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Criteria of Resistant Architectural Elements to Earthquakes in Rental House Building in Jakarta

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Abstract **Original Research Article**

This research was conducted with the aim of finding out a few architectural elements that are resistant to earthquakes in residential units of rental apartments in Jakarta. Jakarta has several flats for rent managed by the National Housing Corporation (Perumnas) regional business area 3. Jakarta is one of the cities that are at moderate earthquake risk and flats are included in the risk category II. As each rental flat is a family shelter, all building elements must be strong in responding to earthquake forces. Architectural elements include elements of reliability of buildings that must still be able to operate properly and protect residents despite earthquakes. Data was collected by observing several rental flats managed by the National Housing Corporation in Jakarta. The research method used was descriptive-qualitative evaluative. From the results of the analysis revealed that there are criteria for architectural elements vulnerable to earthquake such as the size of the material used, laying architectural elements on a stable and strong base, architectural elements need anchoring (anchor), and the use of proper hinges. This research is expected to provide new insights for architects, residents, managers and developers about the types of architectural elements that affect the reliability of rental flats in Jakarta. Data analysis model is a method of constant comparison (constant comparative method) and research subjects are subjects who are in an area and meet certain requirements related to the research problem.

Keyword: Anchoring, architectural elements, earthquake, flat, reliability.

INTRODUCTION

Jakarta's capital city of Indonesia is located on the island of Java. Geographically DKI Jakarta has an area of 661.52 km2, located in the north of Java Island. This position is a strategic potential for the development and growth of the economy and services, the center of national activities for industry, trade, transportation, communication, and tourism. DKI Jakarta is a magnet for newcomers from various regions in Indonesia. Housing needs as a consequence that must be provided by the government. One of the housing facilities provided by the government is rental apartments. Simple Flats (rusunawa) are simple flats that are rented out to urban communities who cannot afford to buy a house or who want to stay for a while for example students, temporary workers and others (http://www.perumnas.co.id) / rusunawa /). Rental Flats managed by perum Perumnas are spread over 5 municipalities in DKI Jakarta. Jakarta belongs to regional business area 3 of the Public Corporation perum Perumnas and has 9 rusunawa with more than 11,000 units. The five of them are: Pulogebang East Jakarta, Cengkareng West Jakarta, Kemayoran Central Jakarta, Sindang Koja North Jakarta, and Pasar Jumat South Jakarta.

Fig-1: Condition of rental apartments

Flats for rent include simple multi-storey apartment buildings. The basic architectural planning of rental apartments in accordance with multi-storey buildings. Rusunawa as a public building must have 4 building reliability requirements, namely safety, health, comfort and convenience for its occupants. This is in accordance with residential criteria that pay attention to building reliability requirements including safety, health, comfort and convenience requirements. Occupant safety factors are included in the safety requirements of building reliability [1]. One of the building safety requirements is to make the building sturdy and can respond to forces that work on the building properly. Building safety is one of them by building resistance to earthquakes.

Jakarta in the earthquake belt, one of the cities in the zone of 0.6-0.7g - areas with a constant acceleration response spectrum of 150% and 0.25-0.3g - areas with a constant acceleration response spectrum of 60% maximum earthquake considered risk-targeted (MCER), SB site class. Earthquake loads affect the structural system, material, building height, and dimensions of the structural elements used. Flats included in the risk category II [2].

Flat rental in Seruni

Building systems consisting of architectural, mechanical, electrical and plumbing elements are integrated with the scope of building planning. Flats or flat must meet the requirements of technical development requirements, namely: space, structure, components, and building materials, completeness of flats, apartment units, shared and shared objects, density and layout of buildings, environmental infrastructure, and environmental facilities [3].

One of the Rusunawa managed by Perumnas is Rusunawa Seruni, East Jakarta, just like the other Perumnas rusunawa (Kemayoran, Cengkareng, Pasar Jumat, and Sindang Koja). This flat was built in 2002-2003 on a land of 0.66 Ha located in the Kelurahan and Kecamatan Pulo Gebang. The shape of each building is in the form of 2 twin blocks each in the form of a 5-story building with 187 residential units with 21 m2 / unit of flats, 21 business units, and 32 units of facilities. Each apartment unit consists of a common room, bathroom, kitchen and sunroom. This rental apartment unit is connected to a corridor with a single loaded system. All Seruni Pulo Gebang Apartment Rental Units (Sarusun) are still used as residences and all facilities are still in good use. The connecting corridor between transit functions as a terrace for each residential unit. The structural system used is a cantilevered multilevel portal behind and in front of the residential unit.

Building Resilience

Flats for rent are included in the performance level of direct use of buildings (immediate occupancy approach). The structure of the rental apartment building is still in a safe condition but only minor minor damage occurred. Building repairs do not disturb the user, their strength and rigidity are almost the same as before the disaster. Vertical and lateral force bearer systems on the structure are still able to bear the earthquake forces that occur.

All buildings in earthquake prone areas must have earthquake resistant building concepts, including Jakarta. Many buildings were damaged by the earthquake. Earthquakes occur due to vibrations caused by energy from inside the earth. All objects including buildings that are above the earth will move due to vibrations. The nature of the building defends itself from the external forces acting on it because the inertia of the building mass refuses to move and causes the building to distort. Buildings as masses that have weight will experience a mass increase of two undesirable effects on earthquake design, that is, it produces an increase in strength, and causes bending or destruction of columns and walls when the mass compresses the part that is bent or moved out by lateral forces [4].

Buildings in earthquake prone areas must be planned as earthquake resistant buildings by taking into account the maximum ground acceleration in the area. Earthquake resistant buildings are buildings that have the ability to withstand the negative (damaging) effects caused by earthquake events in one area. It is very important to plan earthquake resistant buildings, because buildings with plans that are weaker than expected against earthquakes, the building is called under design or buildings that are not earthquake resistant (non earthquake resistance), this type of building is very dangerous. Conversely, if the building planning exceeds the standard and earthquake zone, the building is included in the over-planning or over design; this is a waste of costs [5].

The earthquake has a psychological impact on building users and physical building. Fear of building users sometimes even casualties during and after the earthquake. Minor to severe damage even collapse on the building. The concept of earthquake resistant buildings is to protect people and assets.

There are several criteria for building structures in earthquake prone areas, namely [6]:

- The structure of the building must be simple, compact and symmetrical,
- The structure of the building must not be too slim so that it has sufficient rigidity,
- Load distribution, stiffness and strength along the height of the building,
- The vertical element of the structure (column) must be made stronger than the horizontal structural element (beam), so that a strong column - weak beam system is formed.

Earthquake resistant building criteria are explained as earthquake resistant building design concepts that take into account several points such as:

- Simple structure and easily identified
- The use of appropriate dilation in adjacent buildings.
- Avoid the concept of vertical unnatural in buildings so that buildings remain strong, rigid, geometry, and mass.
- The use of shear walls, bracing, and other building stiffener as a lateral force retaining system
- Use the right diaphragm.
- Minimizing damage due to earthquakes

The meaning of the word resistant (resistant) which has a strong meaning, while the strength can be physically that has a fixed meaning of his situation or position and so on, despite experiencing various things; not damaged quickly - change, lose, fade, and so on [7]. Earthquake resistant buildings have strength and stability by paying attention to aspects of construction, building materials, building functions, land and location, as well as building systems and building economics. From the explanation above, aspects of the structural system are aspects that must be considered and considered. The main function of the structural system is to carry safely and effectively the load acting on the building, and to channel the load to the ground through the foundation. Loads that work on buildings consist of vertical, horizontal loads, temperature differences, vibrations, and so on. In the process of designing a building structure system also needs to pay attention to: architectural requirements, mechanical and electrical systems, construction methods and economic aspects [8].

In the scope of architectural aspects of the structure includes the type of system structure and configuration. The vast scope of architecture including this system can form space. The structure of the building becomes a facility that facilitates the activities (space functions and system functions). The structural aspects are in accordance with the shape and function of the building and its relation to other systems in the building [9]. Operational and Functional Components (OFC) differ from one building type to another because of different building functions and designs. Similarly OFC is different from one country to another. The difference lies in construction practices and local industry standards. Each country must develop its own OFC for different buildings and identify the appropriate aseismic approach for its own needs [10].

The non-structural physical aspects consist of several components that work and respond to each other due to external earthquake forces. This response is not only between non-structural components, but also non-structural components with structural components. Earthquake movement due to earthquakes has three effects on non-structural elements of a building: (1) direct effects or movements on non-structural elements, (2) effects of structural components on non-structural components and (3) impact effects on interfaces between adjacent structures [11].

The main causes of damage to non-structural components (FEMA, 2011), such as: the presence of force of inertia and building deformation. When a building vibrates due to the strength of an earthquake, the building's base usually moves with the ground. The entire building and its contents on the stand experience an inertia force that pushes them back and forth in the opposite direction to the excitation of the stand point. When uncontrolled or slightly controlled objects are shaken during an earthquake, the force of inertia can cause them to slide, sway, or reverse. As a result of the building moving, equipment in the building such as cabinets, free standing bookshelves, and items stored on the shelves fall and can be damaged. These items can also move and interact with other items, falling, overturned or disconnected from installed components.

During an earthquake, the structural components of a building can change shape, bend or stretch and compress in response to earthquake strength. When buildings change shape, columns or walls change shape and any windows or partitions that are firmly attached to the structure must also be deformed or moved in the same amount. Fragile materials such as glass, plaster partitions, and stone fillers or veneers cannot tolerate significant deformation and will crack. After cracking, the force of inertia in the out-of-plane direction can cause parts of this architectural component to dislodge and fall far from its original location, possibly injuring the person passing underneath [12].

Damage due to the earthquake occurred as a whole on non-structural elements of the building. Gluing and anchoring relationships require the strength of building elements as a strong foundation. The strength of non-structural elements not only in the material used, but the basis for attaching the material, is also quite strong. Imperfect gluing, making non-structural elements loose from the base and fall. The fall of this material results in the risk of building users being hit by non-structural elements. These materials are glued by using adhesives without mechanical ties to the supporting substrate, can be a pair of brick, concrete, cement plaster, or structural framework. The inherent glues that are inherently fragile are sensitive to deformation, and their seismic performance depends on the performance of the supporting substrate. Media deformation causes cracking, which can cause the adhesive to separate from the substrate.

METHOD

The research method used is descriptive explorative, with the Post Occupancy Evaluation (POE) approach, an evaluation of building performance, which

consists of performance criteria, setting / places, user / occupants. In performance criteria there are evaluations: technical, functional, behavioral. The settings / places consist of evaluating settings, rooms, building, facilities. While for users / occupants consisting of individuals, groups, organizations.

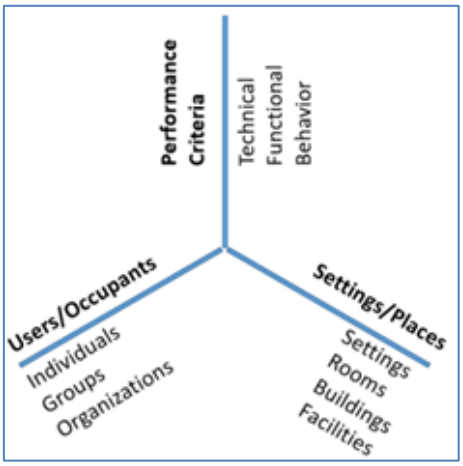

Fig-2: Elements of Building Performance

Evaluation is limited to performance criteria-functional and technical, place-space as a place of activity, user-groups (residents of flat rental in Pulo Gebang, East Jakarta). Evaluation of the technical scope is the safety and ease of occupants of building buildings in activities within buildings and this relates to the reliability of buildings as a comfort requirement, functional scope starting from the ease requirements in the form of study of motion in space, ease of use in using building facilities occupant safety in using facilities in the building. POE process at the stage of indication, investigation and diagnosis. Data collection uses space observation techniques.

Data collection uses observation techniques in several units of rental flats in Jakarta by non-random sampling. Observation in the form of observations on architectural elements used in residential units of rental flats. Total respondents obtained as many as 100 units of residential flats for rent in Jakarta. Text data collected were analyzed with content analysis. Content analysis is performed open coding.

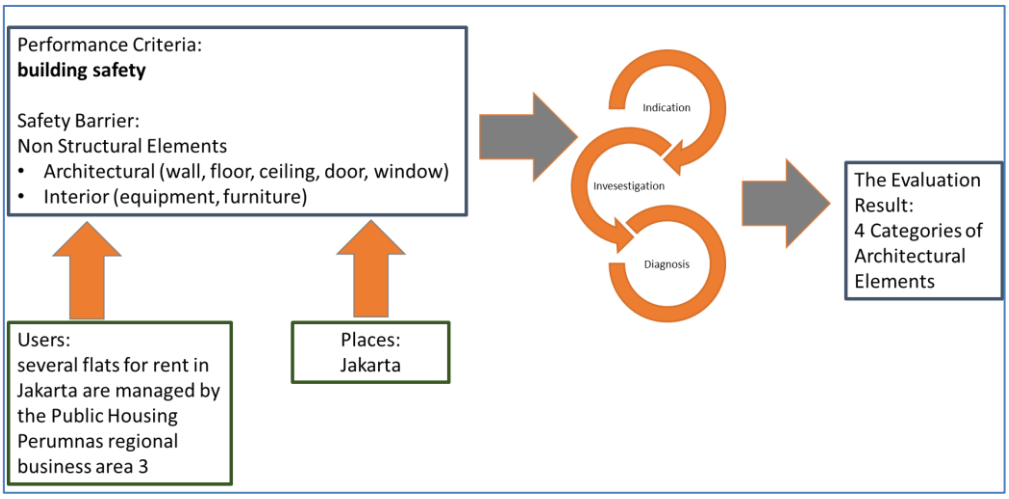

Fig-3: Schematic thinking

RESULT AND DISCUSSION

Building Form

Flat rental managed by Perum Perumnas is intended for one occupant to 2 residents from the general public. The unit of Flats (Sarusun) for rent or Seruni Pulo Gebang unit rental consists of 3 main rooms, namely a common room, a kitchen, a bathroom and a drying room. Seruni's low-rise apartment building structure includes a simple and easily identifiable structure. One building block of flats for rent has 2 buildings. Each building has 5 floors and each floor consists of 12 units of flats. This building has stairs in the middle of the building. Buildings with one another back to back. Sufficient space between buildings (approx. 9 meters) does not result in a blow to one another. One and the other buildings have the same height. Buildings have regular shapes. The diaphragm in this building transmits lateral loads to vertical structural elements (columns and bearing walls) and subsequently to the foundation. Each apartment unit has several non-structural elements that are likely to be damaged by an earthquake (for example: pipes, partitions, plaster walls and broken glass).

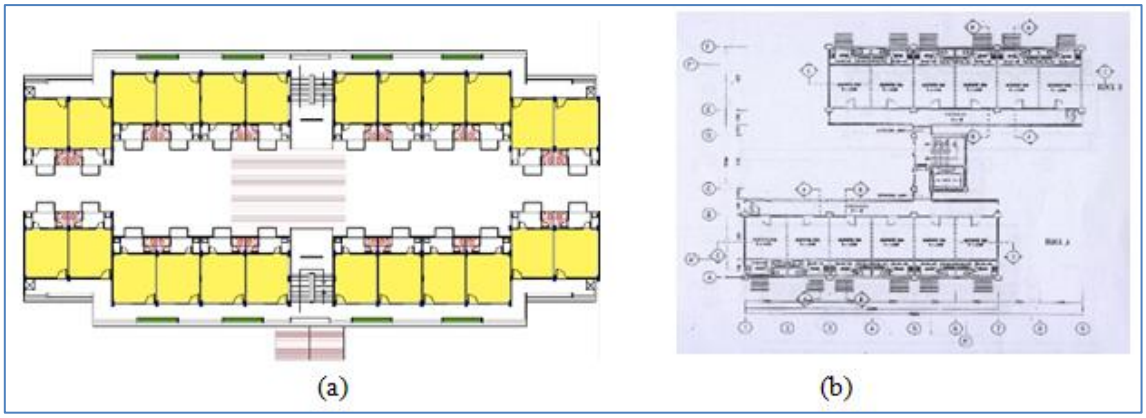

Fig-4: PuloGebang and Kemayoran Rental Flats (a); Pasar Jumat Flats (b)

Non Structural Elements

Non-structural elements used are divided into interior furniture elements and architectural elements. Furniture elements are all types of furniture that are used by residents as tools and means for living. Users use standard furniture easily found on the market. Non-structural elements of furniture consist of free-standing furniture such as cabinets, tables, chairs, beds having a maximum height of 120 cm. In addition there are items mounted on the wall, such as display shelves and wall clocks. The function of furniture other than as tools and facilities, as well as a shared room divider. For example, a cabinet made of plastic limits the space between a gathering room and bedroom. Standard market furniture is single function. The wardrobe only functions as a wardrobe. The function of storing other items can be combined with the cabinet function. Proper and good storage method, the optimal function of the cabinet. Measuring or anchoring free-standing cabinets or shelves to the wall to prevent falls.

Non-architectural elements of rental flats consist of space-forming elements, such as walls, floors, doors, windows, sills, and ceilings (frame and cover). Concrete frame binds strongly to the elements forming the wall. This power construction minimizes earthquake damage. Concrete frames are also firmly attached to other structural elements in the building. The two basic elements of the floor and the cover have strong bonded ties. The relationship between the door frame or window with a door or window, is connected properly and precisely. The inherent glues that are inherently fragile are sensitive to deformation, and their seismic performance depends on the performance of the supporting substrate. Media deformation causes cracking, which can cause the adhesive to separate from the substrate. This apartment flats residential units do not use ceiling coverings.

Sufficient space on the edge of the frame needs to be applied to minimize damage to the glass window. Frame and window sash planning by providing sufficient space for relative movement between partitions and adjacent building structure elements. The glass area is minimized by the use of smaller glass fields and be equipped with frames.

Flats residents can use several steps to borrow. Strong vibrations due to earthquakes make furniture fall down and close the fallen road, vibrate, thrown, fell. The surface of the floor becomes slippery due to the spilling of liquids from bottles and the connection of pipes. Broken glass and cutlery at the location of the injured person can even lead to death. Flats are rented as earthquake resistant buildings by installing anchors on furniture.

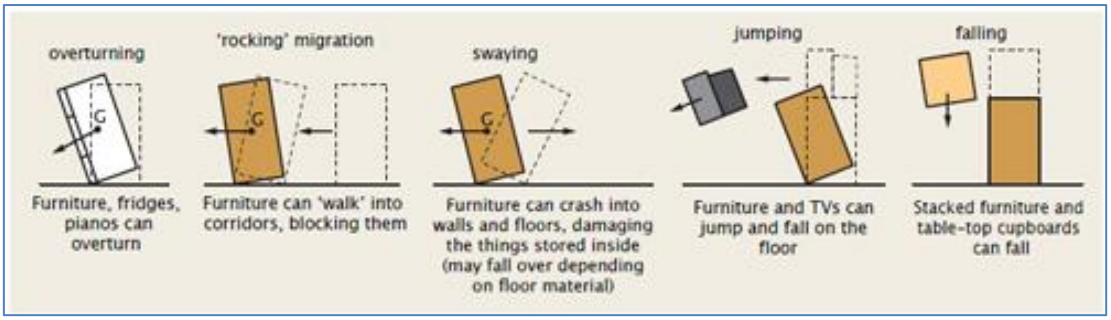

Fig-5: Furniture can be upside down, moving, swaying, jumping, falling, or sliding on the floor (http://www.kochi-kia.or.jp/earthquake/english/?ss=008)

Architects provide storage racks for household appliances. Heavy and dangerous equipment (iron, television) is not placed on the furniture. Storage on top of other furniture makes it easy for dangerous equipment to slip and even throw. Another way to keep furniture standing firm is by installing the right anchor.

Angkur is installed to prevent the furniture from sliding, vibrating, throwing, and falling. The cupboard has a lock that is strong enough so that the cupboard doesn't open when shaken. Cabinets are arranged on the wall using a special belt. Special slope of the belt against the wall no more than 30 degrees. The objects in the shelves or cabinets are made to move. Installing a rubber base on each rack can help the objects in the shelf or cabinet to move slightly or slip [13].

Open coding is done to identify meaning segments and keywords / categories that represent meaning segments. Open coding from observations of several rental apartments in Jakarta such as: Criteria for cross-section size, maximum opening width 80 cm, the maximum height of the door is 250 cm, Cold Rolled Steel thickness according to applicable regulations, strapped firmly on the wall, no wheels and has a good enough stand, mounted on a strong floor base and proper installation method, the lamp holder is good enough so that the lamp stand is stable, and being on a flat base so it is stable. Cross-section size, maximum opening width of 80 cm, the maximum height of the door is 250 cm, maximum jalousian hole height of 50cm, lockable and maximum height of 120 cm, minimum thickness of window glass is 5 mm representing the meaning of the material size segment. All equipment is firmly attached to the floor plate, mounted on a strong floor base and proper installation method, no wheels and has a good enough stand, the lamp holder is good enough so that the lamp stand is stable, and being on a flat base so it is stable represents the strong base meaning segment. Armature is firmly attached, has anchors on the wall, be in a safe position and have a key, and strapped firmly on the wall represent segments of anchoring meaning. The hinge works well in the right position representing the meaning of the hinge.

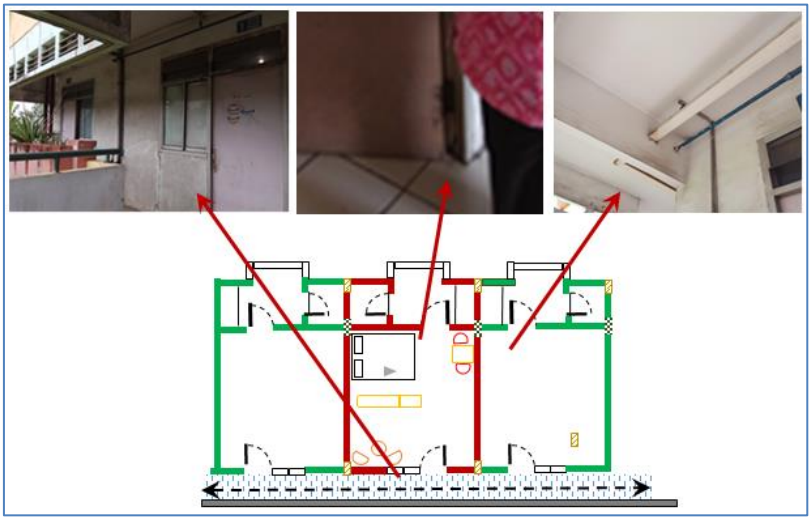

Fig-6: Plan of "Seruni" Rental Flats

Table-1: Architectural Elements of Flats Rentals

No	Component	Sub component	Material	Reliability Parameters	Criteria
1	Ceiling	Ceiling	Without ceiling cover	safety	All equipment is firmly attached to the floor plate
2	Wall	Wall Frame	Concrete Column	safety	Cross-section size and specifications according to strength calculations
3		Wall System	Pracetak slab wall	safety	firmly bound between elements using the right join
4	Floor	Covering	Ceramic size 30 x 30	safety, comfort, security	mounted on a strong floor base and proper installation method
5	Door	Specification	Opening width	safety, comfort, security	Maximum opening width 80cm
6			Door height	safety, comfort, security	The maximum height of the door is 250cm
7			Jalousie hole	safety, security	Maximum jalousian hole height of 50cm
8			Hinge	safety, security	The hinge works well in the right position
9			Cold rolled steel door frame	safety, security	Cold Rolled Steel thickness according to applicable regulations
10			Teakblock door	safety, security	Teakblok doors are nailed to the frame firmly
11	Window	Specification	Opening width	safety, comfort, security	Maximum opening width 80cm
12			Door height	safety, comfort, security	Maximum window height of 120 cm does not include jalousie
13			Jalousie hole	safety, comfort, security	Maximum jalousian hole height of 50cm
14			Hinge	safety, security	The hinge works well in the right position
15			Cold rolled steel door frame	safety, security	Thickness of Cold Rolled Steel in accordance with applicable regulations
16			Glass window shutters	safety, security	Minimum thickness of window glass is 5 mm
17	Frame	Window, Door	Cold Rolled Steel	safety, comfort, security	Cold Rolled Steel thickness according to applicable regulations
18		Table	desk	safety, comfort, security	It has no wheels and has a good enough stand
19			coffee table	safety, comfort, security	It has no wheels and has a good enough stand
20		Kursi	Dining chairs	safety, comfort, security	It has no wheels and has a good enough stand
21			Sofa	safety, comfort, security	It has no wheels and has a good enough stand
22		Lamp	Stand lamp	safety, comfort, security	The lamp holder is good enough so that the lamp stand is stable
23			Desk lamp / study lamp	safety, comfort, security	The lamp holder is good enough so that the lamp stand is stable
24			Ceiling light	safety, comfort, security	Armature is firmly attached
25		Cupboard	Wardrobe	safety, comfort, security	Have anchors on the wall, be in a safe position and have a key
26			Kitchen set	safety, comfort, security	Lockable and maximum height of 120 cm
27			Shoe rack	safety, comfort, security	Lockable and maximum height of 120 cm
28		Equipment	Computers and devices	safety, comfort, security	Being on a flat base so it is stable
29			Television	safety, comfort, security	Strapped firmly on the wall
30			Air conditioning	safety, comfort, security	Strapped firmly on the wall
31			Pantry table	safety, comfort, security	The top cabinet is mounted on the wall
32			Refrigerator	safety, comfort, security	Being in a safe position
33			Stove	safety, comfort, security	Being on a flat base so it is stable
34			Water dispenser	safety, comfort, security	Being on a strong base so that it remains standing stably

From 34 material criteria of architectural elements, four categories of criteria for architectural elements are: material size (13), strong base (12), anchoring (7), and hinge (2). Material size affects 38%, strong base 35%, anchor (21%), and hinges (6%). All materials used must comply with building safety specifications, both the size and type of material.

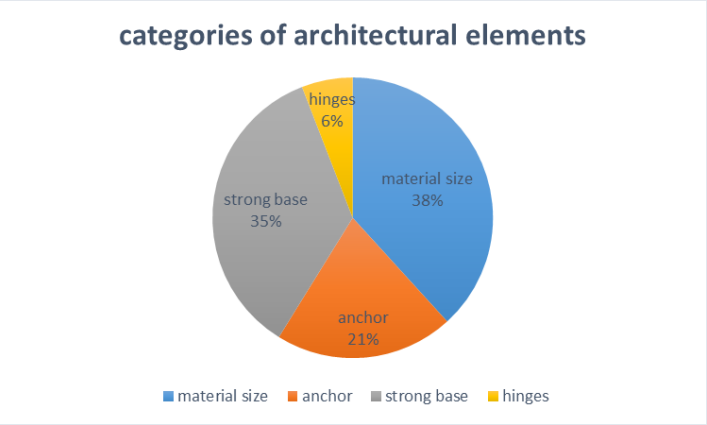

Fig-7: Distribution diagram of categories of architectural elements

Table-2: Categories of architectural elements

Categories of architectural elements			
Material size	Anchoring	Strong Base	Hinge
13	7	12	2

CONCLUSION

The results of this study found 4 categories of architectural elements important for earthquake resistance in rental flats managed by the Housing Regional III Jakarta. Planners for rental flats must pay attention to the specifications and sizes of the materials used. Material compatibility with its function, such as the size of the door frame anchor on the wall and the distance between the anchor. In addition, the planner also pays attention to the method of implementing the installation of architectural elements such as ensuring the foundation or stand of the architectural elements is really strong and even. The use of hinges (location and number) affects the changing position of the door or window, so the door cannot be opened. The occupants also play a role in the resilience of architectural elements against earthquakes, such as ensuring that furniture used is not wheeled, furniture remains stable when an earthquake occurs. If furniture has the possibility of sliding or tipping over when an earthquake occurs, then the furniture can be anchored or fastened to the wall.

The category of architectural element criteria can be used as a guide for architects when planning rental flats and residents of flats that have earthquake resistant architectural elements.

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REFERENCES

1. Undang undang no.28 Tahun 2002 tentang Bangunan Gedung, 2002.
2. SNI 1726 2012 tentang Standart Perencanaan Ketahanan Gempa Untuk Struktur Bangunan Gedung dan Non Gedung. 2012.
3. Peraturan Menteri Pekerjaan Umum No.60/PRT/M/1992 tentang Persyaratan Teknis Pembangunan Rumah Susun. Jakarta, Indonesia
4. Taranath BS. Wind and Earthquake Resistant Buildings Structural Analysis and Design, Marcel Dekker, New Jersey.2005.
5. Sunardjo M, Gunawan T, dan Pribadi S. Gempabumi Indonesia. Jakarta. Badan Meteorologi Klimatologi dan Geofisika.2012.
6. Siswanto AB, dan Salim MA. Basic Criteria Design of Earthquake Resistant Building Structures, International Journal of Civil Engineering and Technology.2018; 9, 1426–1436.
7. Indonesia Dictionary. The meaning of the word resistant, data obtained through the internet site https://kbbi.web.id/tahan, downloaded on April. 21, 2019.
8. Idham, Noor Cholis. Merancang Bangunan Gedung Bertingkat Rendah, Yogyakarta, Graha Ilmu.2013.
9. Juwana JS. Panduan Sistem Bangunan Bertingkat Tinggi, Erlangga. Jakarta.2005.
10. Yao GC, dan Lin, Chi-Chang. Identification of Earthquake Damaged Operational and Functional Components in Hospital Buildings. Journal of the

Chinese Institute of Engineers, 2000; 23, 409-416.
11. Dixit AM, Yatabe R, Guragain R, Dahal RK, dan Bhandary NP. Non-structural earthquake vulnerability assessment of major hospital buildings in Nepal, Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards, 2014; 8, 1-13.
12. D'Ayala Dina, Carmine G, Stylianos M, dan Viviana N. Review of the non-structural considerations for seismically retrofitting hospitals, impact on hospital functionality, and hospital selection. Department for International Development (DFID), the Climate, Environment, Infrastructure and Livelihoods Professional Evidence and Applied Knowledge Services (CEIL PEAKS) programme. Evidence on Demand the Climate, Environment, Infrastructure and Livelihoods.2015.
13. Kochi International Association. An Information Booklet for the International Community in Kochi-Preparing for Nankai Earthquake. 2008. Data obtained from the internet site http://www.kochi-kia.or.jp/earthquake/english/?s=00&ss=000- 01, downloaded on October 27, 2019.