Cartagena de Indias, Colombia
8 al 13 de octubre
2018

XXXVI CONVENCIÓN - ASAMBLEA
UPADI
Congreso Panamericano en construcciones seguras y manejo de desastres

IAEA
International Association of Engineering and Architecture

CONGRESO PANAMERICANO EN SEGURIDAD, CONSTRUCCIONES SEGURAS Y MANEJO DE DESASTRES

CARTAGENA DE INDIAS, COLOMBIA – 10 Y 11 DE OCTUBRE DE 2018

ANÁLISIS COMPARATIVO DEL COMPORTAMIENTO DE INGENIEROS APRENDICES Y ESTUDIANTES DE POSTGRADO FRENTE AL FORMATO DE INSPECCIÓN POST-SISMO DE BOGOTÁ (COLOMBIA)

COMPARATIVE ANALYSIS OF THE BEHAVIOR OF APPRENTICE ENGINEERS AND POSTGRADUATE ENGINEERS IN FRONT THE POST-EARTHQUAKE ASSESSMENT FORMAT OF BOGOTÁ. (COLOMBIA)

Zulma Stella Pardo Vargas[1]

RESUMEN

El formato de evaluación post-sismo de Bogotá, requiere que el inspector establezca el sistema estructural de la edificación que analiza. Una vez realizado lo anterior, el ingeniero determina si el predio es habitable o no y el porcentaje de daño que tiene el mismo. Este trabajo presenta un análisis comparativo entre tres investigaciones realizadas con ingenieros aprendices e ingenieros de postgrado, el grupo A tiene 37 ingenieros, el grupo B consta de 97 y el grupo de postgrado tiene 16. La importancia de estas inspecciones radica en que son determinantes para destinación de recursos de la oficina local de atención de emergencias, por esta razón es fundamental que las respuestas converjan.

A partir de este análisis comparativo se presentan recomendaciones para la conformación de grupos de trabajo, educación de inspectores, nuevos cursos de ingeniería civil y para las políticas públicas.

Palabras Clave

Evaluación post-sismo; política pública; sistemas estructurales; ingeniero aprendiz; ingeniero especialista en estructuras; daño estructural; oficina local de manejo de las emergencias.

[1] Zulma S. Pardo V. Civil Engineer. Master degree in Structures. Building Management Specialist. Specialist and Master Degree in ITC for education. CEO Z.J. Ingenieros Estructurales Ltda.

Abstract

post-earthquake inspection format of Bogotá, requires that an inspector establishes the structural system of the building.

Finally, he establishes if the building is habitable or not and the percentage of damage. This work presents the comparative analysis between three researches done with apprentice engineers and post-graduate engineers, the group A has 37 people, the group B has 97 people and the post-graduate group has 16 people. The importance of these inspections lies in the decisions of investment of resources that the local emergency management office takes. For this reason, is fundamental that the answers converge.

The results of this comparison and some proposals about to conformation of work group, education for inspectors, new courses in the civil engineering and recommendations for public policy are presented.

Keywords:

post-earthquake evaluation; public policy; structural system; apprentice engineer; specialist structural engineer; structural damage; local emergency management office

1. THE PROBLEM

In June and July of 2018, during the development of forensic engineering course in the Gran Colombia University (=UGC), this test was realized.

The test pretended to evaluate the capacity of identify structural systems and your possible damage post-earthquake in groups of apprentice engineers.

In this article, the problem is to establish, if the groups of apprentice engineers are able to determine correctly the structural system and they are able to qualify the structural damage using the post-earthquake assessment format current in Bogotá.

2. THE EXPERIMENT

2.1. THE PARTICIPANTS

The sample involved 97 participants, where all were students of civil engineering of fifth year in the Gran Colombia University. The participants stablished 26 groups composed for 2 groups of 6 people, 7 groups of 5 people, 7 groups of 4 people, 3 groups of 3 people, 5 groups of 2 people and 2 students worked alone. For this reason, are presented 26 answers in the results for each structure. The figure 1, presents this composition.

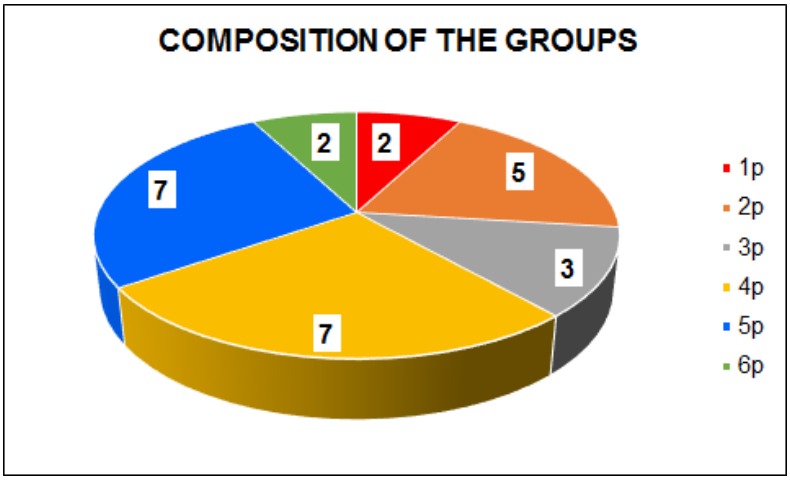

Figure 1.- Composition of the work groups. Source: Elaborated by Zulma S. Pardo V.

2.2. THE TEST

The experimental program used four damaged structures of the Ecuador earthquake of April 2016. With photos from different points, each participant has to evaluate de level of damage. The photos and more explanations is possible see in (Pardo).

In (Pardo), is presented a previous experiment with postgraduate students, and in (Pardo, Behavior of apprentice engineers in front the post-earthquake assessment format), are analyzed other test with apprentice engineers.

The photos for the three experiments are the same and they permit to establish de damage level and the structural system for one expert.

Each group or participant observed the photos during 10 minutes for structure. They wrote the structural system identified, the damage level and they chose the card for each building defining the percentage of damage.

When the test finished the author presented the correct evaluation for each structure.

2.3. POSSIBLE ANSWERS

For the first questions about structural system identification, the participants could choose:

1. Concrete frame
2. Steel frames
3. Dual system
4. Wood structural system
5. Mixed system
6. Masonry System.
7. NS/NR, when the participant could not identify the system between the previous.

For the second question, the damage level was evaluated across the following cards:

Green: When the structural stability of the building is not compromised and the habitants can live in them.

Yellow: When there is a part in the building with damage and localized. In this sector the habitants cannot live but in another sector of building is possible to live.

Orange: When the structural stability of the building is compromised but is not possible to determine if it is collapsed or not. The habitants cannot live in them. The structure requires more studies to determine if it is collapsed or not.

Red: When the structural stability of the building is compromised and the habitants cannot live in them. The building is named in collapse.

For the third question, the damage level was in percentage, this could be:

1. Between 0 to 10%.
2. Between 10% to 30%.
3. Between 30% to 50%.
4. Between 50% to 100%.

3. RESULTS ANALYSIS

The next figures present the results about the structural system. The figure 2, presents the results for Group A (=Gr A), object of this article and de Group B (=Gr B), results presented in (Pardo, Behavior of apprentice engineers in front the post-earthquake assessment format).

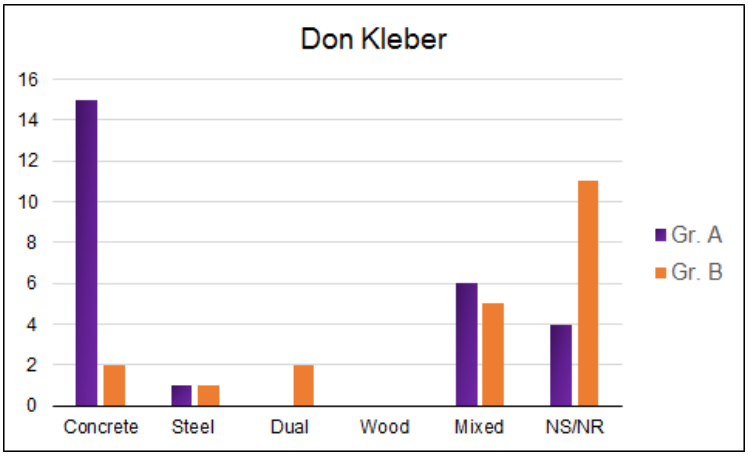

Figure 2.- Structural System. Source: Elaborated by Zulma S. Pardo V.

The correct answer was a steel system, both groups cannot identify the real system.

For Torre de Oro structure the real system is concrete structure. The students could not identify adequately and

the Gr B, thought was a dual system for the walls presented in the photos. These walls were in concrete with sea sand with aspect porous, probably the participants had a confusion for this reason.

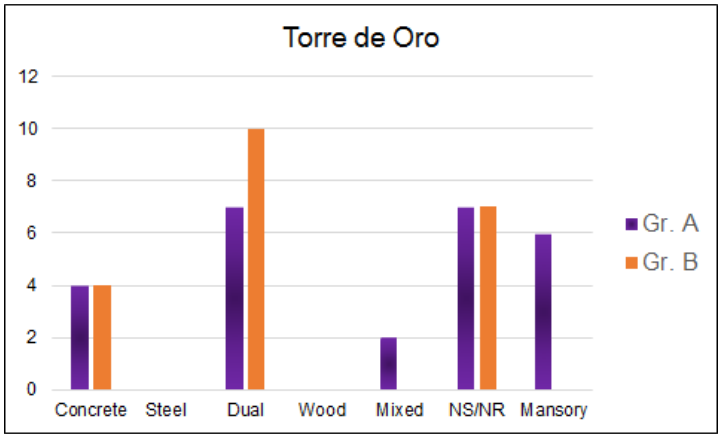

Figure 3.- Structural System. Source: Elaborated by Zulma S. Pardo V.

For Recarga, the real system is concrete structure. The Gr B had more doubts about the system respect Gr A.

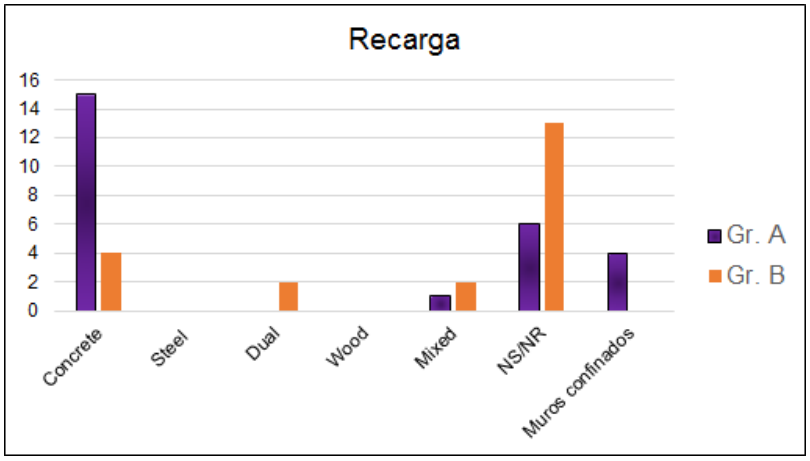

Figure 4.- Structural System. Source: Elaborated by Zulma S. Pardo V.

For Gaviotas, the real system is concrete structure. The Gr B had more doubts about the system respect Gr A.

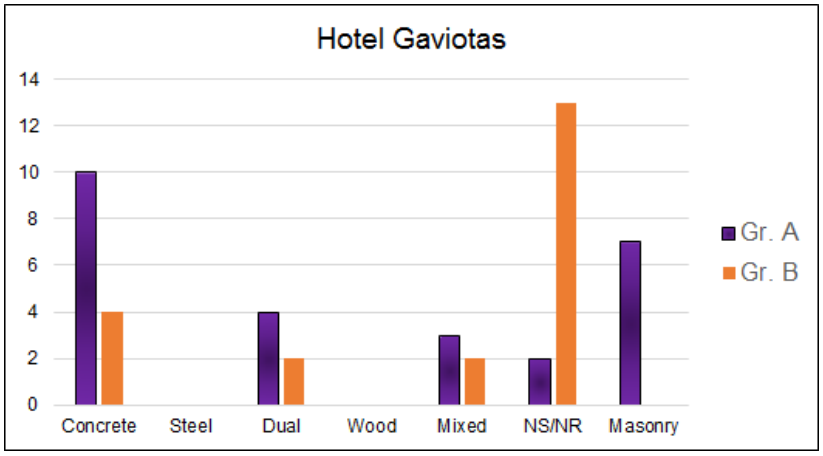

Figure 5.- Structural System. Source: Elaborated by Zulma S. Pardo V.

The figures 2 to 5, permit to establish that the apprentice engineers have difficult to identify the structural system. If they work in groups with more partners the answers are more disperse. The ambiguous answers (=NS/NR), are not attributable to groups with more participants.
For the local emergency management office is complicated to take decisions with this evaluation. The data could generate a solution wrong and the use of resources inadequate.

In the next figure, it is presented a comparison between three experiments, now is included post-graduate, more detail can be find in (Pardo, ¿Qué podriamos aprender del sismo de Ecuador de abril de 2016?).

For the selection of card there are convergence between Gr A. and post-graduate, while the Gr B has more dispersion.

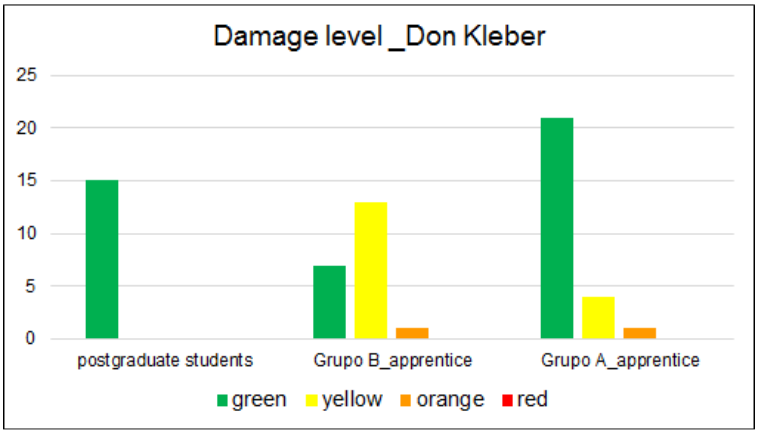

Figure 6.- Selection of card_Don Kleber. Source: Elaborated by Zulma S. Pardo V.

For the selection of card there are convergence between Gr B. and post-graduate, while the Gr A has more dispersion.

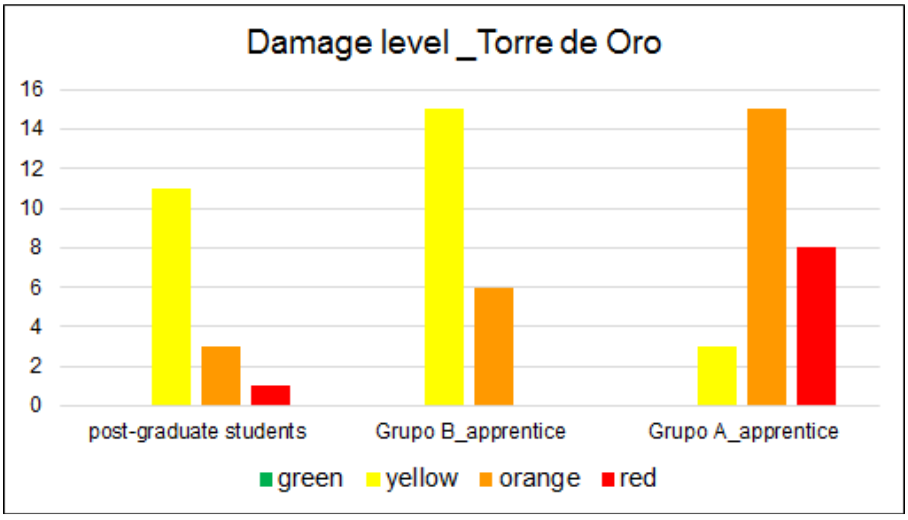

Figure 7.- Selection of card_Torre de Oro. Source: Elaborated by Zulma S. Pardo V.

For the selection of card there are convergence between Gr A. and post-graduate, while the Gr B has more dispersion.

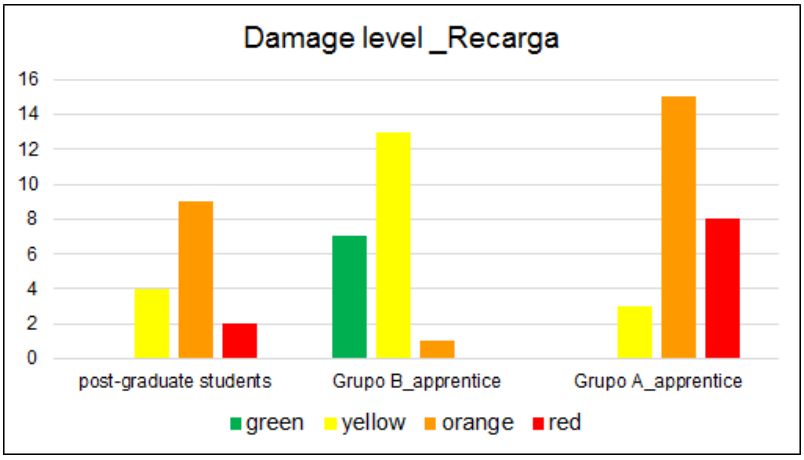

Figure 8.- Selection of card_Recarga. Source: Elaborated by Zulma S. Pardo V.

For the selection of card there are convergence between Gr A. and post-graduate, while the Gr B has more dispersion.

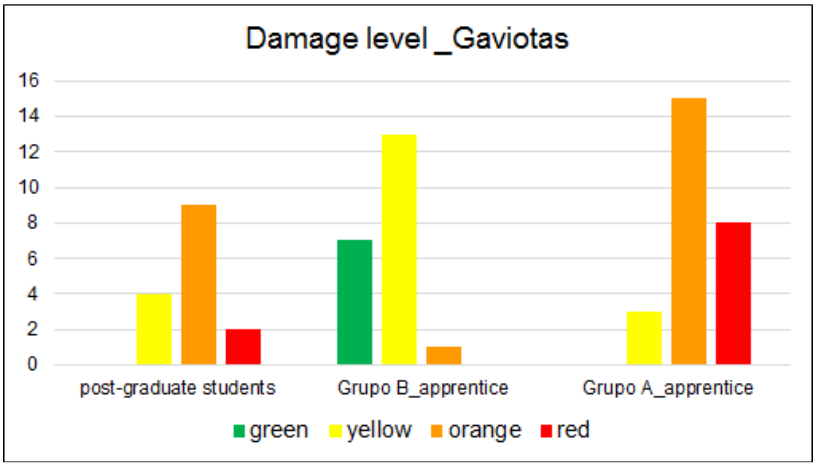

Figure 9.- Selection of card_Recarga. Source: Elaborated by Zulma S. Pardo V.

For the selection of de card there is convergence for post-graduate and Gr A, except in the case Torre de Oro.

About the results of percentage of damage. It is presented a comparison between Gr A and post-graduate students, only. Because for the Gr B, there are not data.

For Don Kleber structure the real percentage of damage is between 0-10%, the Gr A concluded the correct, while post-graduate did an evaluation inadequate.

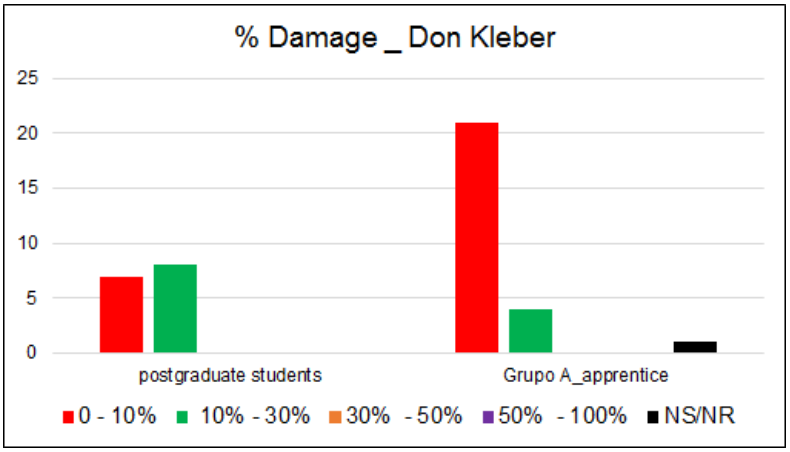

Figure 10.- Percentage of damage Don Kleber. Source: Elaborated by Zulma S. Pardo V.

For Torre de Oro structure the real percentage of damage is between 30-50%, the post-graduate concluded the right, while Gr A did an evaluation near to the real.

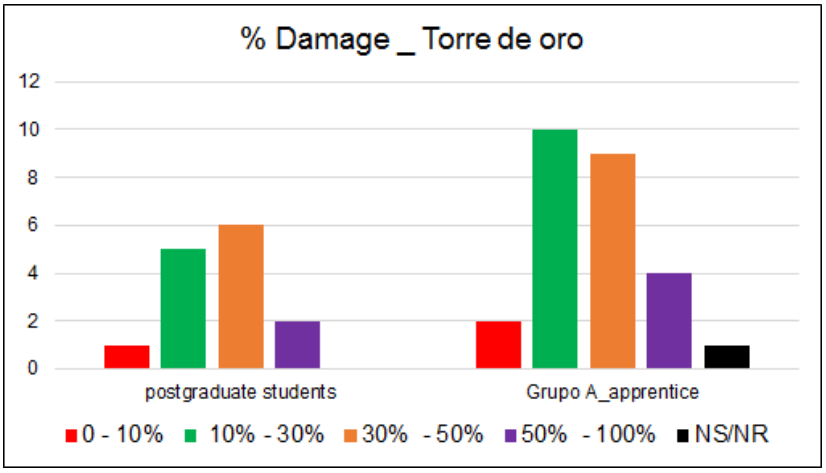

Figure 11.- Percentage of damage Torre de oro. Source: Elaborated by Zulma S. Pardo V.

For Recarga structure the real percentage of damage is between 30-50%, the post-graduate concluded the correct, while Gr A did an evaluation near to the real.

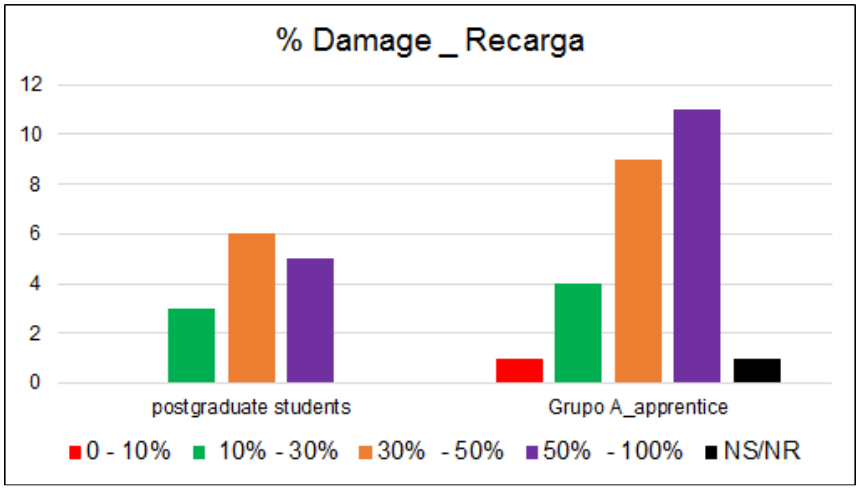

Figure 12.- Percentage of damage Recarga. Source: Elaborated by Zulma S. Pardo V.

For Gaviotas structure the real percentage of damage is between 50-100%, both groups concluded the correct. For collapsed structures the participant has not doubts.

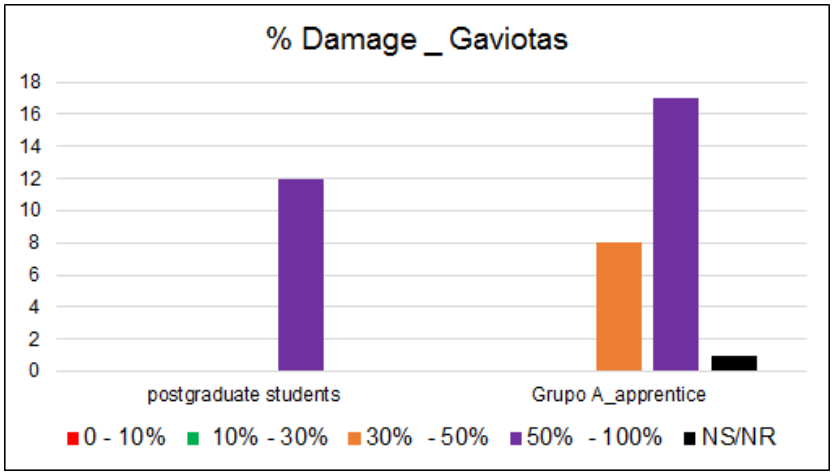

Figure 13.- Percentage of damage Recarga. Source: Elaborated by Zulma S. Pardo V.

4. CONCLUSIONS

1. The performance for post-earthquake assessment has more convergence when is realized for post-graduate or groups of apprentice engineers minimum of 4 people. For apprentice alone or with groups of less to 4 people there are no convergence in the selection of the card.
2. Equal that in previous studies (Pardo, Behavior of apprentice engineers in front the post-earthquake assessment format), (Pardo, ¿Qué podriamos aprender del sismo de Ecuador de abril de 2016?), the apprentice engineers have difficult to determine the structural system. The answers of post graduate students generate more dispersion in the results and more problems for the local emergency management office.
3. With a short instruction, concise and precise, about post-earthquake assessment, the apprentice engineers are able to evaluate a structure adequately.
4. The instructor for apprentice engineers have to know the objective of post-earthquake assessment format and he have to be concise, precise and clear in your instruction.
5. The author recommends to the local emergency management office, conformed groups minimum of 4 people for post-earthquake assessment if only is available apprentice engineers. If the office has post-graduate engineers in structures and they have an extra instruction in the post-earthquake assessment format and in the identification of failure structures. The post graduate engineers in structures with this additional instruction are able do the inspection without problems, of individual form.
6. The author recommends to establish in Bogotá levels for the post-earthquake inspectors, for level of studies and extra courses, so, when the emergency occurs, it will be easy for the local emergency management office to conform groups for the post-earthquake assessment.
7. The difficult to identify the structural system of both, apprentice engineers and post graduate students, justify the necessity of to study in depth the structural systems in the Colombian Universities, so much in undergraduate programs how in the post graduate courses.
8. The author recommends to create a new elective course in the Colombian Universities, named “Structural Systems”, where, each student obtain abilities for identify the different systems.

9. The governmental entities of risk management, in Colombia (UNGRD- Unidad de Gestión de Riesgos y Desastres), have to foment the instruction of civil engineers in this kind of formats and to promote periodic courses about this theme.
10. The (FOPAE_AIS), requires minimum 30 hours and practical exercises with revision of the teacher. The local emergency management office proposes a short course for upgrade of inspectors, the author considers this time is not enough for a good instruction and recommends minimum 20 hours for the upgrade.
11. The local emergency management office has to implement educational material available online for the instruction of inspectors and have to do periodic exams that validate the competence of them.
12. La Initiative CAPRA, (Platform), that will be in operation in October 2018, the author hopes consider the field conclusions that the different researches with post-earthquake assessment format have been presented.

5. REFERENCES

AIS. «Cartilla de evaluación Postsismo.» 2001.

FOPAE_AIS. *Guía de patologías constructivas, estructurales y no estructurales*. Tercera. Alcaldía de Bogotá, 2011.

Pardo, Zulma Stella. «¿Qué podriamos aprender del sismo de Ecuador de abril de 2016?» *Congreso Nacional de Ingeniería Sísmica*. Ed. Asociación Colombiana de Ingenería Sísmica (AIS). Barranquilla, 2017.

—. «Behavior of apprentice engineers in front the post-earthquake assessment format.» *Curso de Ingeniería Forense*. Ed. Intercenter_UGC. Bogotá, 2018.

Platform, CAPRA_Probabilist Risk Assessment. *https://elearning.ecapra.org/course/index.php?categoryid=1*. s.f. 15 de Septiembre de 2018.