INTERNATIONAL JOURNAL of ENGINEERING SCIENCE AND APPLICATION
Selman, Vol.3, No.2, 2019

Alternative Procedures of Damage Evaluation Integrated Rapid Assessment Techniques for Reinforced Concrete Buildings

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Received: 23.02.2019 Accepted:27.06.2019

Abstract- Rapid seismic assessment techniques have been frequently preferred over the last decade with less effort and time. Recently, two of the most leading examples in this area are P25 method and Capacity Index method, they both are based on scoring and evaluation of main structural parameters being close to the code based design approach instead of simple checks and survey. However, damage states of members are not directly reflected to the vulnerability assessments according to the damage qualification but some generalized coefficients are used. From this viewpoint, in this study, the microregional building stock (150 systems) is selected, P25 and Capacity Index method are carried out and damage state of members is taken into account by visual observation scores. With the procedures proposed in this study, alternative evaluation procedures of damage qualification integrated rapid assessment techniques are proposed in a simpler and clearer way. The main aim of this research is to emphasize the validity of rapid assessment techniques combined with damage qualification of members.

Keywords Rapid assessment technique, P25 method, Capacity Index method, Damage qualification.

1. Introduction

More recently, rapid assessment techniques have been gaining popularity considering an urgent need for valid and reliable structural evaluation of buildings. This serious interest arises from the advantages and successful results of their methodologies. When compared to the conventional detailed techniques, rapid assessment methods not only reduce time and effort required but also offer more simple procedures and effective evaluations. The main aim of rapid assessment technique is estimating the structural capacities of a large number of buildings in a practical way by help of main structural parameters and simplified relationships. However, their criteria and methodologies require to be developed in terms of the damage states of elements [1]-[7]. There is no doubt that the influence of damage quantification on the main structural parameters and total score of systems is undeniable. The total score needs to be consequently determined by the combination of failure scores regarding the existing damage formation of members. Next, the degree of interaction among failure scores can be specified by statistical approaches and final score is obtained for structural systems [1]-[7].

Research on rapid safety assessment procedures involves numerous techniques as FEMA-154 and FEMA-155 Rapid Visual Screening Method [8],[9], Japanese Seismic Index Method (JSI) [10] Capacity Index Method [4], P25 Method [1],[7], and PERA by İlki and collaborators[11] can be pronounced as the most effective methods in this area. FEMA Rapid Visual Screening Method determines potential seismic hazard according to the main structural and soil parameters. This method is the basis of all developed procedures and recently preferred in the rapid seismic vulnerability assessment of buildings. Japanese Seismic

Index Method, one of the most widely known technique, contains three main levels. First level is used to evaluate the strength parameters of vertical elements. But in second and third levels, ductility capacity of elements and contribution of horizontal members are also included. In the second level, the deformation capacities of vertical elements are evaluated with their strength capacities assuming a strong beam concept. In the third level, the strength and ductility properties of beams are also considered in addition to vertical elements in order to evaluate the seismic capacities of structural systems. Calculating strength and ductility parameters stated in these levels and comparing with seismic demand, seismic safety condition of structural system can be assessed [8],[9]. The procedure proposed by Yakut [4] may be also useful in this area being on an equal basis with JSI[10]. This method attempts to estimate the elastic base shear capacity of structures calculating Basic Capacity Index. The assessments are made comparing capacity index with a cutoff value and the final decision is reached on the structural system. P25 method is also one of the simplest tools to detect collapse-vulnerable structures. This method is based on seven scores about main structural parameters such as irregularities, pounding, etc. The influence of interactive failures on total score is calculated by interactive correction factors [4]. PERA(Performance Based Rapid Seismic Assessment Method) is little bit different from the other techniques in this area and a detailed procedure based on performance based design. Since the procedure is simplified version of theoretical seismic design approach and the member damage levels are determined according to the demand/capacity ratios of elements, results are highly accurate and reliable [11]. NZSEE(New Zealand Seismic Assessment Method)[12], Hassan and Sozen method [13], and Sucuoğlu et al.[14] method are the other prominent examples of rapid assessment techniques.

Post-earthquake damage evaluation of Japanese standards specified damage classes for reinforced concrete members and classified them[10]. İlki and collaborators [15] identify damage stages in a clearer way. Flexural damage progression initiates with first cracking of concrete due to flexural tension and yielding of tensile rebars. The following stages are crushing of covering concrete at flexural failure after yielding of rebars, spalling of the covering concrete, and finally crushing of the core concrete [15]. The first visible stages of shear damage progression are first shear (diagonal) crack formation, and yielding of stirrups. The next stages are crushing of concrete in compression zone, shear crack development and spalling of concrete, fracture of stirrups, and finally large shear deformations in longitudinal rebars, crushing of the core concrete [15]. These visible damage levels can be adopted into safety assessment methods of structures in a more detailed manner to reach realistic and effective results.

The aim of this research is to adopt visual inspection of members into the rapid assessment techniques to the extent that the degree of damage states becomes an individual parameter besides the other main structural parameters. In this context, P25 method and Capacity Index method are selected since they are two of the prominent techniques in this area and they contain all main parameters in terms of structural design and calculations. They are evaluated with the visual inspection detailing considering the damage forms of members. In order to build a database, 150 examples are selected from the buildings located in Karşıyaka (İzmir), which are stored in the archive of Turkish Association of Civil Engineers (Turkish Chamber of Civil Engineers, İzmir). Their main structural parameters are computed and visual damage states are discussed by help of the information recorded in their reports and in situ checks if seen as necessary. The results are interpreted in terms of structural performance of systems and discussed so that the importance of damage qualification is highlighted on the final decisions of rapid assessment techniques.

2. Theoretical Details and Applications

Rapid safety assessment approach of this study includes two main stages. In the first stage, P25 Method[1],[2] and Capacity Index Method[4] are selected for this study. P25 Method considers structural parameters affecting the seismic behavior of system and these may be listed as basic score P1 ,which is calculated from cross-sectional areas and flexural stiffness of structural members, short column score P2, soft and weak storey score P3, overhangs and frame discontinuities score P4, pounding score P5, soil failure scores P6 and P7. The minimum value of these scores among seven parameters from P1 to P7 is determined and the failure interaction possibility among these scores is taken into consideration by correction factor for the final score. The scoring essentials and details can be found in [1],[16],[17]. The high risk band is between scores 15 and 35 according to P25 method, so the safety limit is accepted as 35, in this context of this study.

The other method, Yakut's technique[4] is based on approximating the base shear capacity of concrete section of members and consequently the total shear concrete capacity of system by adding up the individual capacities of members. Second step is reaching the yield base shear capacity from the total shear capacity of concrete and the elastic design base shear associate design code according to Turkish Seismic Design Code[18]. The ratio between the yield base shear capacity and elastic design base shear is called as Basic Capacity Index (BCPI) and this is modified by two coefficients C_A (coefficient of discontinuities and visual inspection details) and C_M (coefficient of construction quality and workmanship features). BCPI turns out to be Capacity Index (CPI) by the modifications of C_A and C_M. Generally, from studies and tests in several databases, CPI greater than 1.5 displays the buildings, which are expected to be safe.

Second stage is visual qualification of structural damages existed in system members. Visual inspection details are adopted into the evaluations according to the principles stated by Japanese Guideline for Post-Earthquake Damage Evaluation and Rehabilitation[10] and also in the visual screening forms of buildings prepared by İlki and collaborators for the Turkish Association of Civil Engineers and Architects[15]. As mentioned earlier, inspired by İlki and collaborators' study, in the first level, flexural damage stages are first flexural cracking, yielding of tensile rebars, crushing of covering concrete, spalling of covering concrete, and crushing of core concrete, consecutively. The main titles of shear damages are first shear crack formation, yielding of stirrups, crushing of concrete in compression zone, spalling, fracture of stirrups, shear deformation in longitudinal rebars, and crushing of the core concrete. The main titles of damage progression are displayed in Table 1 and 2. For flexural and shear damage progression, first cracking formation and yielding are classified as type "A" whereas crushing of covering concrete is "B". Spalling and final crushing of core concrete are "C" and "D". Each type has different weighed factors and according to them, damage point is calculated as seen in Equation (1) for vertical members(V) such as columns, shear walls. Similarly, the equation (2) belongs to the horizontal members (H) such as beams. In Equation (1) and Equation (2), "O" represents the sum of cross-sectional areas of non-damaged members while "A", "B", "C", and "D" are damaged cross-sectional areas being relevant to their damage classes [15]. The total scores obtained from P25 technique and Capacity Index Method are modified according to damage qualification percentages expressed in Equation (1) and Equation (2).

$$\mathrm{V} = \left[\frac{0.15\ \mathrm{A} + 0.35\ \mathrm{B} + 0.65\ \mathrm{C} + 1\ \mathrm{D}}{\mathrm{A} + \mathrm{B} + \mathrm{C} + \mathrm{D} + \mathrm{O}}\right] 100 \quad (1)$$

$$H = \left[\frac{0.65\ \mathrm{C} + 1\ \mathrm{D}}{\mathrm{A} + \mathrm{B} + \mathrm{C} + \mathrm{D} + \mathrm{O}}\right] 100 \quad (2)$$

To evaluate the validity of the proposed approach in this research study, the structural data set, which is compiled for the 150 different reinforced concrete buildings are examined by the rapid assessment techniques with visual observation of structural members. Appendix A(Table A.1-A.4) contains structural scores of systems according to P25 Method and consequent assessments, detailingly, whereas Appendix A(Table A.5-A.7) displays the results of Capacity Index Method.

Table 1. Main titles for flexural damage states [15]

Degree	Type
I	First flexural cracking(A)
II	Yielding of tensile bars(A)
III	Crushing of concrete cover(B)
IV	Spalling of concrete cover(C)
V	Crushing of core concrete (D)

Table 2. Main titles for shear damage states [15]

Degree	Type
I	First shear cracking(A)
II	Yielding of stirrups(A)
III	Crushing of concrete in compression zone(B)
IV	Spalling of concrete in compression zone (C)
V	Crushing of core concrete (D)

2.1. Application

In order to clarify the analysis procedure of structural systems in this study, chosen example (no:19 shaded ; can be seen in Appendix A) is a six-storey reinforced concrete frame-shear wall building. The software program SAP2000[19] is used for the analysis of system. The used concrete class is C25 and steel is B420C. The plan view of this system is given in Figure 1, the general view of system model can be seen in SAP2000 program[19] in Figure 2 and the geometrical and reinforcement details of columns, beams, and shear walls are seen in Figure 3. Dead load(G) is 3 kN/m^2 whereas live load is 2 kN/m^2. Earthquake loads "E_x" in x direction and "E_y" in y direction are applied according to the equivalent static load methodology in Turkish Seismic Design Code 2018 [18]. The construction date is 2002 and ground water level is below 10 m. The site class is ZB.

The fundamental period (T_1) is 0.447 s. Table 3 shows the interstorey drift ratios of the system and as seen from the table 3, all the values are obtained below the limit drifting value 0.02. R is response modification factor and for this system R=7 for dual systems (cantilever shear wall- frame systems) according to Turkish Seismic Design Code 2018[18]. The reinforcement design is checked according to SAP2000 program[19] and eventually all elements are satisfied with the reinforcement design requirements of The Turkish Standard TS-500[20].

The considered load combination is G+Q+EX+0.3EY since the system is symmetrical and Structural Importance factor(I) is 1 while Spectral Response Acceleration factor Sa(T) is 2.29 [18]. (taking into account the short period region). Using linear elastic method, which is described in Turkish Seismic Design Code 2018 [18], performance level of the structural elements are determined by help of elastic demand to capacity ratios (r factors) comparing with their limitations and damage classifications are shown in Table 4.

The damage states of members are in conformity with the performance level “Controlled Damage”. For this system, in any story, there is no shear force carried by columns in “Extensive Damage” member level [18]. So, the other requirement of the “Controlled Damage” level is also fulfilled.

Table 3. Inter-story drift ratios of the system [18]

Storey No	Interstory drift values (Δ/h)	
6	0.005	<0.02
5	0.00566	<0.02
4	0.00616	<0.02
3	0.00593	<0.02
2	0.0048	<0.02
1	0.00252	<0.02

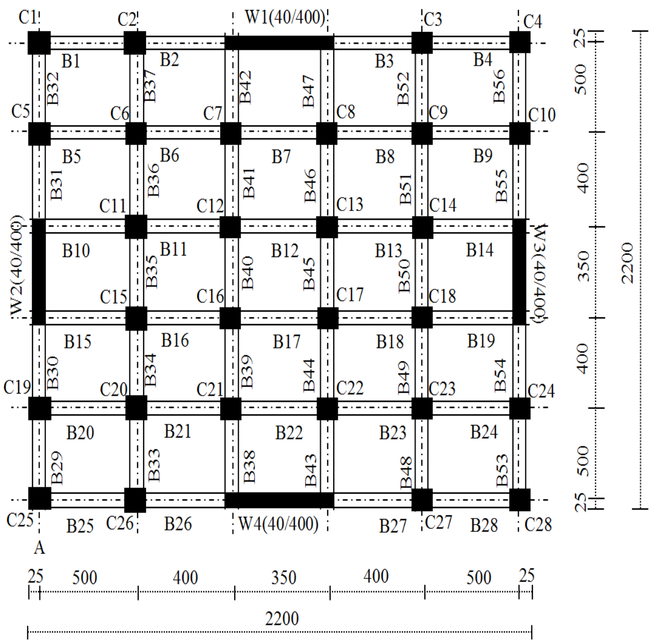

Fig. 1. Lay-out view of the structural system no:19 (All dimensions are in cm.)

As a result, performance level of this system examined can be pronounced as “Controlled Damage” level.

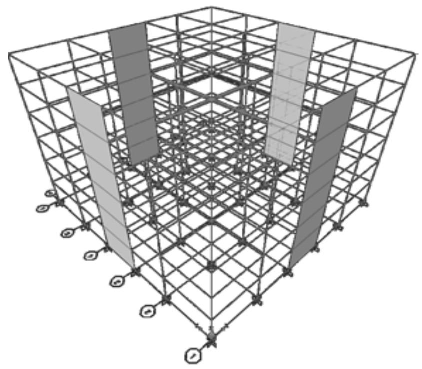

Fig. 2. Model of the structural system no:19 in SAP2000[19]

Table 4. Performance levels of elements according to the demand/capacity ratios of linear elastic procedure[18]

S.No.	Slight damage level	Moderate damage level
6	86% beams 100% columns 100% shear walls	14% beams 0% columns 0% shear walls
5	36% beams 100% columns 100% shear walls	64% beams 0% columns 0% shear walls
4	64% beams 100% columns 100% shear walls	36% beams 0% columns 0% shear walls
3	71% beams 100% columns 100% shear walls	29% beams 0% columns 0% shear walls
2	68% beams 100% columns 100% shear walls	32% beams 0% columns 0% shear walls
1	93% beams 100% columns 0% shear walls	7% beams 0% columns 100% shear walls

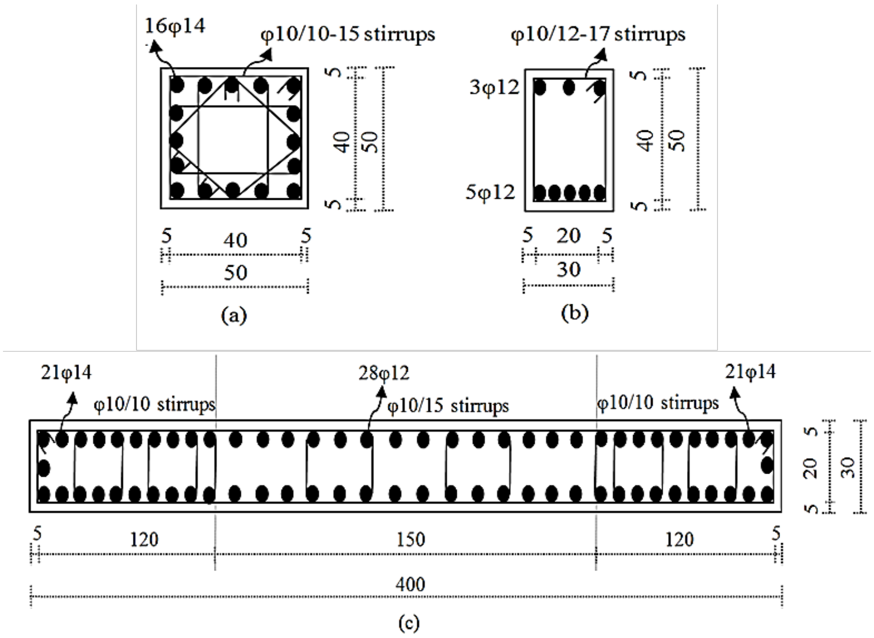

Fig. 3. Geometrical and reinforcement details of the structural system no:19 (a)For columns (b)For beams (c) For shear walls(All dimensions are in cm but diameter of rebars are in mm.).

2.2. P25 Method Procedure Details

Firstly, visual examination of building is performed in terms of the Equations (1) and (2). For the first (ground) floor, even though no damage formation can be seen in the vertical elements, concrete spalling has caught attention in two beams, so V is 0 while H is 2.32% according to Equation (3).

$$H = \left[\frac{(0.65).30.50.2}{30.50.56}\right]100 = 2.32 \quad (3)$$

According to P25 method [1], firstly, the critical storey is selected as the ground floor of this system and the floor area(A_p) is calculated as $A_p = L_x\ L_y = 22.5\ 22.5 = 506.25\ m^2$, plan dimensions L_x and L_y are the x and y sides of the smallest rectangle into which the plan of the critical storey is inserted. The moments of inertia values in x and y directions (I_{px} and I_{py}) of the plan areas are 21357.42 m^4. Next, the sum of cross sectional areas of columns(A_c), shear walls(A_s) and infill walls(A_m), A_{ef} in x and y directions (A_{efx}, A_{efy}) obtained in Equation(4). The thickness of partition walls are 20 cm. Since the structural system is identical and symmetrical in x and y directions, A_{efx} and A_{efy} are equal and also the moment of inertias (I_{ef}, $I_{efx} = I_{efy}$) in Equation(5).

$$A_{efx,y} = A_C + A_S + 0.15A_m \quad (4)$$

$$I_{efx,y} = I_C + I_S + 0.15I_m \quad (5)$$

The shorter dimensions of shear walls smaller than 0.4 m are ignored in the calculations of moment of inertias since they do not contribute too much to the moment of inertia values in each direction. By help of these values, effective area index C_{Aef} and effective moment of inertia index C_{Ief}, are calculated in Equation (6.a), Equation (6.b) and Equation(7.a), Equation (7.b) consecutively. The effective indexes are written in terms of area index C_A and moment of inertia index C_I [1].

$$C_{Ax,y} = 2\ 10^5 \left[\frac{A_{ef}}{A_p}\right] \quad (6.a)$$

$$C_{Aef} = [(0.87\ C_{Amin})^2 + (0.5\ C_{Amax})^2]^{0.5} \quad (6.b)$$

$$C_{Ix,y} = 2\ 10^5 \left[\frac{I_{ef}}{I_p}\right]^{0.2} \quad (7.a)$$

$$C_{Ief} = [(0.87\ C_{Imin})^2 + (0.5\ C_{Imax})^2]^{0.5} \quad (7.b)$$

Table 5 displays the main parameters calculated of P25 Method. Next, the final score P1 is calculated according to Equation (8) and h_0 is effective height and is written in terms of the total height of structural system, H=18 m in Equation (9). f_i, correction factors of irregularity are shown in Table 6. The correction factor table can be found according to P25 method in [1], [16], [17].

Table 5. Calculation of P_1 score of P25 Method [1]

Parameters	
$A_{efx,y}$	16.4 m^2
$I_{efx,y}$	14.03 m^4
$C_{Ax,y}$	6479.012
C_{Aef}	6501.33
$C_{Ix,y}$	46187.73
C_{Ief}	46346.8
h_O	505
P_1	64.2

$$C_{Ief} = \left[\frac{(C_{Aef}+C_{Ief})}{h_0}\right] \prod_{i=1}^{14} f_i \quad (8)$$

$$h_0 = -0.6\text{H}^2 + 39.6H - 13.4 \quad (9)$$

P_2 short column score is 70 since the ground floor contains only one short column risk due to partial height of brick masonry infill walls and its height is 80% of the storey height. P_3 and P_4 scores are 100 since there is no discontinuity of peripheral frame and P_5 is 100 because the system does not include any pounding risk. Calculated liquefaction potential is classified as minor and ground water level is below 10 m so P_6 is 60, but P_7 is 100 because local site class is ZB [1],[17]. Scores are listed for this system in Table 7 and then, the weighted score is calculated in (10), P_w as 77.3, w_i, weighing factors are listed in Table 8.

P_{score} is obtained as 60 for this structural system. In the context of this study, the final score is evaluated within damage states' scores and V=0 and H= 2.32% are found out in (3) so P_{score} is rectified by using (1-V) and (1-H) in Equation (10). P_t = 58.61 (final score) and since P_t is greater than 35, this structural system is classified as "secure".

$$P_t = P_{score}\,(1-V)(1-H)$$

$$P_t = 60.(1-0)(1-0.0232) = 58.61 \quad (10)$$

Table 6. The correction factors of P25 Method [1]

Factors	
f_1	1
f_2	1
f_3	1
f_4	1
f_5	1
f_6	1
f_7	0.95
f_8	0.9
f_9	1
f_{10}	1
f_{11}	0.795
f_{12}	1
f_{13}	0.95
f_{14}	0.95
$\prod_{i=1}^{14} f_i$	0.61345

Table 7. P scores of P25 Method [1]

Scores		Scores	
P_1	64.2	P_w	77.3
P_2	70	P_{min}	60
P_3	100	P_{score}	60
P_4	100		
P_5	100		
P_6	60		
P_7	100		
A	1		
B	1		

Table 8. The weighing factors of P25 Method [1],[2]

Scores	w_i
P_1	4
P_2	1
P_3	3
P_4	2
P_5	1
P_6	3
P_7	2
P_{min}	4

2.3. Capacity Index Method Procedure Details

In the second assessment procedure, with Yakut's approach [4], first, the shear capacity of concrete sections of components (columns and shear walls) is computed for columns and shear walls, in Equation (10). Diagonal cracking strength of reinforced concrete beams is in Equation (11) according to TS-500[20] and this empirical equation is developed based on the experiments and observations of tensile strength of concrete. N_d represents axial force while Ac cross-sectional area of members. γ is coefficient for axial force level. The tensile strength of concrete is 1.75 MPa.

$$V_c = 0.65\, f_{ctd}\, b_w\, \mathrm{d} \left(1 + \gamma \frac{N_d}{A_c}\right) \tag{11}$$

The total concrete shear capacity (V_c) of structural system is then obtained by adding up the individual values of columns and shear walls. For this structural system, there are 28 square columns, two shear walls in plane direction and two shear walls in transverse direction in both x and y directions[4], [17]. Next, the yield base shear capacity (V_y) is found out by help of Equation (12), empirical relationship calibrated by this method [4], neglecting the contribution of infill walls (V_y=V_{yw}).

$$V_y = \frac{V_C}{0.95\, e^{0.125n}} \tag{12}$$

The main goal of this method is to compare yield base shear and code base shear so the code base shear (V_{code}) is obtained according to the linear elastic method in Turkish Seismic Design Code[18] as shown in Equation (13). S_{aR}(T) represents Seismic Response Coefficient [18].

$$V_{code} = \mathrm{m}\, S_{aR}(\mathrm{T}) \tag{13}$$

Table 9 is the summary of the of Capacity Index Method parameters and the code base shear (V_{code}) is calculated as 3888.6 kN. The basic capacity index (BCPI) is found out as 1.3 according to Equation (14).

$$\mathrm{BCPI} = \frac{V_y}{V_{code}} \tag{14}$$

With modification factors "C_A"= 0.85 and "C_M"=0.9175 proposed for the structural systems in Turkey[4], total capacity index (CPI) is 1.014 in (15). In this study, for visual detections, C_M is also modified by (1-V)(1-H) like in P25 method in Equation (15) and final score becomes 0.99 .

$$\mathrm{CPI} = \mathrm{C}_A\, \mathrm{C}_M\, \mathrm{BCPI}\,(1 - \mathrm{V})(1 - \mathrm{H}) \tag{15}$$

This structural system needs to be further examined since visual inspection integrated CPI is less than 1.5 according to this method[4], [17].

Table 9. The main parameters of Capacity Index Method [4]

Parameters	
Weight	29290 kN
V_C	101.67 kN
V_y	5052.6 kN
V_{code}	3888.6 kN
BCPI	1.3
CPI	1.014
CPI_{score}	0.99

Appendix A(Table A.1-A.4) show the building stock, which is evaluated with P25 Method and scoring details are shown for each system with their final decisions whereas Appendix A(Table A.5-A.7) provide the results of Capacity Index Method procedure.

3. Results and Discussions

In order to clarify the analysis details of buildings, one structural system is selected from database and its evaluation procedure is described in Theoretical Details and Applications. Furthermore, the linear elastic method parameters and results of 30 structural systems (20% of database) are shown with corresponding rapid assessment results in Appendix A.8, for the comparison. At first glance, the close agreement is observed between the linear elastic method and rapid assessment results. Both two methods P25 and Capacity Index (CI) satisfactorily predict the final scores of structural systems with visual inspection. Buildings with a "Controlled Damage" performance level are secure according to the rapid assessment approaches. For the example in chapter 2, the performance level of system example is "Controlled Damage" according to the linear elastic method [18] and similarly, P25 method with visual inspection estimates its final level as secure. However, final score of CI with visual inspection is less than the security limit (1.5), basic capacity index (BCPI) of system is sufficiently high [1]-[6].

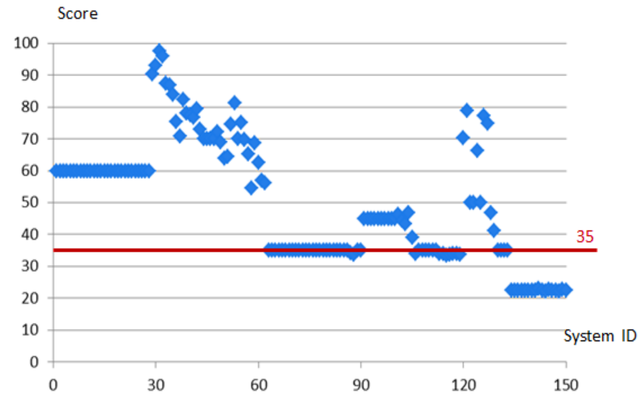

Fig. 4. P25 final scores of structural systems

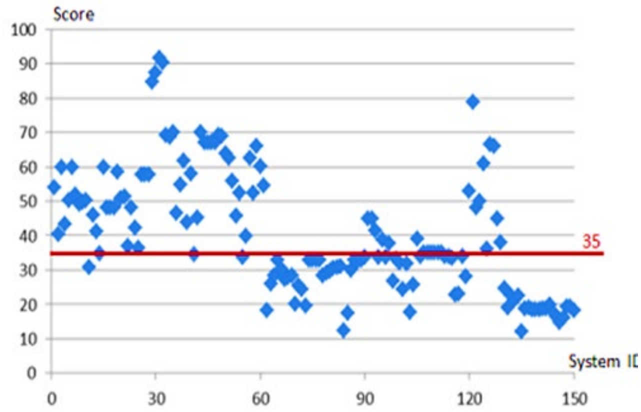

Fig. 5. Final scores of structural systems according P25 approach with visual evaluation of members.

Figure 4 shows P25 approach results whereas Figure 5 demonstrates P25 approach with visual inspection of members. Without visual detections, eighty seven buildings are secure regarding the conventional P25 method. With visual evaluation of members, number of secure buildings is decreased as can be seen from Appendix Table A.8. With damage evaluation of members, final scores of buildings between 50 and 60 eventually get closer to the limit value 35 and the need for evaluation arises for this interval by detailed analytical methods. The other crucial point is that the buildings in limit value drop to below 35 and be in high risk band. The degree of agreement between linear elastic method results and P25 results with visual examination is obvious and can be seen in Appendix Table A.8. All buildings that satisfy to the "Controlled Damage" performance level are found out as "secure" according to P25 approach with damage qualification.

Figure 6 shows CI approach results whereas Figure 7 demonstrates CI approach with visual inspection of members. Like P25 approach results, with damage detection and scoring of members, final scores of seventeen buildings drop to below the limit 1.5 even though they are secure according to the conventional CI method and only five buildings scores are above the limit 1.5 while the rest of the stock is below 1.5. CI tends to give lower scores than P25 approach. The final scores of many buildings can be between 1.2 and 1.5 (in the risk band), even they satisfy to "Controlled Damage" performance level according to the linear elastic method.

The validity and reliability of final scores of rapid assessment methods can be enhanced by some regulations, particularly for CI method. Even though the relationship among individual scores is well established in P25, there is no relationship among the main scoring parameters in CI. The empirical coefficients such as construction quality and location conditions are developed. However, CI is a prominent method, gives reliable results, and its theoretical structure is well established.

Both for P25 and CI method, visual inspection and detection of damage states may be added up as an individual scoring item in methodology. The interaction between damage scores and other structural parameters may be constructed by developed statistical relationship. In this study, for the sake of simplicity and clarity, the damage state scores are considered as simple reduction factors, which are only dependent upon number of damaged elements and their damage levels. Despite this simple revision, visual inspection integrated evaluation shows that damage qualification is an important tool as much as the other main structural parameters. Undoubtedly, with this, it is thought that the structural capacity estimation of systems with rapid assessments can be more accurately reflected to the reality.

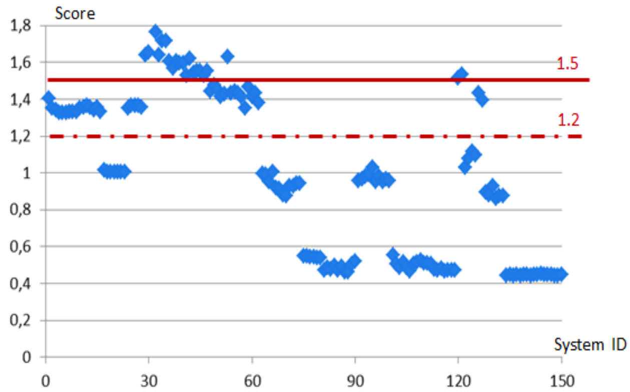

Fig. 6. CI final scores of structural systems

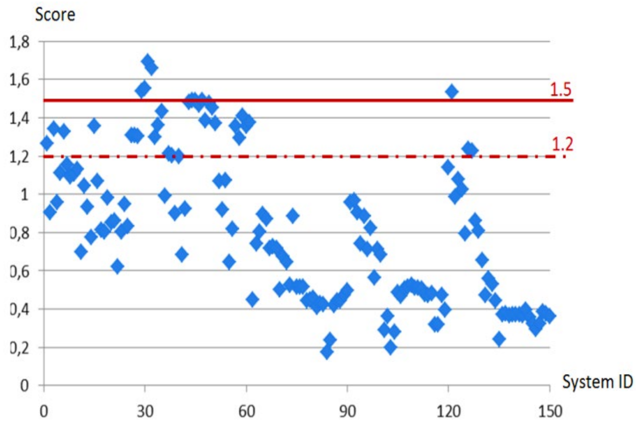

Fig. 7. Final scores of structural systems according CI approach with visual evaluation of members.

4. Conclusion

To obtain the valid final scores and consequent results of bearing systems in a much more realistic manner, rapid assessment techniques are combined with visual observation and detection of damage states of members. However, this is ensured by some modification factors in several techniques in this area, this rectification may be not sufficient since the influence of damage states on general structural behavior is not clearly identified. This viewpoint states that visual detection and damage qualification of members becomes a part of rapid assessment procedures as an individual tool.

This study is composed of two main parts. First step in this research is to implement P25 and CI methods in the building stock selected and record their final scores. The main purpose in selecting these two methods is that they are both based on theoretically simple relationships and criteria. Both two methods contain all main structural parameters and give reliable results proven in first step when code based design approach is conducted for examples. Second step is to adapt visible damage states of members as a new tool on P25 and CI methods. With this approach offered in this study, all possible damage states for elements are listed and according to their qualifications, final scores are remodified in a simpler way inspired by İlki and collaborators' work. Comparisons with code based design evaluations show that the combination of rapid assessment techniques with visual screening allows much more valid scores and potential rehabilitation strategies. According to P25 approach, all buildings of "Controlled Damage" performance level are found to be safe. As it is expected, buildings of "Collapse Prevention" level are in the risk band. The close agreement can be seen for P25 approach but for CI approach, it is a little bit different. Similarly, building stock of "Collapse Prevention" level is in the "unsafe" region but buildings of "Controlled Damage" level are spread out in the risk band between 1.2 and 1.5 scores except five buildings above 1.5. It can be said that CI approach is stricter and the compliance with linear elastic results of CI approach is provided since building stock of "Controlled Damage" level is not in the "unsafe" region. The integration of damage qualification enables the rapid assessment techniques to evaluate structural systems in a realistic manner. This agreement between results highlights that new researches are expected to be conducted for improving detailed rapid assessment techniques integrated with visual damage detection of members and in situ checks.

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Appendix A.

Table A.1: General overview of damage qualification integrated P25 results for buildings no: 1-55

	P_0	P_1	P_2	P_3	P_4	P_5	P_6	P_7	α	P_w	β	P_{min}	P_{score}	(1-V)	(1-H)	P_t	
1	142.00	96.79	100.00	100	100	100	60	100	1	85.35781	1	60.00	60	1	0.9	54	secure
2	134.00	93.06	100.00	100	100	100	60	100	1	84.6119	1	60.00	60	0.84	0.8	40.32	secure
3	138.00	94.65	100.00	100	100	100	60	100	1	84.93084	1	60.00	60	1	1	60	secure
4	121.00	82.99	100.00	100	100	100	60	100	1	82.59878	1	60.00	60	0.89	0.81	43.254	secure
5	127.30	82.95	100.00	100	100	100	60	100	1	82.58986	1	60.00	60	0.93	0.9	50.22	secure
6	129.66	84.49	100.00	100	100	100	60	100	1	82.89742	1	60.00	60	1	1	60	secure
7	115.60	79.29	100.00	100	100	100	60	100	1	81.85801	1	60.00	60	0.96	0.9	51.84	secure
8	108.00	70.37	100.00	100	100	100	60	100	1	80.07467	1	60.00	60	0.91	0.9	49.14	secure
9	111.23	71.52	100.00	100	100	100	60	100	1	80.30487	1	60.00	60	0.92	0.9	49.68	secure
10	121.24	76.92	100.00	100	100	100	60	100	1	81.38433	1	60.00	60	0.93	0.9	50.22	secure
11	111.65	76.10	100.00	100	100	100	60	100	1	81.22042	1	60.00	60	0.78	0.66	30.888	needs to be evaluated
12	114.76	82.34	100.00	100	100	100	60	100	1	82.46777	1	60.00	60	0.88	0.87	45.936	secure
13	112.87	80.98	100.00	100	100	100	60	100	1	82.19656	1	60.00	60	0.86	0.8	41.28	secure
14	118.43	84.97	100.00	100	100	100	60	100	1	82.99441	1	60.00	60	0.77	0.75	34.65	needs to be evaluated
15	119.30	81.32	100.00	100	100	100	60	100	1	82.26329	1	60.00	60	1	1	60	secure
16	136.50	93.04	100.00	100	100	100	60	100	1	84.60804	1	60.00	60	1	0.8	48	secure
17	131.60	80.73	70.00	100	100	100	60	100	1	80.64605	1	60.00	60	1	0.8	48	secure
18	99.76	61.20	70.00	100	100	100	60	100	1	76.73959	1	60.00	60	1	0.8	48	secure
19	104.65	64.2	70.00	100	100	100	60	100	1	77.34	1	60.00	60	1	0.9768	58.608	secure
20	99.49	61.03	70.00	100	100	100	60	100	1	76.70646	1	60.00	60	0.94	0.9	50.76	secure
21	121.32	74.42	70.00	100	100	100	60	100	1	79.38479	1	60.00	60	0.95	0.9	51.3	secure
22	110.98	68.08	70.00	100	100	100	60	100	1	78.11618	1	60.00	60	0.8	0.77	36.96	secure
23	121.98	74.83	70.00	100	100	100	60	100	1	79.46577	1	60.00	60	0.9	0.89	48.06	secure
24	142.00	87.11	70.00	100	100	100	60	100	1	81.92203	1	60.00	60	0.88	0.8	42.24	secure
25	134.56	82.55	70.00	100	100	100	60	100	1	81.00922	1	60.00	60	0.79	0.77	36.498	secure
26	126.98	77.90	70.00	100	100	100	60	100	1	80.07922	1	60.00	60	1	0.96	57.6	secure
27	125.40	76.93	70.00	100	100	100	60	100	1	79.88537	1	60.00	60	1	0.96	57.6	secure
28	129.90	79.69	70.00	100	100	100	60	100	1	80.43748	1	60.00	60	1	0.96	57.6	secure
29	132.34	90.20	100.00	100	100	100	100	100	1	96.08187	1	90.20	90.20468	1	0.94	84.7924	secure
30	133.67	92.83	100.00	100	100	100	100	100	1	97.13212	1	92.83	92.83031	1	0.94	87.26049	secure
31	142.24	97.56	100.00	100	100	100	100	100	1	99.02497	1	97.56	97.56242	1	0.94	91.70867	secure
32	139.87	95.94	100.00	100	100	100	100	100	1	98.37473	1	95.94	95.93683	1	0.94	90.18062	secure
33	134.24	87.47	100.00	100	100	100	100	100	1	94.98858	1	87.47	87.47146	0.9	0.88	69.27739	secure
34	133.33	86.88	100.00	100	100	100	100	100	1	94.7514	1	86.88	86.87849	0.9	0.88	68.80777	secure
35	122.27	83.86	100.00	100	100	100	100	100	1	93.546	1	83.86	83.86499	0.95	0.88	70.11113	secure
36	115.67	75.37	100.00	100	100	100	100	100	1	90.14846	1	75.37	75.37115	0.8	0.77	46.42863	secure
37	109.92	70.68	100.00	100	100	100	100	100	1	88.2728	1	70.68	70.682	0.9	0.86	54.70786	secure
38	142.00	82.41	100.00	100	100	100	100	100	1	92.96307	1	82.41	82.40767	0.88	0.85	61.64094	secure
39	134.56	78.09	100.00	100	100	100	100	100	1	91.23599	1	78.09	78.08997	0.76	0.74	43.9178	secure
40	126.98	77.57	100.00	100	100	100	100	100	1	91.0278	1	77.57	77.5695	0.88	0.85	58.02199	secure
41	125.40	76.60	100.00	100	100	100	100	100	1	90.64173	1	76.60	76.60431	0.68	0.66	34.38002	needs to be evaluated
42	129.90	79.35	100.00	100	100	100	100	100	1	91.74131	1	79.35	79.35327	0.77	0.74	45.21549	secure
43	132.34	72.96	100.00	100	100	100	100	100	1	89.18462	1	72.96	72.96155	1	0.96	70.04308	secure
44	133.67	77.57	100.00	100	100	70	100	100	1	88.01469	1	70.00	70	1	0.96	67.2	secure
45	142.24	82.55	100.00	100	100	70	100	100	1	89.00939	1	70.00	70	1	0.96	67.2	secure
46	139.87	81.17	100.00	100	100	70	100	100	1	88.73431	1	70.00	70	1	0.96	67.2	secure
47	122.21	74.66	100.00	100	100	70	100	100	1	87.43112	1	70.00	70	1	0.96	67.2	secure
48	124.45	72.22	100.00	100	100	100	100	100	1	88.88911	1	72.22	72.22278	1	0.96	69.33387	secure
49	118.89	69.00	100.00	100	100	100	100	100	1	87.59844	1	69.00	68.99611	1	1	68.99611	secure
50	109.90	63.78	100.00	100	100	100	100	100	1	85.51156	1	63.78	63.77889	1	1	63.77889	secure
51	111.11	64.48	100.00	100	100	100	100	100	1	85.79244	1	64.48	64.4811	1	0.97	62.54667	secure
52	122.23	74.67	100.00	100	100	100	100	100	1	89.86713	1	74.67	74.66782	0.88	0.85	55.85153	secure
53	133.12	81.32	100.00	100	90	100	100	100	1	91.52812	1	81.32	81.3203	0.76	0.74	45.73454	secure
54	123.32	75.33	100.00	100	90	70	100	100	1	86.56674	1	70.00	70	0.88	0.85	52.36	secure
55	122.89	75.07	100.00	100	90	100	100	100	1	89.0284	1	75.07	75.071	0.68	0.66	33.69187	needs to be evaluated

Table A.2.General overview of damage qualification integrated P25 results for buildings no: 56-96

56	114.32	69.84	100.00	100	90	100	100	100	1	86.93431	1	69.84	69.83577	0.77	0.74	39.79242	secure
57	112.23	65.13	100.00	100	100	100	100	100	1	86.05243	1	65.13	65.13108	1	0.96	62.52583	secure
58	121.98	54.62	70.00	100	100	100	100	100	1	80.34949	1	54.62	54.62372	1	0.96	52.43877	secure
59	142.00	68.68	70.00	100	100	100	100	100	1	85.97038	1	68.68	68.67596	1	0.96	65.92892	secure
60	134.56	62.67	70.00	100	100	100	100	100	1	83.56697	1	62.67	62.66744	1	0.96	60.16074	secure
61	126.98	56.86	70.00	100	100	100	100	100	1	81.2451	1	56.86	56.86276	1	0.96	54.58825	secure
62	125.40	56.16	70.00	100	100	100	100	100	1	80.96209	1	56.16	56.15522	0.61	0.53	18.15498	needs to be evaluated
63	129.90	55.26	70.00	100	100	100	100	35	1	70.05237	1	35.00	35	0.89	0.84	26.06009	needs to be evaluated
64	132.34	60.80	70.00	100	100	100	100	35	1	71.16077	1	35.00	35	0.93	0.87	28.45521	needs to be evaluated
65	133.67	59.14	60.00	100	90	100	100	35	1	69.32806	1	35.00	35	1	0.94	32.9	needs to be evaluated
66	142.24	60.51	70.00	100	90	100	100	35	1	70.1023	1	35.00	35	0.96	0.90	30.32064	needs to be evaluated
67	139.87	59.50	60.00	100	90	100	100	35	1	69.40065	1	35.00	35	0.91	0.86	27.24449	needs to be evaluated
68	134.24	57.11	70.00	100	90	100	100	35	1	69.42163	1	35.00	35	0.92	0.86	27.84656	needs to be evaluated
69	133.33	56.27	60.00	100	100	100	100	35	1	69.75345	1	35.00	35	0.93	0.87	28.45521	needs to be evaluated
70	122.27	51.18	70.00	100	90	70	100	35	1	66.73673	1	35.00	35	0.78	0.73	20.01636	needs to be evaluated
71	115.67	48.03	60.00	100	90	100	100	35	1	67.10543	1	35.00	35	0.88	0.83	25.47776	needs to be evaluated
72	109.92	45.27	60.00	100	100	100	100	35	1	67.55312	1	35.00	35	0.86	0.81	24.33284	needs to be evaluated
73	142.00	57.99	60.00	100	100	100	100	35	1	70.09861	1	35.00	35	0.77	0.72	19.50641	needs to be evaluated
74	134.56	54.50	60.00	100	90	100	100	35	1	68.39931	1	35.00	35	1	0.94	32.9	needs to be evaluated
75	96.67	38.82	60.00	100	90	100	100	35	1	65.26444	1	35.00	35	1	0.94	32.9	needs to be evaluated
76	139.87	67.65	60.00	100	90	100	60	35	1	65.02916	1	35.00	35	1	0.94	32.9	needs to be evaluated
77	122.21	62.22	70.00	100	90	100	60	35	1	64.44313	1	35.00	35	1	0.94	32.9	needs to be evaluated
78	124.45	57.18	60.00	100	90	100	60	35	1	62.93576	1	35.00	35	0.93	0.87	28.45521	needs to be evaluated
79	118.89	57.50	60.00	100	90	70	60	35	1	61.49984	1	35.00	35	0.94	0.88	29.07044	needs to be evaluated
80	109.90	50.49	60.00	100	90	100	60	35	1	61.59875	1	35.00	35	0.95	0.89	29.69225	needs to be evaluated
81	111.11	56.56	60.00	100	90	100	60	35	1	62.81295	1	35.00	35	0.87	1	30.45	needs to be evaluated
82	122.23	59.11	70.00	100	90	100	60	35	1	63.8229	1	35.00	35	0.88	1	30.8	needs to be evaluated
83	96.87	49.32	70.00	100	90	100	60	35	1	61.86307	1	35.00	35	0.89	1	31.15	needs to be evaluated
84	89.90	43.48	60.00	100	90	100	60	35	1	60.19573	1	35.00	35	0.66	0.54	12.474	needs to be evaluated
85	75.60	40.51	70.00	100	90	100	60	35	1	60.10254	1	35.00	35	0.77	0.65	17.5175	needs to be evaluated
86	99.80	45.85	60.00	100	90	100	60	35	1	60.67066	1	35.00	35	0.95	0.9	29.925	needs to be evaluated
87	71.50	34.58	60.00	100	90	100	60	35	1	58.33192	0.987489	34.58	34.14718	1	0.96	32.78129	needs to be evaluated
88	74.30	34.14	60.00	100	90	100	60	35	1	58.15491	0.986162	34.14	33.66487	1	0.96	32.31828	needs to be evaluated
89	127.70	65.01	60.00	100	90	100	60	35	1	64.5021	1	35.00	35	1	0.94	32.9	needs to be evaluated
90	121.10	61.65	60.00	100	90	100	60	35	1	63.83011	1	35.00	35	1	0.96	33.6	needs to be evaluated
91	127.30	82.95	100.00	100	100	70	45	100	1	75.83986	1	45.00	45	1	1	45	secure
92	129.66	84.49	100.00	100	100	100	45	100	1	77.64742	1	45.00	45	1	1	45	secure
93	115.60	79.29	100.00	100	100	100	45	100	1	76.60801	1	45.00	45	1	0.92	41.4	secure
94	108.00	70.37	100.00	100	100	70	45	100	1	73.32467	1	45.00	45	0.88	0.85	33.66	needs to be evaluated
95	111.23	71.52	100.00	100	100	100	45	100	1	75.05487	1	45.00	45	1	0.86	38.7	secure
96	121.24	76.92	100.00	100	100	70	45	100	1	74.63433	1	45.00	45	0.89	0.84	33.642	needs to be evaluated

Table A.3. General overview of damage qualification integrated P25 results for buildings 97-141

97	111.65	76.10	100.00	100	100	70	45	100	1	74.47042	1	45.00	45	0.94	0.89	37.647	secure
98	114.76	82.34	100.00	100	100	70	45	100	1	75.71777	1	45.00	45	0.79	0.75	26.6625	needs to be evaluated
99	112.87	80.98	100.00	100	100	70	45	100	1	75.44656	1	45.00	45	0.89	0.83	33.2415	needs to be evaluated
100	118.43	84.97	100.00	100	100	100	45	100	1	77.74441	1	45.00	45	0.87	0.82	32.103	needs to be evaluated
101	108.70	46.31	50.00	77	70	70	60	100	1	62.07362	1	46.31	46.30905	0.75	0.7	24.31225	needs to be evaluated
102	104.40	44.48	50.00	79.5	70	100	60	100	1	63.21585	1	44.48	44.47713	0.87	0.82	31.72999	needs to be evaluated
103	101.12	43.35	50.00	82	70	70	60	100	1	61.64028	1	43.35	43.35071	0.67	0.61	17.71743	needs to be evaluated
104	99.98	46.81	50.00	83.6	70	100	60	100	1	64.76392	1	46.81	46.8098	0.76	0.72	25.61432	needs to be evaluated
105	85.60	39.11	50.00	81.2	70	70	60	100	1	59.8246	1	39.11	39.11149	1	1	39.11149	secure
106	79.90	34.04	50.00	84.4	70	70	60	100	1	58.2758	1	34.04	34.03949	1	1	34.03949	needs to be evaluated
107	107.70	48.23	70.00	86	100	100	100	35	1	66.5458	1	35.00	35	1	1	35	secure
108	121.10	55.64	70.00	84	100	70	100	35	1	66.22792	1	35.00	35	1	1	35	secure
109	133.67	59.14	60.00	92	90	100	100	35	1	68.12806	1	35.00	35	1	1	35	secure
110	113.30	45.66	70.00	88	90	100	100	35	1	65.33261	1	35.00	35	1	1	35	secure
111	139.87	59.50	60.00	83	90	70	100	35	1	65.35065	1	35.00	35	1	1	35	secure
112	112.30	45.26	70.00	82	90	100	100	35	1	64.35201	1	35.00	35	1	1	35	secure
113	122.20	52.39	50.00	76.5	90	70	60	35	1	56.45256	0.973394	35.00	34.0688	1	1	34.0688	needs to be evaluated
114	101.10	47.33	50.00	77.7	90	70	60	35	1	55.62183	0.967164	35.00	33.85073	1	1	33.85073	needs to be evaluated
115	89.40	40.85	50.00	74.4	90	70	60	35	1	53.82955	0.953722	35.00	33.38026	1	1	33.38026	needs to be evaluated
116	94.40	40.22	50.00	83.3	90	70	60	35	1	55.03837	0.962788	35.00	33.69757	0.86	0.79	22.89413	needs to be evaluated
117	99.60	44.60	50.00	84.9	90	70	60	35	1	56.15535	0.971165	35.00	33.99078	0.88	0.77	23.03215	needs to be evaluated
118	98.80	45.39	50.00	86.67	90	70	60	35	1	56.57927	0.974345	35.00	34.10206	1	1	34.10206	needs to be evaluated
119	95.50	42.25	50.00	81.17	90	70	60	35	1	55.12601	0.963445	35.00	33.72058	1	0.83	27.98808	needs to be evaluated
120	121.06	70.26	100.00	100	100	100	100	100	1	88.10218	1	70.26	70.25544	0.92	0.82	53.0007	secure
121	128.89	78.74	100.00	100	100	100	100	100	1	91.49451	1	78.74	78.73628	1	1	78.73628	secure
122	121.21	70.34	100.00	83.9	100	50	100	100	1	79.1535	1	50.00	50	1	0.96	48	secure
123	112.34	65.19	100.00	100	100	50	100	100	1	80.53898	1	50.00	50	1	1	50	secure
124	114.23	66.29	100.00	100	100	70	100	100	1	85.0167	1	66.29	66.29175	1	0.92	60.98841	secure
125	118.80	68.94	100.00	100	100	50	100	100	1	81.28878	1	50.00	50	0.88	0.82	36.08	secure
126	126.60	77.34	100.00	88.98	100	100	100	100	1	89.28195	1	77.34	77.33737	1	0.86	66.51014	secure
127	122.67	74.94	100.00	84.4	90	100	100	100	1	86.63464	1	74.94	74.93661	1	0.88	65.94422	secure
128	102.22	46.71	50.00	71.2	70	70	60	100	1	61.36213	1	46.71	46.70533	1	0.96	44.83712	secure
129	96.60	41.15	50.00	84.4	70	70	60	100	1	61.12165	1	41.15	41.15413	1	0.92	37.8618	secure
130	111.30	49.84	70.00	86	100	100	100	35	1	66.86822	1	35.00	35	0.88	0.8	24.64	needs to be evaluated
131	104.40	47.97	70.00	83.5	100	70	100	35	1	64.61835	1	35.00	35	0.78	0.7	19.11	needs to be evaluated
132	112.20	49.64	60.00	81.1	90	100	100	35	1	64.59324	1	35.00	35	0.82	0.78	22.386	needs to be evaluated
133	115.70	46.63	70.00	87.4	90	100	100	35	1	65.43607	1	35.00	35	0.8	0.76	21.28	needs to be evaluated
134	99.80	42.78	50.00	77.6	70	50	45	25	1	46.44696	0.898352	25.00	22.45881	1	1	22.45881	needs to be evaluated
135	97.70	45.74	50.00	78.8	70	50	45	25	1	47.21846	0.904138	25.00	22.60346	0.77	0.7	12.18327	needs to be evaluated
136	101.20	46.24	50.00	71.2	70	50	45	25	1	46.17786	0.896334	25.00	22.40835	0.94	0.89	18.74682	needs to be evaluated
137	105.50	44.95	50.00	77.6	70	50	45	25	1	46.87915	0.901594	25.00	22.53984	0.96	0.88	19.04166	needs to be evaluated
138	89.90	40.26	50.00	81.07	70	50	45	25	1	46.4621	0.898466	25.00	22.46164	0.96	0.86	18.54433	needs to be evaluated
139	99.80	45.85	50.00	71.1	70	50	45	25	1	46.08566	0.895642	25.00	22.39106	0.96	0.86	18.48606	needs to be evaluated
140	95.40	42.21	50.00	77.3	70	50	45	25	1	46.28666	0.89715	25.00	22.42875	0.96	0.86	18.51718	needs to be evaluated
141	93.30	37.60	50.00	83.9	70	50	45	25	1	46.3555	0.897666	25.00	22.44166	0.94	0.89	18.77469	needs to be

Table A.4. General overview of damage qualification integrated P25 results for buildings 142-150

																	evaluated
142	98.80	42.09	50.00	81.1	90	50	45	25	1	48.83328	0.91625	25.00	22.90624	0.93	0.88	18.74647	needs to be evaluated
143	87.70	39.27	50.00	81.07	70	50	45	25	1	46.26507	0.896988	25.00	22.4247	1	0.88	19.73374	needs to be evaluated
144	88.90	40.85	50.00	73.94	70	50	45	25	1	45.51005	0.891325	25.00	22.28314	0.92	0.86	17.63042	needs to be evaluated
145	83.40	36.90	50.00	81.2	90	50	45	25	1	47.80982	0.908574	25.00	22.71434	0.86	0.84	16.40884	needs to be evaluated
146	98.70	45.35	70.00	73.44	70	50	45	25	1	47.33558	0.905017	25.00	22.62542	0.82	0.8	14.84228	needs to be evaluated
147	93.20	41.23	60.00	73.12	70	50	45	25	1	45.96499	0.894737	25.00	22.36844	0.88	0.82	16.14106	needs to be evaluated
148	91.23	36.77	60.00	75.5	70	50	45	25	1	45.42865	0.890715	25.00	22.26787	0.96	0.9	19.23944	needs to be evaluated
149	93.40	39.79	50.00	78.6	90	50	45	25	1	47.99817	0.909986	25.00	22.74966	0.94	0.9	19.24621	needs to be evaluated
150	86.60	38.78	50.00	85.6	70	50	45	25	1	46.84605	0.901345	25.00	22.53363	0.92	0.88	18.24323	needs to be evaluated

Table A.5. General overview of damage qualification integrated Capacity Index results for buildings 1-53

	C_A	C_M	BCPI	CPI	(1-V)(1-H)	CPI_{final}	
1	0.85	0.9175	1.8	1.403775	0.9	1.263398	needs to be evaluated
2	0.85	0.9175	1.73	1.349184	0.672	0.906651	needs to be evaluated
3	0.85	0.9175	1.72	1.341385	1	1.341385	needs to be evaluated
4	0.85	0.9175	1.7	1.325788	0.7209	0.95576	needs to be evaluated
5	0.85	0.9175	1.7	1.325788	0.837	1.109684	needs to be evaluated
6	0.85	0.9175	1.7	1.325788	1	1.325788	needs to be evaluated
7	0.85	0.9175	1.71	1.333586	0.864	1.152219	needs to be evaluated
8	0.85	0.9175	1.71	1.333586	0.819	1.092207	needs to be evaluated
9	0.85	0.9175	1.71	1.333586	0.828	1.104209	needs to be evaluated
10	0.85	0.9175	1.73	1.349184	0.837	1.129267	needs to be evaluated
11	0.85	0.9175	1.74	1.356983	0.5148	0.698575	needs to be evaluated
12	0.85	0.9175	1.75	1.364781	0.7656	1.044877	needs to be evaluated
13	0.85	0.9175	1.74	1.356983	0.688	0.933604	needs to be evaluated
14	0.85	0.9175	1.72	1.341385	0.5775	0.77465	needs to be evaluated
15	0.85	0.9175	1.74	1.356983	1	1.356983	needs to be evaluated
16	0.85	0.9175	1.71	1.333586	0.8	1.066869	needs to be evaluated
17	0.85	0.9175	1.3	1.013838	0.8	0.81107	needs to be evaluated
18	0.85	0.9175	1.29	1.006039	0.8	0.804831	needs to be evaluated
19	0.85	0.9175	1.29	1.006039	0.9768	0.982699	needs to be evaluated
20	0.85	0.9175	1.29	1.006039	0.846	0.851109	needs to be evaluated
21	0.85	0.9175	1.29	1.006039	0.855	0.860163	needs to be evaluated
22	0.85	0.9175	1.29	1.006039	0.616	0.61972	needs to be evaluated
23	0.85	0.9175	1.29	1.006039	0.801	0.805837	needs to be evaluated
24	0.85	0.9175	1.73	1.349184	0.704	0.949825	needs to be evaluated
25	0.85	0.9175	1.75	1.364781	0.6083	0.830196	needs to be evaluated
26	0.85	0.9175	1.75	1.364781	0.96	1.31019	needs to be evaluated
27	0.85	0.9175	1.75	1.364781	0.96	1.31019	needs to be evaluated
28	0.85	0.9175	1.74	1.356983	0.96	1.302703	needs to be evaluated
29	0.85	0.9175	2.1	1.637738	0.94	1.539473	secure
30	0.85	0.9175	2.12	1.653335	0.94	1.554135	secure
31	0.85	0.9175	2.31	1.801511	0.94	1.693421	secure
32	0.85	0.9175	2.26	1.762518	0.94	1.656766	secure
33	0.85	0.9175	2.1	1.637738	0.792	1.297088	needs to be evaluated
34	0.85	0.9175	2.2	1.715725	0.792	1.358854	needs to be evaluated
35	0.85	0.9175	2.2	1.715725	0.836	1.434346	needs to be evaluated
36	0.85	0.9175	2.06	1.606543	0.616	0.98963	needs to be evaluated
37	0.85	0.9175	2.01	1.567549	0.774	1.213283	needs to be evaluated
38	0.85	0.9175	2.06	1.606543	0.748	1.201694	needs to be evaluated
39	0.85	0.9175	2.05	1.598744	0.5624	0.899133	needs to be evaluated
40	0.85	0.9175	2.05	1.598744	0.748	1.19586	needs to be evaluated
41	0.85	0.9175	1.96	1.528555	0.4488	0.686015	needs to be evaluated
42	0.85	0.9175	2.08	1.62214	0.5698	0.924295	needs to be evaluated
43	0.85	0.9175	1.98	1.544153	0.96	1.482386	needs to be evaluated
44	0.85	0.9175	1.99	1.551951	0.96	1.489873	needs to be evaluated
45	0.85	0.9175	1.99	1.551951	0.96	1.489873	needs to be evaluated
46	0.85	0.9175	1.96	1.528555	0.96	1.467413	needs to be evaluated
47	0.85	0.9175	1.99	1.551951	0.96	1.489873	needs to be evaluated
48	0.85	0.9175	1.85	1.442769	0.96	1.385058	needs to be evaluated
49	0.85	0.9175	1.89	1.473964	1	1.473964	needs to be evaluated
50	0.85	0.9175	1.86	1.450568	1	1.450568	needs to be evaluated
51	0.85	0.9175	1.81	1.411574	0.97	1.369227	needs to be evaluated
52	0.85	0.9175	1.83	1.427171	0.748	1.067524	needs to be evaluated
53	0.85	0.9175	2.09	1.629939	0.5624	0.916678	needs to be evaluated

Table A.6. General overview of damage qualification integrated Capacity Index results for buildings 54-111

54	0.85	0.9175	1.84	1.43497	0.748	1.073358	needs to be evaluated
55	0.85	0.9175	1.85	1.442769	0.4488	0.647515	needs to be evaluated
56	0.85	0.9175	1.84	1.43497	0.5698	0.817646	needs to be evaluated
57	0.85	0.9175	1.81	1.411574	0.96	1.355111	needs to be evaluated
58	0.85	0.9175	1.73	1.349184	0.96	1.295216	needs to be evaluated
59	0.85	0.9175	1.88	1.466165	0.96	1.407518	needs to be evaluated
60	0.85	0.9175	1.81	1.411574	0.96	1.355111	needs to be evaluated
61	0.85	0.9175	1.84	1.43497	0.96	1.377571	needs to be evaluated
62	0.85	0.9175	1.77	1.380379	0.3233	0.446276	needs to be evaluated
63	0.85	0.9175	1.28	0.99824	0.744574	0.743264	needs to be evaluated
64	0.85	0.9175	1.27	0.990441	0.813006	0.805235	needs to be evaluated
65	0.85	0.9175	1.22	0.951448	0.94	0.894361	needs to be evaluated
66	0.85	0.9175	1.29	1.006039	0.866304	0.871535	needs to be evaluated
67	0.85	0.9175	1.18	0.920253	0.778414	0.716337	needs to be evaluated
68	0.85	0.9175	1.17	0.912454	0.795616	0.725963	needs to be evaluated
69	0.85	0.9175	1.13	0.881259	0.813006	0.716469	needs to be evaluated
70	0.85	0.9175	1.12	0.87346	0.571896	0.499528	needs to be evaluated
71	0.85	0.9175	1.19	0.928051	0.727936	0.675562	needs to be evaluated
72	0.85	0.9175	1.19	0.928051	0.695224	0.645204	needs to be evaluated
73	0.85	0.9175	1.21	0.943649	0.557326	0.52592	needs to be evaluated
74	0.85	0.9175	1.208	0.942089	0.94	0.885564	needs to be evaluated
75	0.5	0.9175	1.199	0.550041	0.94	0.517039	needs to be evaluated
76	0.5	0.9175	1.192	0.54683	0.94	0.51402	needs to be evaluated
77	0.5	0.9175	1.191	0.546371	0.94	0.513589	needs to be evaluated
78	0.5	0.9175	1.189	0.545454	0.813006	0.443457	needs to be evaluated
79	0.5	0.9175	1.18	0.541325	0.830584	0.449616	needs to be evaluated
80	0.5	0.9175	1.18	0.541325	0.84835	0.459233	needs to be evaluated
81	0.5	0.9175	1.03	0.472513	0.87	0.411086	needs to be evaluated
82	0.5	0.9175	1.06	0.486275	0.88	0.427922	needs to be evaluated
83	0.5	0.9175	1.04	0.4771	0.89	0.424619	needs to be evaluated
84	0.5	0.9175	1.08	0.49545	0.3564	0.176578	needs to be evaluated
85	0.5	0.9175	1.03	0.472513	0.5005	0.236493	needs to be evaluated
86	0.5	0.9175	1.07	0.490863	0.855	0.419687	needs to be evaluated
87	0.5	0.9175	1.01	0.463338	0.96	0.444804	needs to be evaluated
88	0.5	0.9175	1.01	0.463338	0.96	0.444804	needs to be evaluated
89	0.5	0.9175	1.1	0.504625	0.94	0.474348	needs to be evaluated
90	0.5	0.9175	1.13	0.518388	0.96	0.497652	needs to be evaluated
91	0.85	0.9175	1.23	0.959246	1	0.959246	needs to be evaluated
92	0.85	0.9175	1.24	0.967045	1	0.967045	needs to be evaluated
93	0.85	0.9175	1.26	0.982643	0.92	0.904031	needs to be evaluated
94	0.85	0.9175	1.27	0.990441	0.748	0.74085	needs to be evaluated
95	0.85	0.9175	1.32	1.029435	0.86	0.885314	needs to be evaluated
96	0.85	0.9175	1.22	0.951448	0.7476	0.711302	needs to be evaluated
97	0.85	0.9175	1.26	0.982643	0.8366	0.822079	needs to be evaluated
98	0.85	0.9175	1.22	0.951448	0.5925	0.563733	needs to be evaluated
99	0.85	0.9175	1.24	0.967045	0.7387	0.714356	needs to be evaluated
100	0.85	0.9175	1.23	0.959246	0.7134	0.684326	needs to be evaluated
101	0.5	0.9175	1.207	0.553711	0.525	0.290698	needs to be evaluated
102	0.5	0.9175	1.103	0.506001	0.7134	0.360981	needs to be evaluated
103	0.5	0.9175	1.06	0.486275	0.4087	0.198741	needs to be evaluated
104	0.5	0.9175	1.12	0.5138	0.5472	0.281151	needs to be evaluated
105	0.5	0.9175	1.06	0.486275	1	0.486275	needs to be evaluated
106	0.5	0.9175	1.02	0.467925	1	0.467925	needs to be evaluated
107	0.5	0.9175	1.1	0.504625	1	0.504625	needs to be evaluated
108	0.5	0.9175	1.12	0.5138	1	0.5138	needs to be evaluated
109	0.5	0.9175	1.14	0.522975	1	0.522975	needs to be evaluated
110	0.5	0.9175	1.11	0.509213	1	0.509213	needs to be evaluated
111	0.5	0.9175	1.117	0.512424	1	0.512424	needs to be evaluated

Table A.7. General overview of damage qualification integrated Capacity Index results for buildings 112-150

112	0.5	0.9175	1.108	0.508295	1	0.508295	needs to be evaluated
113	0.5	0.9175	1.04	0.4771	1	0.4771	needs to be evaluated
114	0.5	0.9175	1.03	0.472513	1	0.472513	needs to be evaluated
115	0.5	0.9175	1.05	0.481688	1	0.481688	needs to be evaluated
116	0.5	0.9175	1.02	0.467925	0.6794	0.317908	needs to be evaluated
117	0.5	0.9175	1.03	0.472513	0.6776	0.320174	needs to be evaluated
118	0.5	0.9175	1.032	0.47343	1	0.47343	needs to be evaluated
119	0.5	0.9175	1.034	0.474348	0.83	0.393708	needs to be evaluated
120	0.85	0.9175	1.94	1.512958	0.7544	1.141375	needs to be evaluated
121	0.85	0.9175	1.968	1.534794	1	1.534794	secure
122	0.85	0.9175	1.32	1.029435	0.96	0.988258	needs to be evaluated
123	0.85	0.9175	1.38	1.076228	1	1.076228	needs to be evaluated
124	0.85	0.9175	1.43	1.115221	0.92	1.026004	needs to be evaluated
125	0.85	0.9175	1.407	1.097284	0.7216	0.7918	needs to be evaluated
126	0.85	0.9175	1.84	1.43497	0.86	1.234074	needs to be evaluated
127	0.85	0.9175	1.79	1.395976	0.88	1.228459	needs to be evaluated
128	0.85	0.9175	1.15	0.896856	0.96	0.860982	needs to be evaluated
129	0.85	0.9175	1.13	0.881259	0.92	0.810758	needs to be evaluated
130	0.85	0.9175	1.19	0.928051	0.704	0.653348	needs to be evaluated
131	0.85	0.9175	1.105	0.861762	0.546	0.470522	needs to be evaluated
132	0.85	0.9175	1.12	0.87346	0.6396	0.558665	needs to be evaluated
133	0.85	0.9175	1.12	0.87346	0.608	0.531064	needs to be evaluated
134	0.5	0.9175	0.97	0.444988	1	0.444988	needs to be evaluated
135	0.5	0.9175	0.974	0.446823	0.539	0.240837	needs to be evaluated
136	0.5	0.9175	0.97	0.444988	0.8366	0.372277	needs to be evaluated
137	0.5	0.9175	0.973	0.446364	0.8448	0.377088	needs to be evaluated
138	0.5	0.9175	0.971	0.445446	0.8256	0.36776	needs to be evaluated
139	0.5	0.9175	0.976	0.44774	0.8256	0.369654	needs to be evaluated
140	0.5	0.9175	0.98	0.449575	0.8256	0.371169	needs to be evaluated
141	0.5	0.9175	0.965	0.442694	0.8366	0.370358	needs to be evaluated
142	0.5	0.9175	0.976	0.44774	0.8184	0.36643	needs to be evaluated
143	0.5	0.9175	0.979	0.449116	0.88	0.395222	needs to be evaluated
144	0.5	0.9175	0.986	0.452328	0.7912	0.357882	needs to be evaluated
145	0.5	0.9175	0.982	0.450493	0.7224	0.325436	needs to be evaluated
146	0.5	0.9175	0.974	0.446823	0.656	0.293116	needs to be evaluated
147	0.5	0.9175	0.972	0.445905	0.7216	0.321765	needs to be evaluated
148	0.5	0.9175	0.971	0.445446	0.864	0.384866	needs to be evaluated
149	0.5	0.9175	0.969	0.444529	0.846	0.376071	needs to be evaluated
150	0.5	0.9175	0.976	0.44774	0.8096	0.36249	needs to be evaluated

Table A.8. General overview of structural parameters of systems no: 1-30 and 135-150 according to the linear elastic method and performance levels (LD:Limited Damage; CD:Controlled Damage; CP:Collapse Prevention ; 98+: construction year after 1998; 98-: construction year before 1998)

ID	System	Story	Date	Concrete	Rebar	V_t/W	T(sec)	Max.interstory drift ratio(Δ/h)	System level	$P_{25score}$	P_{25t}	CPI	CPI_{final}
1	Shear wall-frame	7	98+	C20	S420	0.34	0.56	0.0066	CD	60	54	1,40378	1,2634
2	Frame	4	98+	C20	S420	0.29	0.25	0.0081	CD	60	40,32	1,34918	0,90665
3	Shear wall-frame	7	98+	C20	S420	0.32	0.54	0.0062	CD	60	60	1,34139	1,34139
4	Frame	4	98+	C20	S420	0.27	0.22	0.0081	CD	60	43,254	1,32579	0,95576
5	Shear wall-frame	6	98+	C20	S420	0.3	0.48	0.0054	CD	60	50,22	1,32579	1,10968
6	Shear wall-frame	6	98+	C20	S420	0.32	0.51	0.0059	CD	60	60	1,32579	1,32579
7	Shear wall-frame	6	98+	C20	S420	0.31	0.46	0.0057	CD	60	51,84	1,33359	1,15222
8	Shear wall-frame	6	98+	C20	S420	0.34	0.45	0.0055	CD	60	49,14	1,33359	1,09221
9	Shear wall-frame	6	98+	C20	S420	0.31	0.49	0.0052	CD	60	49,68	1,33359	1,10421
10	Shear wall-frame	6	98+	C20	S420	0.31	0.43	0.0056	CD	60	50,22	1,34918	1,12927
11	Frame	5	98-	C20	S420	0.28	0.32	0.0077	CD	60	30,888	1,35698	0,69857
12	Shear wall-frame	6	98+	C20	S420	0.29	0.41	0.0074	CD	60	45,936	1,36478	1,04488
13	Frame	5	98+	C20	S420	0.28	0.35	0.0075	CD	60	41,28	1,35698	0,9336
14	Frame	5	98-	C20	S420	0.28	0.37	0.0069	CD	60	34,65	1,34139	0,77465
15	Shear wall-frame	6	98+	C20	S420	0.32	0.47	0.0051	CD	60	60	1,35698	1,35698
16	Shear wall-frame	6	98+	C20	S420	0.32	0.46	0.0053	CD	60	48	1,33359	1,06687
17	Shear wall-frame	6	98+	C20	S420	0.34	0.52	0.0051	CD	60	48	1,01384	0,81107
18	Shear wall-frame	6	98+	C20	S420	0.34	0.51	0.0052	CD	60	48	1,00604	0,80483
19	Shear wall-frame	6	98+	C20	S420	0.35	0.45	0.0062	CD	60	58,608	1,00604	0,9827
20	Shear wall-frame	6	98+	C20	S420	0.31	0.43	0.0053	CD	60	50,76	1,00604	0,85111
21	Shear wall-frame	6	98+	C20	S420	0.32	0.48	0.0051	CD	60	51,3	1,00604	0,86016
22	Frame	5	98-	C20	S420	0.25	0.33	0.0074	CD	60	36,96	1,00604	0,61972
23	Shear wall-frame	6	98+	C20	S420	0.34	0.49	0.0052	CD	60	48,06	1,00604	0,80584
24	Frame	5	98-	C20	S420	0.25	0.32	0.0072	CD	60	42,24	1,34918	0,94983
25	Frame	5	98-	C20	S420	0.26	0.33	0.0078	CD	60	36,498	1,36478	0,8302
26	Shear wall-frame	7	98+	C20	S420	0.31	0.55	0.0065	CD	60	57,6	1,36478	1,31019
27	Shear wall-frame	7	98+	C20	S420	0.32	0.52	0.0066	CD	60	57,6	1,36478	1,31019
28	Shear wall-frame	7	98+	C20	S420	0.33	0.53	0.0063	CD	60	57,6	1,35698	1,3027
29	Shear wall-frame	7	98+	C20	S420	0.39	0.54	0.0064	CD	90,2047	84,7924	1,63774	1,53947
30	Shear wall-frame	7	98+	C20	S420	0.42	0.51	0.0066	LD	92,8303	87,2605	1,65334	1,55413
135	Frame	5	98-	C18	S420	0.15	0.32	0.0097	CP	22,6035	12,1833	0,44682	0,24084
136	Frame	5	98-	C18	S420	0.14	0.32	0.0094	CP	22,4083	18,7468	0,44499	0,37228
137	Frame	5	98-	C16	S420	0.14	0.35	0.0096	CP	22,5398	19,0417	0,44636	0,37709
138	Frame	5	98-	C16	S420	0.18	0.33	0.0095	CP	22,4616	18,5443	0,44545	0,36776
139	Frame	5	98-	C16	S420	0.12	0.32	0.0088	CP	22,3911	18,4861	0,44774	0,36965
140	Frame	4	98-	C16	S420	0.11	0.27	0.0085	CP	22,4287	18,5172	0,44958	0,37117
141	Frame	4	98-	C16	S420	0.17	0.29	0.0089	CP	22,4417	18,7747	0,44269	0,37036
142	Frame	5	98-	C16	S420	0.15	0.33	0.0087	CP	22,9062	18,7465	0,44774	0,36643
143	Frame	5	98-	C18	S420	0.18	0.39	0.0081	CP	22,4247	19,7337	0,44912	0,39522
144	Frame	5	98-	C18	S420	0.19	0.35	0.0091	CP	22,2831	17,6304	0,45233	0,35788
145	Frame	5	98-	C18	S420	0.15	0.37	0.0092	CP	22,7143	16,4088	0,45049	0,32544
146	Frame	5	98-	C18	S420	0.15	0.34	0.0088	CP	22,6254	14,8423	0,44682	0,29312
147	Frame	5	98-	C16	S420	0.12	0.31	0.0084	CP	22,3684	16,1411	0,44591	0,32177
148	Frame	5	98-	C16	S420	0.15	0.35	0.0086	CP	22,2679	19,2394	0,44545	0,38487
149	Frame	5	98-	C16	S420	0.11	0.34	0.0081	CP	22,7497	19,2462	0,44453	0,37607
150	Frame	5	98-	C16	S420	0.12	0.38	0.0082	CP	22,5336	18,2432	0,44774	0,36249