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Provisions Comparison of the National Building Regulations (The Eighth Topic) and Iranian Code of Practice for Seismic Resistant Design of Buildings (2800 Standard) for Masonry Buildings with Ring Beam

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ABSTRACT

Buildings with masonry materials are one of the weakest buildings against earthquakes, and the importance of proper design and correct construction of these buildings is not hidden. Among The buildings with masonry materials, the buildings with Ring beams are the most common of such buildings. Engineers use internal and external regulations and standards to design ring beam masonry buildings. The two main references for the design and construction of masonry buildings with Ring beams are the Code of Practice for Seismic Resistant Design of Buildings (Standard 2800, Fourth Edition) and the Eighth Topic of the National Building Regulations (2020 Edition) under the title of design and construction of buildings with masonry materials. The Provisions for masonry buildings with Ring beams are given in the fifth chapter of the Eighth Topic of the National Building Regulations and the Seventh Chapter of the 2800 Standard. In this research, an attempt has been made to examine the Provisions of masonry buildings with Ring beams of these two references and to identify the discrepancies and differences in the provisions. The investigation of these two references has shown that there were more than 66 cases of differences in Provisions regarding masonry buildings with Ring beams between the Eighth Topic of the National Building Regulations and the Seismic Resistant Design of Buildings. Most of the differences in the criteria were related to the sections of vertical and horizontal Ring beams, structural walls, and Non-structural walls with 34 cases and 51.5% compared to the total difference. Also, the type of soil is classified in the Eighth Topic of The National Construction Regulations with 3 types of soil and the 2800 Standard of Conduct is classified with 4 types of soil.

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1. Introduction

Masonry materials are one of the oldest man – made materials used in construction and be one of the most

unknown [1]. Being unknown is confirmed by the fact that when the revisions of the references and specialized Codes in the field of materials and regulations of masonry buildings are examined, we will see many changes in it. In

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Iran, there are two important references for the design and construction of masonry buildings, including The National Building Regulations (The Eighth Topic), under the title of design and construction of masonry buildings, 2019 Edition [2], and Iranian Code of Practice for Seismic Resistant Design of Buildings (2800 Standard, Fourth Edition) for Masonry Buildings with Ring Beam [3]. The Provisions for masonry buildings with ring beam are given in the fifth chapter of the eighth topic of the National Building Regulations and in the seventh chapter of Iran's 2800 Standard. The study and review of the previous editions of these two references have shown that there were many differences in the standards of masonry buildings [4]. Also, considering that in the 2018 edition of the 8th topic of the National Building Regulations, the Provisions and Regulations of the United States Uniform Code [5, 6] have been used, but there are still many contradictions and differences with the Building Design Code in different parts of the building. Against the earthquake, the 2800 Standard has been observed. Other references, such as books on seismic design of brick buildings [7], masonry buildings and a review of industrial buildings [8], and the design of earthquake-resistant structures [9], provide the Provisions and details of the design and construction of reinforced and unreinforced masonry building with examples and drawing shapes have been provided for better understanding of the reader.

In this research, it has been tried to determine the standards of masonry buildings with Ring beam in different sections, including the classification of masonry buildings, architectural requirements, structural requirements in the foundations, Seats, Structural walls and Non-structural walls, openings, lintel, ties, and roofs in the eighth topic of the National Building Regulations (edition of 2018) and the code of design of buildings against earthquakes, Standard 2800, edition 4, have been examined and compared, and the differences in the standards in these two references have been identified.

2. Provisions for masonry buildings with ring beam

2.1. Classification of masonry buildings

In the eighth topic of the National Building Regulations, masonry buildings are divided into two categories, including reinforced masonry building and masonry buildings with ring beams, and in Iran's Standard 2800, masonry buildings are divided into two categories under the headings of masonry buildings with horizontal and vertical Ring beams, and masonry buildings with Cohesive bars. In some other authorities, masonry buildings have been classified into four categories including non-reinforced, semi-reinforced, reinforced and framed [7].

2.2. Architectural requirements

Differences in standards in the section of architectural requirements of masonry buildings with ring beams between two review authorities and its summary are shown in table 1. Regarding the difference in the level of the roof on the floor or the difference in level, it is stated in the eighth topic of the national building regulations that if the difference in level is less than 600 mm, a separate horizontal Ring beam should be implemented in the boundary wall between the two parts that have a difference in level, or the two parts by means of Seismic seams separate from each other and in case it is more than 600 mm, it is necessary to separate the two parts of the building by means of a seismic joint. In the Standard 2800, only in the case that the difference in the level of the roof is more than 600 mm, they should be separated with additional Ring beams or construction joints. Also, the anchor of the cantilever in horizontal ring beams for the construction of a parapet on the projecting part of the building according to the Standard 2800 is shown in Figure 1.

2.3. Structural requirements

Structural requirements include excavation and foundation, base course, structural and non-structural walls, openings, lintel, parapet, ties, roofs and ridge. The difference between of provisions of the structural requirements section between the eighth topic of the National Building Regulations and the Standard 2800 has been investigated. The differences in provisions in the excavation and foundation section are shown in table 2, and the details of anchor of vertical ring beam in the masonry foundation base on Iran's Standard 2800 are shown in Figure 2.

In both references of the 8th topic of the National Building Regulations and the 2800 Standard of Iran, the base course width in masonry building with ring beam depends on the width of the wall, the height of the base course, the number of story and type of soil of the construction site. Investigations have shown that there are 3 types of soil classification in the 8th topic of the National Building Regulations, but in the 2800 Standard of Iran, 4 types of soil are classified. In the 2800 standard, soil type 4 is soil whose permissible strength is about 1 kg/cm² and the width of the base course in this type of soil for 1, 2 and 3 story buildings is 500, 1000 and 1500 mm respectively, which is in the eighth topic of the National Building Regulation has not mentioned it. Since both the eighth topic of the National Building Regulations and the Standard 2800 of Iran state the use of concrete foundations instead of masonry foundations, the differences in the provisions of this section in Table 3.

Table 1.
difference of Provisions in the architectural requirements section

Row	Title	Topic 8	2800 Standard
1	The maximum length of the masonry building ring beam	3 time the width of building with 25 m	3 time the width of the building
2	Basement height	Maximum 2.5 m	_____
3	Projection of building (the upper story is ahead of the lower story)	_____	Maximum 1 m
4	The use of steel ring beam in the projection	_____	It is allowed
5	Construction of parapet on the front of projection	A maximum height of 500 mm is allowed	It is unobstructed in the case of anchor of cantilever in horizontal ring beams according to Figure 1

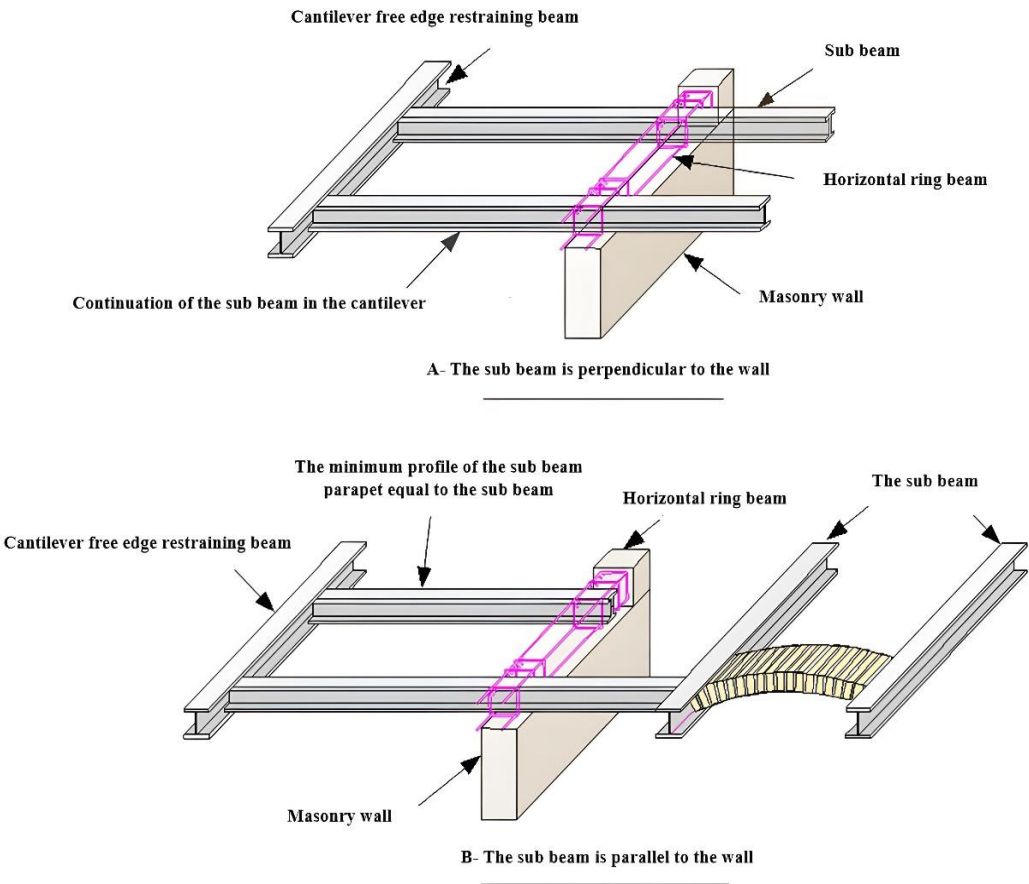


Figure 1: cantilever anchor in the horizontal ring beams of the building based on Iran's 2800 Standard

One of the most important parts of a masonry building with ring beams is its structural walls. Investigations have shown that in the section of structural wall, there are differences in provisions between these two references and there are 11 cases differences between the eighth topic and Iran's 2800 Standard. One of the differences is the maximum length of a structural wall between two vertical ring beams, which is equal to 5 m in the eighth topic of the National Building Regulations, but in Iran's 2800 Standard, the length of a structural wall is equal to the minimum value of 5 m and 30 times the thickness of the wall.

Another case is the thickness of structural wall in the stories and basement, which is stated in the eighth topic of the National Building Regulations for the first and second stories of the basement to be 350 mm, 320 mm, 200 mm respectively.

The next item, based on the eighth topic of the National Building Regulations, to determine the minimum amount of the relative wall, structural walls with conditions such as: the length of the wall should not be less than one-third of its height, the length of the wall should be more than 1 m, and the columns and piers on the side and between the

Table 2.

difference of Provisions in the excavation and foundations

Row	Title	Topic 8	2800 Standard
1	The depth of excavation	At least 800 mm	
2	The depth of foundation	at least 500 mm	It depends on the width of the base course minus the width of the horizontal ring beam
3	The width of foundation	It should not be less than 1.5 times the width of the base course	
4	Construction of the foundation in the form of dry	Not allowed	
5	Type of foundation	Paste with at least 350 lime kg/m ³ , rubble stone immersed in concrete with 25 kg/m ³ cement, broken range work with sand-cement or sand-cement mortar, concrete with a cement 250 kg/m ³	Brick foundation, stone foundation, concrete foundation with minimum strength equal to 20 MPa

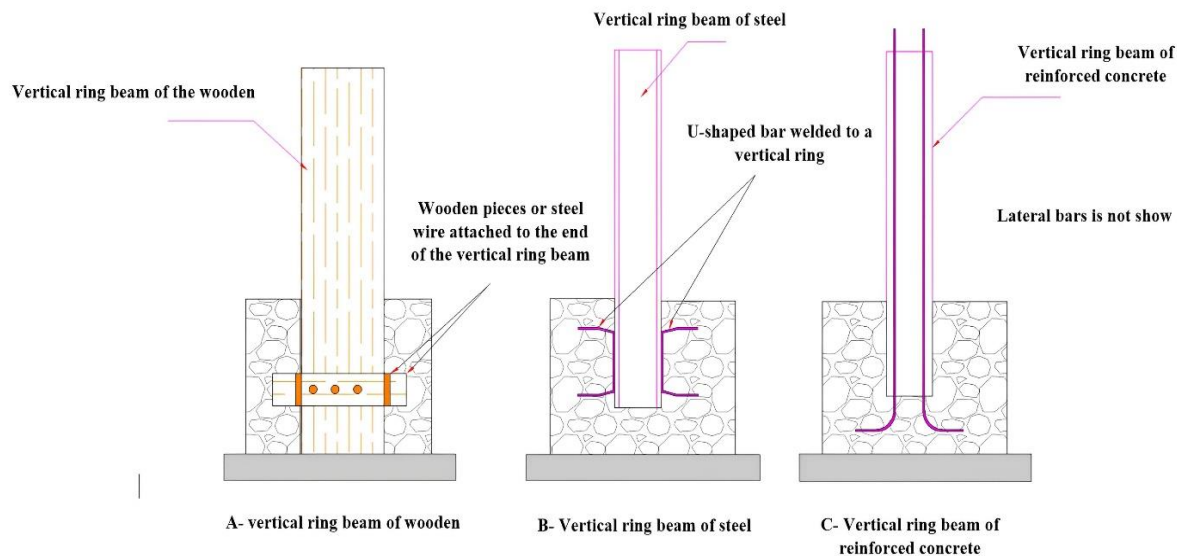


Figure 2: The details of vertical ring beam anchor in the foundation of masonry based on 2800 Standard

openings should be proportional their length to effective height should be more than one third, that these conditions are not included in Iran's 2800 Standard. Another point of difference, according to the eighth topic of the National Building Regulations, the structural walls on each story and in each direction must be spread evenly and symmetrically on the surface in such a way that the distance between the center of the story surface and the center of the surface of the relative walls of that story (eccentricity) in each extension, not more than 5% of the dimension of the building in that direction and if this distance is greater than the above value, its effect on the surface of the wall should be taken into account, and this case is not observed in Iran's 2800 Standard. The further investigation of these two references in this section has shown that there were other provisions differences in structural walls other than those mentioned, and these provisions differences are listed in Table 4.

Another one of the differences between the eighth topic of the National Building Regulations and Iran's 2800 Standard is the basement wall provisions. In the eighth

topic of the National Building Regulations, the height of the basement wall is 2.5 m and the minimum thickness of the wall is 320 mm, and all lintels must be made of in situ concrete or masonry, and steel lintels should be avoided in the basement. While in the 2800 Standard of Iran, it is sufficient to mention only the minimum thickness of the basement wall equal to 350 mm and it is silent other cases.

Another difference between the 8th topic of the National Building Regulations and the 2800 Standard of Iran is the openings. The maximum dimensions of the opening are 2 m in the 8th topic of the National Building Regulations, and this length is 2.5 m in Iran's 2800 Standard. The cases of differences in standards in the implementation of non-structural walls and lintel are listed in Table 5.

Another case of difference between the 8th topic of the National Building Regulations and the 2800 Standard of Iran is the provisions for parapets. According to the requirements of the eighth topic of the National Building Regulations, the height of the parapet should not be more than 500 mm and its thickness should not be less than 200 mm. According to the 2800 Standard of Iran, if the

thickness of the wall is equal to 100 mm or 200 mm, the height of the parapet should not exceed 500 mm or 700 mm, respectively. The details of parapet anchor with a height of more than 700 mm according to Iran's 2800 Standard are shown in Figure 3. In the eighth topic of the National Building Regulations, no executive details have been provided like Iran's 2800 Standard.

One of the important parts of masonry buildings with ring beam is ties. The ties play an important role in the cohesion and integration of masonry building with ring beam. The ties include horizontal and vertical ring beams, and differences such as ribbed bar type, ribbed bar distance,

use of steel and wooden section instead of concrete ring beams and double corner ring beams, etc. have been observed in the provisions of ties of two references. Differences in provisions for horizontal ring beam are shown in Table 6 and vertical ring beam in Table 7.

Another difference in this section is the width of the chimney in horizontal concrete ring beams, which the maximum diameter or width of the chimney in the eighth topic of the National Building Regulations is equal to one sixth and in The 2800 Standard of Iran, this size is equal to one half of the width of the horizontal concrete ring beam according to Figure 4.

Table 3.

difference of Provisions in the concrete foundation section

Row	Title	Topic 8	2800 Standard
1	The Width of concrete foundation	The Width of the foundation should not be more than 1.5 times the width of the wall or 600 mm.	The width of the foundation should match the width of the base course.
2	Concrete foundation depth	At least 500 mm	_____
3	Maximum distance of bending	300 mm	300mm, but in another place, provided the number of bending ribbed bars, which is not consistent.
4	Longitudinal ribbed bars	Diameter 12 with a maximum distance of 300 mm	_____
5	Lateral ribbed bar in concrete foundations whose width is more than 800 mm	_____	It should be construction in two loops
6	Leveling on concrete foundation in cold regions with glaciers	At least 400 mm below the ground level	_____
7	Classification of the soil of the construction site	3 type of soil	4 type of soil

Table 4.

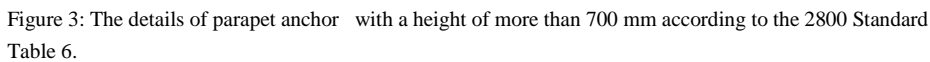
difference of Provisions in the structural wall construction section

Row	Title	Topic 8	2800 Standard
1	Soaking of material units	It is necessary	_____
2	The distance between the vertical joint in the wall	At least a quarter of the length of the material unit	Do not put the vertical joint in the same direction
3	The thickness of the horizontal joints	It should not be less than 10 mm and more than 15 mm	_____
4	The thickness of the horizontal joints in case of bed joint reinforcement	Maximum to 20 mm	_____
5	The number of horizontal ribbed bars in the middle third of the wall	It is necessary for walls that are longer than 2.5 m	It is necessary for walls with shoulder length between 3 and 5 m
6	The number of horizontal ribbed bars in the middle third of the wall	In three levels of the middle of the wall, two ribbed bars with a diameter of at least 8 mm	In three levels of the middle of the wall, one ribbed bars with a diameter of at least 10 mm
7	Curing of wall	At least for 3 days with water	_____

Table 5.

difference of Provisions in the non-structural wall and lintel construction sections

Row	Title	Topic 8	2800 Standard
1	The free length of the non-structural wall	40 times the width of the wall and a maximum of 5 m	40 times the thickness of the wall and a maximum of 6 m
2	Anchor the edge of the non-structural wall	The vertical edge of the wall must be anchored with an vertical element	The vertical edge of the wall must be anchored with minimum size 6 steel channel section
3	Instead of using toothing, you can:	Two horizontal bars with a diameter of at least 8 mm and a distance of 500 mm are used in the height of the wall	It used an size 8 or 10 mm bar with a distance of 600 mm in the height of the wall
4	The length of the support of the lintel	At least 350 mm or one tenth of the length of the span, whichever is more	At least 200 mm



Row

the equivalent bar system, instead of imp vertical ring beams without providing design relationships, which is

given in the eighth topic of the National Building Regulations under the title of reinforced masonry building with providing of the design relationships. The details of vertical and horizontal ribbed bars in the equivalent bar system.

The cases of differences in regulations between topics 8 of the National Building Regulations and Iran's 2800 Standard are the construction of vertical steel ring beam. According to the provisions of Iran's 2800 Standard, steel vertical ring beams can be used instead of concrete vertical ring beams in building materials, and in this case, no provisions have been observed in the eighth topic of the National Building Regulations. The details of the construction of the vertical steel ring beam according to Iran's 2800 Standard are shown in Figure 6.

Differences and inconsistencies such as the integration of concrete beam-block roof, trusses and wooden roof, slanted roofs, curved roof, flat wooden roof, ridge, dome roof, false ceiling and boundary walls in the two references of the eighth topic of the National Building Regulations and 2800 Standard of Iran view has been.

3. Conclusion

In this research, the provisions of topics 8 of the National Building Regulations, 2018 edition, with the Table 7.

Difference of Provisions in the vertical ring beam sections

Row	Title	Topic 8	2800 Standard
1	Using a vertical wooden ring beam	—	It is unobstructed for one-story building located in areas with medium and low relative risk
2	The diameter of the longitudinal bars in a vertical concrete ring beam	At least size 12	At least size 10
3	Using a double vertical ring beam	In the outer corners of a two-story building or with a basement	—
4	At least diameter of the lateral bars in the vertical concrete ring beam and its maximum distance	Size 8 bar with a maximum distance of 200 mm	Size 6 bar and its distance is equal to the minimum width of the ring beam and 250 mm
5	The distance of stirrup in the critical area	Maximum 100 mm	Maximum 150 mm
6	Concrete coating in vertical concrete ring beams	At least 30 mm	At least 25 mm
7	At least length of the vertical anchor of the longitudinal bars of the vertical concrete ring beam in the foundation	at least 250 mm	At least 400 mm
8	The use of equivalent vertical ring beams	—	It can be made of Steel and wooden vertical ring beam
9	The use of vertical and horizontal bars in the equivalent bar system (instead of the vertical ring beam)	Reinforced masonry building	Construction details are given in Figure 5
10	Construction of reinforced concrete or steel ring beams around the openings	It is necessary for the openings whose dimensions are more than 2 m	—

Iranian Code of Practice for Seismic Resistant Design of Buildings (2800 Standard, fourth edition), for masonry buildings with ring beam have been examined and compared. Differences in standards have been observed in building classification sections with masonry building, architectural requirements, structural requirements including excavation and foundation, concrete foundation, base course, structural and non-structural walls, openings, lintel, ties and roofs:

1-The results of the research have shown that there were more than 66 cases of provisions discrepancies in different sections.

2-The most difference of provisions between the standards of masonry building was respectively in the wrapping sections with 17 cases, structural and non-structural walls with 17 cases, excavation and concrete foundation with 12 cases.

3-The results of the investigation have shown that The 2800 Standard, contrary to the eighth topic of the National Building Regulations, has considered the use of simple bars in some areas of Iran as unobstructed.

4-In the design of foundations of masonry building with ring beam, investigations have shown that the classification of the soil type in the eighth topic of the National Building Regulations was based on 3 type of soil and in The 2800 Standard of Iran based on 4 type of soil.

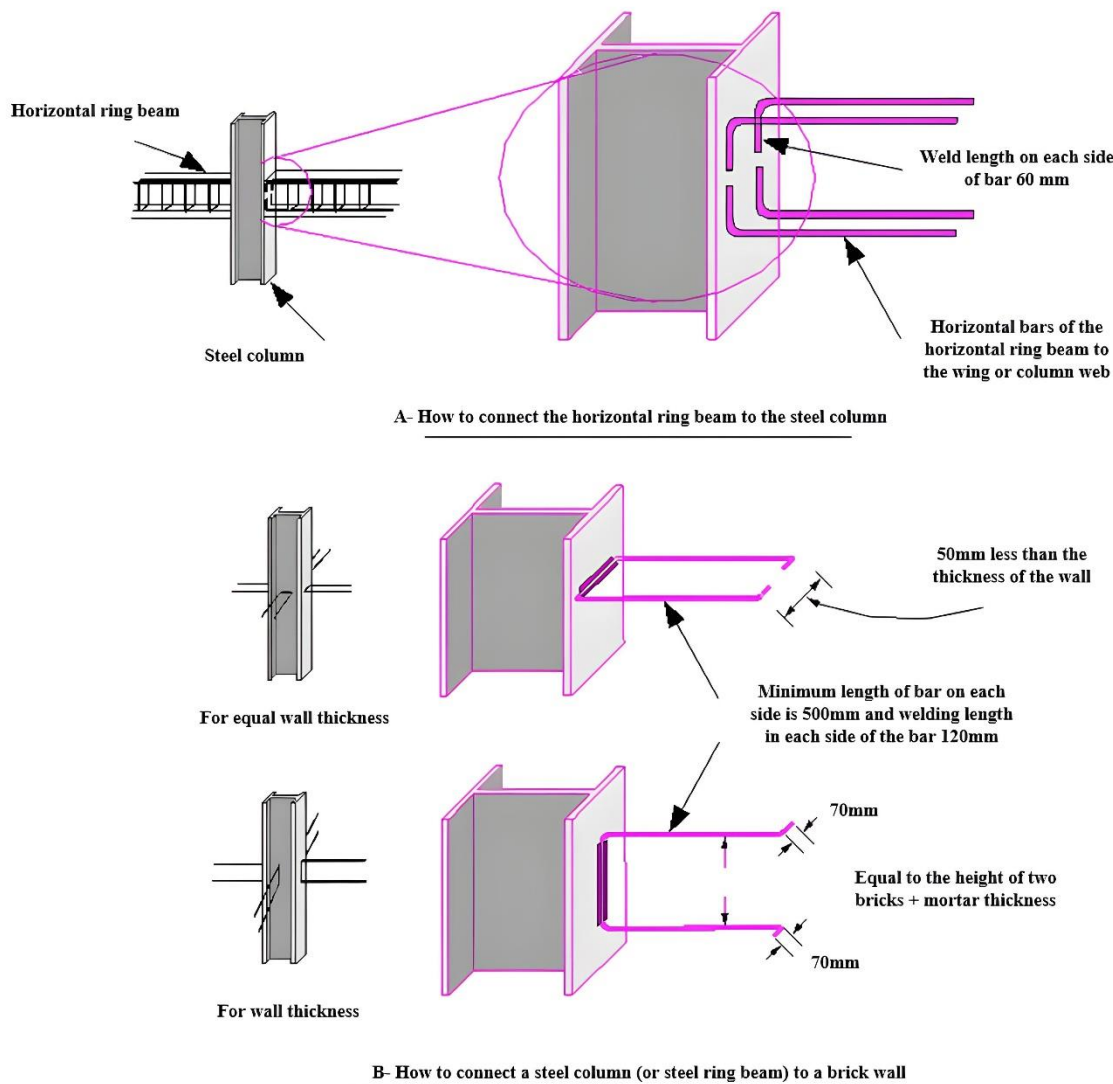


Figure 6: The details of connecting the horizontal ring beam and the brick wall to the steel column according to the 2800 Standard

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