BY THE OWNER/AUTHORISED REPRESENTATIVE OF THE OWNER

I, the undersigned ....., owner/authorised representative of the owner, declare that I have received a copy of this form, have studied and have understood its contents and the various findings will be taken into account in the building's maintenance program.

Signature .....

(Name) .....

The inspection and completion of the R.A.V.I.F. form is necessary under 4.(2)(b) of the Regulation of the Energy Performance of Buildings Laws of 2006 up to 2020 for up to two-storey buildings.

ANNEX 1

INSTRUCTIONS FOR THE COMPLETION OF THE RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

October 2023

INSTRUCTIONS FOR THE COMPLETION OF THE RAPID ASSESSMENT AND VISUAL INSPECTION FORM FOR THE LOAD-BEARING STRUCTURE OF EXISTING BUILDINGS (R.A.V.I.F.)

General

The **Rapid Assessment and Visual Inspection Form for the Load-Bearing Structure of Existing Buildings** consists of five pages.

- For each structurally independent building (not divided into smaller substructures by joints) only one R.A.V.I.F. form is completed.
- The Form is divided into eight (8) sections, from A to H, which are explained below.

An "observations/comments" box is provided in most sections, where comments that are worth special mention or require further clarification can be included. Check boxes should be marked with X or √.

It is understood that the completion of the form, including assessing whether any damage/signs of deterioration or other issues identified during the visual inspection of the building are of concern or not, relies on the judgement of the Inspecting Engineer.

Section A: Building Identity (1st page)

1. District

Record the District in which the building is located.

2. Municipality/Community

Record the Sheet/Plan, the block and parcel.

3. Address

The full postal address of the building, i.e. street, number, postcode, district and contact number of the owner or management committee is recorded. In the case that several autonomous Authorities occupy the building, it is useful to provide additional telephone numbers.

4. Complex

Record the official name of the complex to which the building under inspection belongs to (where applicable).

4a. Building

Record the official name of the building. If it forms part of a complex, it should be made clear which building is of interest. If the building has no name, indicate the name of the Organisation/Authority that uses it or the owner of the building.

4b. Geographical Position of Building (Coordinates):

The geographical coordinates (X, Y) for the position of the building are specified according to the Geodetic System ΚΓΣΑ93 (Ellipsoid: WGS84 (φ, λ) & Cartographic Projection: LTM 93). Geographical coordinates are obtained by locating the reference point on the orthophoto maps of the web portal of the Department of Lands and Surveys web portal (DLS Portal). The building's reference point should be set as the building's main entrance or as the building's centre and correspondingly described in section "Additional Information" of the form (building's main entrance/centre). If the assigned geographical coordinates follow the WGS84 Geodetic Reference System, then their conversion to the ΚΓΣΑ 93 system is required. The geographical coordinates (X, Y) should be recorded as integers, i.e. no digits should be included following the decimal point (i.e. X= 232996, Y=391676).

5. Building use

Record the initial use of the building (for which a permit was issued). Subsequently, indicate the current use of the building (in case the initial use has changed). If the building has more than one use, record the main one at the time of the inspection.

6. User

Record the full name of the user.

7. Owner

Record the full name of the owner.

8. Contracting Authority

Record the Contracting Authority (if applicable).

Section B: Technical Information of the Building (1st page)

9. Number of floors / basements

Record the number of floors of the building (e.g., ground floor + 3) and the number of basements. Any kind of structure whose purpose is to enclose the staircase landing above roof level does not count towards the number of floors. In the case of sloping ground surface, record the number of floors from the lowest point of the ground surface. A floor is considered to be a basement if it is predominantly below ground and is adequately encased in perimeter walls.

10. Floor plan area

Record the area most representative of the building's floor plan. If no drawings are available, the floor plan area should be measured on site and estimated.

11. Total built area

Record the total area of the building which results from the summation of the above-ground floor areas, including the ground floor (excluding basements, mezzanines, flat

roofs, balconies, covered areas with pergolas, etc.). If no drawings are available, the total area of the building is estimated and a relevant note is made in the "additional information" subsection of the form.

12. Year of Structural Design

Record the year the building's structural design was carried out (if any).

13. Year of construction

Record the year the building was constructed based on information or its structural characteristics.

This information is particularly useful and crucial in deciding whether more in-depth investigation is required. Therefore, every effort should be made for identifying the building's year of construction.

If it is not possible to identify an exact date, the recording of a broader reference period (e.g. 1933 - 1937) is allowed, even by approximation.

14. Year of last addition/extension

Record the year of the last addition/ extension to the building. If the existing building was structurally upgraded as a result of the addition/extension, this must be indicated in field with number 17 of the form.

This field refers to vertical extensions or horizontal extensions structurally connected to the existing structure.

It is noted that this field seeks to establish whether additions/extensions to an existing building were, either as provided for in the original design, or by an assessment of the load-bearing capacity of the building according to more recent regulations to those used in the original study.

15. Available Structural Design Report/Structural Drawings

The structural design (report/drawings) of the building can be obtained from the records of the Authority that issued the building permit or from the owner.

Where only certain documents (usually drawings) are available, indicate YES or NO, depending on the available information.

If the structural drawings of the building are not available, then in addition to the inspection carried out based on the R.A.V.I.F. form, the building must also be inspected with the use of the V.I.F. and R.V.S.B. forms.

16. Is the building classified as Listed?

Record whether the building has been classified as listed.

17. Has the building been repaired/structurally upgraded?

If the building has undergone structural interventions, either for repair or for structural upgrading, the corresponding box is marked with an X or √.

Note: Of particular interest are the cases where buildings were designed without seismic regulations, which have undergone repair and structural interventions in order to restore their load-bearing capacity or for the addition of floors, as well as the case of buildings where interventions were carried out to repair damages (e.g. caused by earthquakes) or for the addition of floors according to more recent earthquake regulations to those implemented (if any) in the original study.

17a. If yes, for what reason and when?

For example, reasons might include repair due to deterioration, or restoration of damage caused by earthquakes or differential settlement, or structural upgrading as a result of the addition of floors to the building, etc.

18. Impact in relation to adjacent structures or civil works

Potential impact in relation to adjacent structures whether they are roadworks, excavations, adjacent buildings, etc.

Section C: Elements of Inspection (2nd page)

In cases where damages identified are deemed as concerning (III), a Successful Visual Inspection Certificate is not issued.

19. Exterior

This purpose of this section is to record any cracks or damages visible on the exterior of the building.

20. Interior

This part purpose of this section is to record any cracks or damages visible inside the building.

19, 20: In relation to the assessment of the condition of the concrete, the following are noted:

The condition of the concrete is defined as follows:

- **Good:** There are no visually apparent problems in the concrete and reinforcements.
- **Moderate:** There may be some signs of moisture but the concrete is not disintegrated, visually there does not appear to be a substantial reduction in its strength and the concrete is able to provide adequate protection (concrete cover) to the reinforcement.
- **Poor:** There are signs of severe moisture or detachment of the concrete cover (to reinforcement) or disintegration of the concrete or corrosion of the reinforcement with reduction of the reinforcement bars cross-sectional area.

It is understood that the assessment of the condition of the concrete of the load-bearing structure of the building relies also on the judgement of the Inspecting Engineer. Indicatively, it is noted that consideration should be given to whether any problems as far as the condition of the concrete is concerned, are of limited extent (e.g. relating to individual elements) or not. Consideration should also be given to the contribution of the elements in which the condition of concrete is assessed as moderate/ poor, to ensuring the structural capacity of the building. For example, where severe problems regarding the condition of the concrete are identified during the visual inspection, which concern a limited part of the elements constituting the load-bearing structure, it is recommended that if the problems relate to a main load-bearing element (e.g. a main column/beam), the condition of the concrete is recorded as "poor". In addition, in such/similar cases, it is recommended that comments/explanations are written down in the "Comments/Observations" field of the form.

Section D: Structural Elements of Storey Levels/Roof Structure (3rd page)

21. Type of Storey Level/Roof Structure

Determine the structural system of the storeys levels/ roof structure.

22. Bearing of Storey/Roof Structure

After on-site inspection, it is judged whether or not the bearing of the storey (slab)/roof structure is satisfactory and the appropriate box is filled in. In the case that the bearing of the storey (slab)/roof structure (on the supporting structure) is judged to be unsatisfactory, an assessment and/or further checks and or inspections to the building or immediate remedial action is required.

23. Nodes / Connections / Diaphragm Functionality

The same comments as in the previous field apply.

24. Deflection

Record whether or not there is deflection (visible to the naked eye) of the structural elements. In case that deflection is identified and it is deemed to be of concern, a Successful Visual Inspection Certificate is not issued and further checks are required.

Section E: Checks (3rd page)

25. Base shear check

A calculation is made on the basis of the equations provided and it is recorded whether the base shear check is satisfied.

A simplified implementation example is presented below as a usage model (pages 10-12 of this document).

Section F: Observations/General Comments/Technical Report (4th page)

This part of the form is intended for any observations /comments of the Inspecting Engineer in relation to the building's condition and the reliability of the information available or any other information deemed necessary to be reported (photographs, sketches, etc.).

Section G: Findings (5th page)

Based on all the previous sections, it is stated whether or not there are apparent areas of concern in the building and subsequently whether or not it meets the requirements for inclusion in the Grant Scheme. It is also stated whether remedial measures are recommended to be taken prior to carrying out work for upgrading the energy performance of the building as well as the carrying out of further inspections to the building.

26. Information of Inspecting Civil Engineer

The details of the Civil Engineer who carried out the visual inspection and/or the rapid base shear check for the building are recorded.

27. Date of Inspection

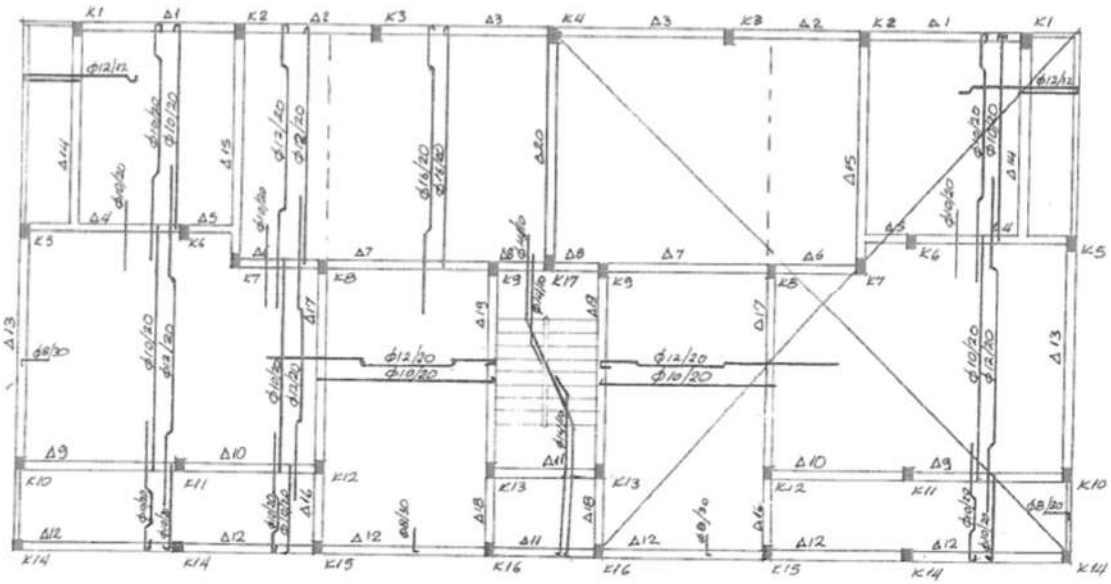
The date of the inspection is recorded.

Section H: Declaration by the Owner/Authorised Representative of the Owner (5th page)

This part comprises a signed statement of the owner/authorised representative of the owner that he/she has received a copy of the form, has studied and understands its contents, and that the various findings will be taken into account in the building's maintenance program.

Example of implementation of Section E: Checks

Typical plan of a two-storey building (slab thickness 15cm):



Columns (concrete mix: 1:1.5:3)			
A/A	**Dimensions**	**Longitudinal Reinforcement**	**Shear Links (Ties)**
K1	20 x 30	4Φ14	Φ6/15
K2	20 x 30	4Φ16	Φ6/15
K3	20 x 30	4Φ14	Φ6/15
K4	20 x 30	4Φ14	Φ6/15
K5	20 x 30	4Φ14	Φ6/15
K6	20 x 30	4Φ16	Φ6/15
K7	20 x 30	4Φ14	Φ6/15
K8	20 x 30	4Φ16	Φ6/15
K9	20 x 30	4Φ16	Φ6/15
K10	20 x 30	4Φ14	Φ6/15
K11	20 x 30	4Φ14	Φ6/15
K12	20 x 30	4Φ14	Φ6/15
K13	20 x 30	4Φ14	Φ6/15
K14	20 x 30	4Φ12	Φ6/15
K15	20 x 30	4Φ14	Φ6/15
K16/17	20 x 30	4Φ14	Φ6/15

A. Determination of seismic demand V_{req}

$$V_{req} = M \times S_d(T)$$

Calculation of building mass with the combination of gravity load and earthquake effects:

1. Floor plan area = 12m x 24m = 288m^2

2. Floor slab thickness = 0.15cm

3. Total permanent (dead) load G= 6kN/m^2

4. Variable-live load Q= 2kN/m^2

5. Combined gravity load and earthquake = 1G+0.3Q = **6.6kN/m^2**

$\Rightarrow$ Mass of building (two floors) for combined gravity load and earthquake (M) = 2 x 288 x 6.6 = **3801.6 kN = 380.16ton**

Calculation of fundamental period of vibration:

From EC8-1 paragraph 4.3.3.2.2.2 (3)

T_1=0.075 x $H^{3/4}$, where H is the total height of the building as defined in said paragraph in EC8-1

$\Rightarrow T_1$= 0.075 x ($6^{3/4}$) = 0.287 sec.

From the Type 1 design spectrum of EC8-1 (paragraph 3.2.2.2) for ground Type C, γ_I=1 and q=2:

S_d (T)/a_g = 1.4375

From Annex A of the National Annex of the EC8 and the Table for Zone 1 we get:

a_g = 0.09g

$\Rightarrow S_d$(T) = 0.13g

$\Rightarrow V_{req} = 380.16 \times 0.13g = 492kN$

Note: For buildings whose building permit was issued after 1986, the value of the behaviour factor may be higher than 1.5 (up to 2.0) based on the judgement of the Engineer.

B. Determination of shear resistance V_{R0}

$$V_{R0} = 0.8 \times \sum V_{R,column}$$

$$V_{R,column} = \min(V_{RC,s}, V_M)$$

$$V_{Rc,s} = \frac{A_{sw}}{s} \times z \times f_{ywd}$$

Calculation per column:

K1:

$$V_{Rc,s} = \frac{\left[\frac{2 * (\pi 6^2/4)}{150} \times 0.9 * d * 220\right]}{1000} = 20.15kN$$

Note: Repeat the calculation of $V_{Rc,s}$ for each column and wall and calculate the sum for the floor.

Calculation of μ from the interaction diagram of a rectangular column with $d_2/h=0.10$

1. Calculation $v = \frac{N}{bhf_{ck}}$

(find the point on the vertical axis of the diagram)

2. Calculation $\omega = \frac{A_s f_{yk}}{bhf_{ck}}$

(choose a point from within the diagram based on the value of ω in the curves)

Interaction diagram for columns of rectangular cross-section

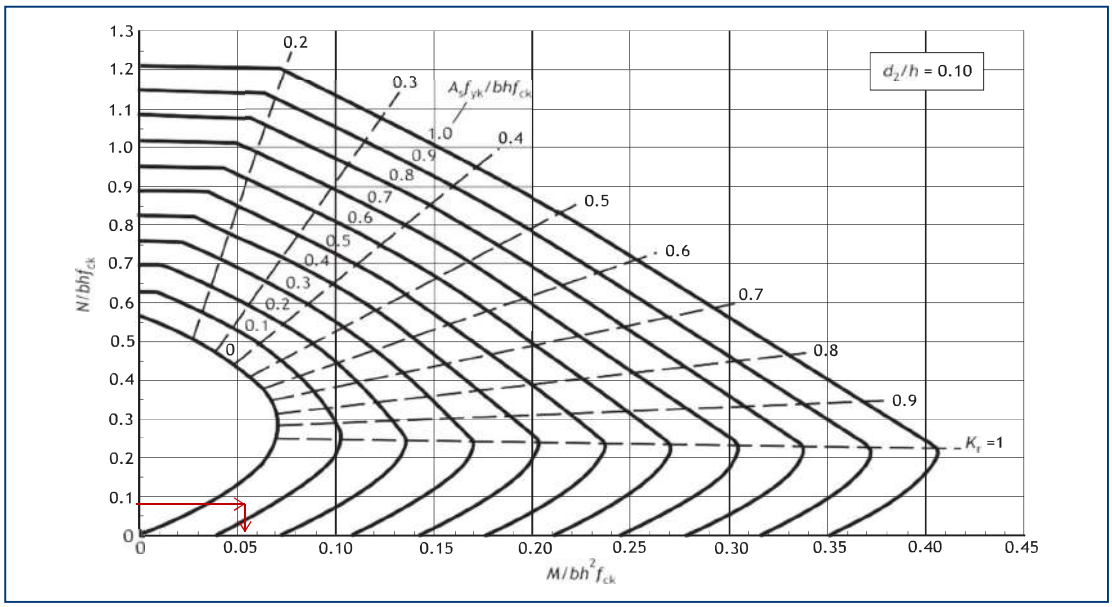


Table of columns for calculation of points 1 and 2 above.

Column	Tributary area of column m²	Axial load (kN)	ν	ω
k1	6	79.2	0.083	0.051
k2	9	118.8	0.124	0.067
k3	10	132	0.138	0.051
k4	14	184.8	0.193	0.051
k5	6	79.2	0.083	0.051
k6	8	105.6	0.110	0.067
k7	9	118.8	0.124	0.051
k8	11	145.2	0.151	0.067
k9	9	118.8	0.124	0.067
k10	6	79.2	0.083	0.051
k11	8	105.6	0.110	0.051
k12	13	171.6	0.179	0.051
k13	8	105.6	0.110	0.051
k14	5	66	0.103	0.056
k15	5	66	0.069	0.051
k16	5	66	0.069	0.051
k17	7	92.4	0.096	0.051

3. Calculation V_M

(find the point vertically on the X-axis for K1=0.052)

$$\Rightarrow M_R = \mu bh^2 f_{cd} = 0.052 * 200 * 300 * \frac{16}{1.5} = 10kNm$$

$$V_M = \frac{2*10}{2.6} = 7.7kN$$

Note: Repeat the calculation of VM for each column and wall and calculate the sum for the floor.

From the sum of $V_{RC,s}, V_M$ for all columns on the floor we find the minimum value from which we calculate the V_{R0}.
Subsequently we compare the V_{R0} with the V_{req} and if the former is greater, the base shear check is therefore satisfied.