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International Research Journal of Engineering, IT & Scientific Research Available online at https://sloap.org/journals/index.php/irjeis/ Vol. 8 No. 5, September 2022, pages: 178-186 ISSN: 2454-2261 https://doi.org/10.21744/irjeis.v8n5.2174 178 Review of the Use of Cross Iron in Reinforced Concrete Column as an Alternative to Shoes Column B. Army a I. Wayan Sujahtra b I. Nyoman Ramia c I. Ketut Sutapa d Article history: Abstract Submitted: 27 June 2022 Revised: 18 July 2022 Accepted: 09 August 2022 The column shoe is the lower end of the column as high as (50-70) mm which is cast first from the column above it to make it easier to determine the column dimensions, determine the shape of the column cross-section, and determine the position of the column. Column shoes Together with the formwork iron stack, clamping the formwork and making it easier to install the column formwork Column shoes from site mix concrete have a weakness in terms of the concrete being non-uniform with the column concrete above it is feared to have problems with the bending moment, Mu, at the end of the column and the normal force, Pu Column shoes made of reinforced concrete are more practical, more economical and simpler and save project execution time, there is no problem with bending moments and normal forces acting on the column because the quality of the column concrete is uniform with the quality of the column shoes and cast at the same time. Keywords: column shoes; concrete column shoes; cross iron; formwork iron stack; steel reinforced concrete; International research journal of engineering, IT & scientific research Corresponding author: B. Army, Department of Civil Engineering Padang State Polytechnic, Indonesia. Email address: barmy663@gmail.com a Department of Civil Engineering Padang State Polytechnic, Indonesia b Department of Civil Engineering Bali State Polytechnic, Indonesia c Department of Civil Engineering Bali State Polytechnic, Indonesia d Department of Civil Engineering Bali State Polytechnic, Indonesia

K. (2022). Review of the use of cross iron in reinforced concrete column as an alternative to shoes column. International Research Journal of Engineering, IT & Scientific Research, 8(5), 178-186. https://doi.org/10.21744/irjeis.v8n5.2174 179 1 Introduction Column shoes are column concrete castings as high as 50-70 mm on the concrete floor surface. Some of the functions of column shoes include: Column shoes are used to determine the position of columns from other columns on the second floor and the next floor in reinforced concrete high-rise buildings, besides that, they are also used to determine the dimensions for the cross-section of the column and column shoes as well as the initial holder of the formwork. - column formwork. Because the thickness of the column shoes is only 50-70 mm, it means that the volume of concrete used to make column shoes is very small even though for concrete orders in a batch plant, at least 1 small mixer truck volume is 5 m3. Therefore, it is rare for project implementers to intentionally order ready mix concrete just to cast column shoes, they more often make their concrete (site mix concrete) whose compressive strength characteristics are not clear. This means that there will be a reduction in the strength of the concrete in the column shoe or in a very vital area of the column in a position to support the loads above it (Tarabia & Albakry, 2014; Rasiwan et al., 2022; Parraga et al., 2017). From the structural analysis of the building, we know that in the column shoe region the bending moment, Mu, is the greatest, and the axial force, Pu, is also the largest along the column. Sadly, the place where Mu and Pu are large is not supported by the quality of the concrete for the column shoes. So it's better not to use concrete column shoes anymore. But start to move using concrete iron that is welded transversely to the main iron column, this transverse iron serves to direct the formwork at the foot of the column to match the dimensions of the column, to match the position of each column to the other column, so that along the column can be cast with ready mix concrete of the same quality (Wang et al., 2020; Kinnunen, 2017; Obayi et al., 2015). The advantages of using transverse iron instead of concrete column shoes are: 1) Make work easier, no need to prepare small formwork and no need to prepare site mix concrete for column shoes, 2) Easy casting, non-staged casting 3) The quality of concrete is uniform

throughout the column because it is cast with the same concrete, at the same time and at the same age along the column 4) Can save execution time, because the column shoe uses a transverse iron, there is no need to wait for the column shoe hardening time 5) Avoiding column quality degradation in the vital column area Literature review Columns are said to be homogeneous if they are made of the same material for the entire length of the column, if the column material is concrete, the casting time and the characteristics of the concrete must be the same, Suhendro (2000) A column kicker is a small piece of concrete that is applied to the bottom of a column or wall to ensure that the correct column or wall coordinates are maintained between the floor slabs. Thus, column kickers must be used in all positions where columns or walls are constructed. After the shoe construction is completed, the column or slab formwork can be placed immediately, and the shoe will ensure proper alignment and location of the column base. Arsyal (2019), The problem that is commonly found in precast systems is the connection system between structural components. In this regard, a study was conducted using column shoes as a connection system for precast columns. The variations in the height of the column shoes used are 12.5 cm, 25 cm, and 37.5 cm. The column used is 25 cm x 25 cm, 240 cm high. Column shoe testing is carried out by providing monotonic lateral loads and cyclic loads which are simulations of earthquake loads. The results of the monotonic lateral load testing with a height of 12.5, 25, and 37.5 cm resulted in a flexural capacity of 7.14, 9.03, and 14.3 kN, respectively. This indicates that the higher the column shoe, the higher the resulting flexural capacity. Column shoes are research variables that have a high variation in this test. The things that are important in designing the column shoe are the shear strength of the bolt that is the link between the column shoe and the footing, the bearing strength of the bolt, the tensile strength of the bolt when the test object is loaded whether the bolt is in a yielding condition or not, the length of the anchor bolt from the column shoe to the footing, and column shoe welding requirements that will affect later tests. - Bolt shear strength, Bolt bearing strength, Bolt tensile strength, Anchor length

Theoretical basis According to Tjokrodimoeljo (1989), the strength of concrete produced in the field tends to vary from mortar to mortar, the magnitude of this variation depends on various factors, including a). variation of material quality (aggregate from one mixture to the next, b). variations in the way of stirring, c). worker stability. According to Tjokrodimoeljo (1989) the production of concrete with a volume ratio of 1 cement: 2 sand: 3 gravel for ordinary concrete and 1 cement: 1.5 sand: 2.5 gravel for water-resistant concrete seems to be no longer satisfactory because it produces a very diverse compressive strength of concrete. . In the Concept Guidelines for Concrete 1898, the volume mix ratio above may only be carried out for concrete with a strength of less than 10 MPa, with a slump not exceeding 100 mm. Purwanto et al. (2020), 1 SCGC Concrete (Self Compacting Geopolymer Concrete) has the advantage of being easier and more effective in casting, so it is hoped that it can be applied to strengthening building structures. A reinforcement method is a form of composite concrete application with different ages of concrete, which consists of an existing structure with conventional concrete materials. Assa et al. (2014), In the implementation of the column structure work, there are two major works, namely the casting of columns, and the dismantling of formwork A). Column casting includes: corners must be strong, adjust the column belt distance, check the corners of the joint formwork, install the column belt and formwork support, do the casting and vibrate, and the outer column formwork as an external vibrator B). Dismantling and installing column formwork: includes: marking column shoes as formwork boundaries, installing column shoes on main reinforcement or stirrup reinforcement, installing column iron into existing iron cuttings, tightening column iron and iron cuttings, installing column formwork, and placing accordingly with the markings that have been made, adjust the alignment of the column formwork, do the casting with a bucket and tremi pipe, compact it with a vibrator, dismantle the column formwork and install the column head (Xie et al., 2020; Shi et al., 2012; Feng et al., 2021). 2 Materials and Methods The research was conducted by: 1) Observation of buildings during construction. Observations were made on several reinforced concrete building projects that were being worked on, using column shoes in their implementation,

especially in highrise buildings. For each column at the top level, before continuing the formwork installation work, column shoes are made for the column formwork benchmark. In the author's observation, the column shoes are made of site mix concrete with an unusual mixture or not clearly proportioned or carelessly with an average height of 50-70mm of column shoe casting. The casting of the column shoe was not compacted properly, leveled with a ruskam and a cement spoon, and the dismantling of the column shoe formwork was carried out as soon as possible. Do not wait for the age of the concrete, which should be directly attached to the column formwork on the column shoes. The loading of the column shoes in the sense that the above column is not cast is based on the age of the column shoes. Do not use a bonding agent (chemical substance) that is applied to the surface of the old concrete before hitting the old concrete with new concrete so that it is monolete/unified. 2) Observation of buildings after the earthquake After the big earthquake in the city of Padang in 2009, it was found that the destruction of columns in highrise buildings with various types of damage to the ends of the columns, especially the ends of the lower columns, namely the meeting of the column with the floor, the damage included: 1) There is a line gap between the concrete of the column shoe and the concrete of the column above it, there is little damage like that 2) The destruction of the concrete on the column shoes is the most common, the lower end of the concrete is destroyed in the position where the column shoes are made, the column remains standing but is supported by reinforcement which is partially visible because the concrete is peeling off due to spooling 3) shifting, the column shifts and tilts because the concrete from the concrete shoes is crushed and the main reinforcement of the column is tilted because the axial force of the column is not supported by the concrete but is transferred to the main steel, such failure is also found

column failures above occur in the same position, namely where the column shoes are made, we conclude, that the failure is entirely in the column shoes with immeasurable and very low quality, or non-uniform and the column concrete above, the casting age is not the same. in turn the inhomogeneity of the concrete material along the column (Gerilla et al., 2007; Berke & Hicks, 2004; Nascimbene & Bianco, 2021). 3 Results and Discussions What are column shoes A column shoe is a tool for positioning the column and constructing the cross-sectional dimensions of the column in the form of concrete castings or made of angled steel profile L30.30.3 or from other steel profiles welded to the column stirrups. Column shoes are shaped according to the cross-section of the column made on the floor surface encircling the iron column with a height of 50-70 mm concrete castings from the floor surface as shown in Fig.1, Pot P-P. and Fig.2 the column looks up, or it can be said that the column shoe is a preliminary casting only 50-70mm high to direct/back the lower column formwork, in Figure 1, the P-P pot beside the column shoe there is concrete iron planted as a support for the formwork on the broad side. What are the dimensions of the column shoes Because column shoes are columns that are cast in advance as high as (50-70) mm to position a column against other columns, determine column dimensions and determine the shape of the column cross-section. Then the crosssectional dimensions of the column shoes are the same as the dimensions of the column itself, so the dimensions of the column shoes are the dimensions of the stirrup/beugel column plus the thickness of the concrete blanket on all four sides. What is the function of column shoes The function of this column shoe is as follows 1) Ensure column dimensions, column dimensions can be printed easily through column shoes because the height of column shoes is only (50-70) mm,

 1) Determining the exact shape of the column of cross section area can be made with the help of column shoes 2) Determining the axles of the columns can easily be done, first determine the center point of the cross-section of each column, and connecting the center points to form the axles of the column 3) Determine the column distances, starting from the

center point of the column cross-section on each column shoe, it can be easily measured the column distances 4) Determine the equivalence of one column with another, using the ratio of the sides of a Pythagorean right triangle 5) Together with the iron-concrete stack and column shoes, the formwork is clamped, so that the column dimensions do not change even though they are under pressure from fresh concrete when casting the column above it, Fig 3. Q-Q pots and Fig.4 Column shoes and formwork are seen above 6) Determine the accuracy of the column position starting from columns A1 to 11 and other columns (B1, C1, A2, B2, C2, A3, B3, C3, A4, B4, and C4) also through each concrete shoe, pay attention to Fig. 5, Building plan with column shoes) 7) Facilitate the initial installation of the formwork, by clamping the lower side of the formwork between the column shoes and the concrete iron stack planted on the floor

IRJEIS ISSN: 2454-2261 □ Army, B., Sujahtra, I. W., Ramia, I. N., & Sutapa, I. K. (2022). Review of the use of cross iron in reinforced concrete column as an alternative to shoes column. International Research Journal of Engineering, IT & Scientific Research, 8(5), 178-186. https://doi.org/10.21744/irjeis.v8n5.2174 183 Weaknesses of concrete column shoes In terms of concrete quality 1) No uniform quality of concrete along the column, due to the small volume of concrete for column shoes, column cross-sectional size 400x400 mm, column shoe height 50-70 mm, number of columns 12 see Fig.5, Building plan with column shoes, it takes ready concrete volume mix 0.096 m3, even though to order ready mix concrete at least 1 truck mixer small size 5m3 volume, too much leftover, and waste 2) Due to the small volume of column shoes, there is a tendency for contractors to make site mix concrete to cast column shoes and ignore quality 3) Because site mix concrete, the dosage of concrete components is based on volume and sufficient water, it will never be of the same quality as ready mix concrete whose concrete component dosage is based on weight and water-cement factor, which is very calculated. 4 In terms of time 1) A lot of time is needed to make the mold, make the mortar, and pour the concrete into the column shoe mold. 2) It takes time to wait for the concrete to be old enough to be loaded, Practical aspects of implementation 1) It is impractical to shoe

columns of concrete, because there is formwork work, and concrete mixing work 2) Need materials of many types. Formwork work, materials: wood, nails, and manual carpentry tools. Concrete work, materials: water, cement, sand, split, and manual concrete mason tools The monolithic aspect of the concrete material along the column 1) Column concrete is not monolithic because of the different strengths of the concrete material 2) Different casting time 3) The difference in density, the column shoes are not vibrated, only cast and leveled with a cement spoon, while the column concrete above is compacted with vibrators and scrapers. Structural analysis of the bending moment, Mu, and the normal force, Pu, at work 1) The bending moment, Mu is greatest at the ends of the upper and lower columns, there should be no difference in the quality of the concrete at the ends of the lower and upper columns. 2) With the presence of concrete column shoes, it is feared that the implementation of the connection of the concrete to the column shoes with the concrete column above it will not be perfect, it also invites danger to the large moments acting on both ends of the upper and lower columns. 3) It is feared that the column cross-section of the problematic column shoe will receive the Normal Force, Pu because the quality of the concrete does not meet the specifications

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Column shoes of concrete steel reinforcement How to make column shoes from concrete reinforcement steel 1) D12 reinforcing iron, cut along / as thick as the decking concrete used, the note that the decking concrete is attached to the main reinforcement not on the beugel then the distance from the outer face of the main reinforcement to the formwork is considered the same as the decking concrete/concrete blanket/cover concrete 2) At a height of 50-70mm from the floor, these pieces of reinforcement are welded to the main column iron as shown in Fig. 6, R-R and Pot Fig.7, column top view 3) Make the formwork stack as a backrest for the outer formwork. 4) Install the formwork by clamping it between the column shoe iron and the formwork stack iron What are the advantages of reinforced concrete column shoes? 1) Very economical, only small pieces of iron are welded to the main iron column 2) Not cast, because the casting of the column shoes is at the same time

as the casting of the column, meaning that the quality of the column shoes is uniform with the column above it, because they are cast with the same concrete and at the same time 3) Save time, because it is finished welding, you can directly install the column formwork 4) Eliminate doubts about the bending moment, Mu, which acts on the lower end of the column while there is no doubt about the quality of the lower end of the column with respect to the normal force, Pu, which acts What are the disadvantages of reinforced concrete steel colon shoes? 1) We need welders and welding equipment to weld pieces of concrete reinforcement to the main iron column 2) There are additional costs for welders in reinforced concrete work 4 Conclusion Immediately leave the use of concrete column shoes because the quality of the concrete for the concrete shoes is not the same as the concrete for the column above it, and switch to the steel reinforced concrete column shoes. The nonuniformity of the concrete along the column, especially in the column shoes, worries that the column has problems in accepting the bending moment, Mu, and the normal force, Pu. It is more practical, time-saving, more economical, and more monolithic, to use column shoes made of reinforced concrete because the shoes are ready to be installed, and the column formwork can be installed directly.

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