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屋顶 Roof

小心！不能使用预制板！

CAUTION! Do not use precast concrete planks for your roof!

在四川省的震区内使用预制板是很危险的

用预制板建造的屋顶是很危险的，是因为预制板的过重和板与板之间搭接过弱。用预制板建造的屋顶在地震时会很容易倒塌而伤害家人。木屋顶与现浇楼板会为更安全。

Precast concrete planks are not safe to use in earthquake-prone areas

Using precast concrete planks for your roof is dangerous because they are too heavy and the connection between each plank is not strong. During a strong earthquake, it is likely that roofs made from precast concrete planks will collapse causing serious injury or death to anyone inside the home. A much safer roof option is to use a timber roof or a cast-in-place reinforced concrete roof.

选择1：使用现浇钢筋混凝土

Option 1: Use cast-in-place reinforced concrete

优点：

- 抗震性好
- 屋面可以利用
- 现浇混凝土屋面板更牢固

Advantages:

- Resists earthquake well
- Roof surface can be used
- Properly make roof will last a long time

缺点：

- 施工难度高，如加固不够也可在地震中倒塌
- 排水慢，易积水。一定要做屋顶防水

Challenges:

- Requires more care to construct. If not reinforced properly it can collapse in an earthquake.
- Be sure to waterproof roof slab. Cast in place roof is more likely to leak.

选择2：使用铺瓦的木质梁架

Option 2: Use timber truss with clay tiles

优点：

- 轻
- 便宜
- 排水快
- 冬暖夏凉
- 施工难度小

Advantages:

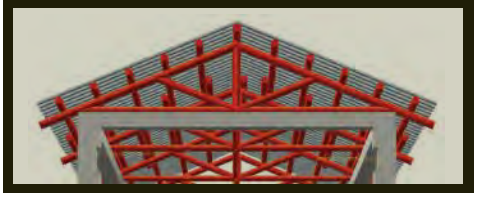
- Light
- Cheap
- Sheds water quickly
- Warm in winter, cool in summer
- Simple construction

缺点：

- 木屋架容易腐蚀，所以必须做防腐处理

Challenges:

- Wood may rot easily, it must be treated with preservative.

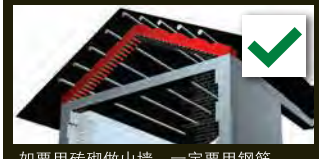


木质山墙：坡屋顶的山墙形状为三角形，山墙可用木板或砖做成。最好用木质山墙，因为它更轻更安全。

Wood Gable Wall: A gable wall is the triangle formed by a sloping roof. Gable walls can be made of wood or brick. The best practice is to use a wood gable wall because they are lighter and safer.

不要使用砖砌山墙。砖砌山墙位置高而且没有框架支撑，容易产生裂缝和发生倒塌。要使用木质山墙或四坡屋顶。

Masonry gable walls can be used but are not recommended because their height and lack of bracing can cause them to crack easily and collapse during an earthquake.



如要用砖砌做山墙，一定要用钢筋混凝土做卧梁(爬山梁)把砖箍起。

If a masonry gable wall is used, then the sloping part of the masonry must be confined by a reinforced concrete beam.

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抗震户型 Earthquake Resistant Building Configuration

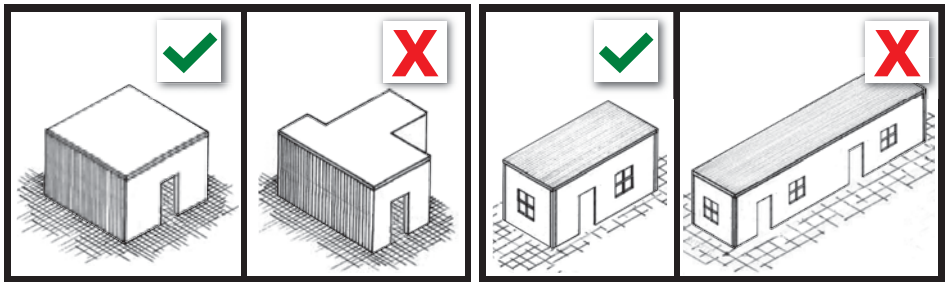
简单、方正和对称的农房户型是房屋的抗震性的关键点

Simple, square, symmetric layout is critical to good performance during earthquakes

房屋外形 Shape Of The House

比较其他不规则类型的房屋，正方形最利于抗震。长度应该小于宽度的4倍。避免L型的房屋。

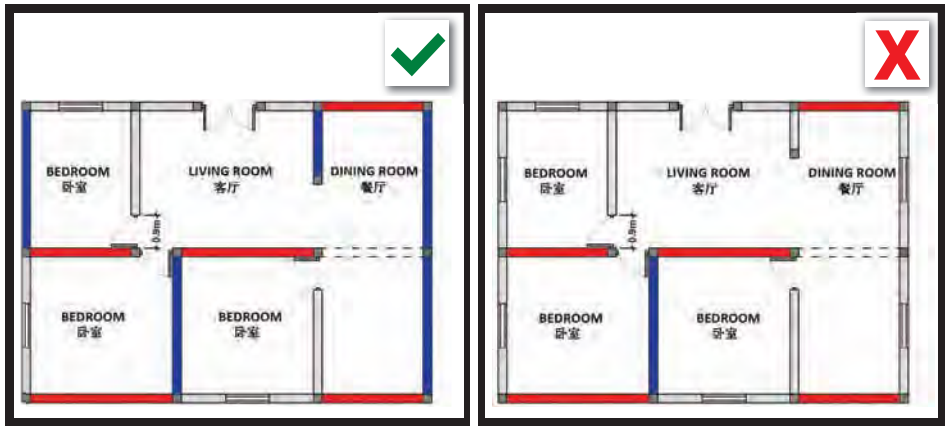
Square is the best shape for earthquake resistance. Length should be less than four times the width. Avoid L-shaped buildings.



墙体密度要对称

Sufficient Symmetric Wall Density

- 南－北、东－西两个走向应分别至少有两段结构墙
  Use a minimum of two structural shear walls in each direction
- 在平面图中尽可能使结构墙近似对称布置
  Structural walls should be approximately symmetric in plan

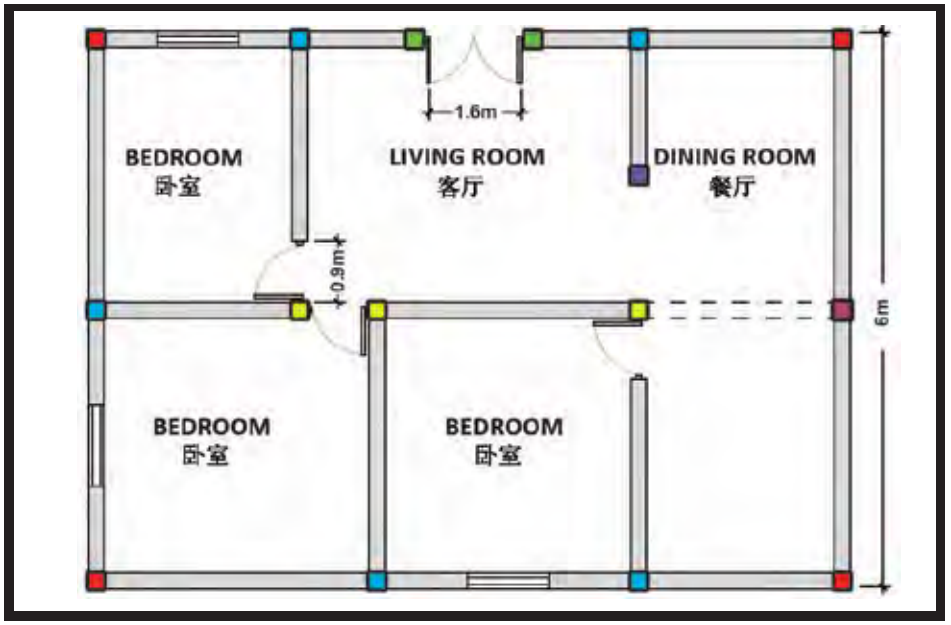


构造柱位 Tie Column Locations

建议: 构造柱必须设置在:

RECOMMENDATION: Tie columns should be located at:

- 每个外墙与外墙连接处
  Every exterior corner
- 每个内墙与外墙连接处
  Every intersection between interior and exterior wall
- 每个内墙与内墙连接处
  Every intersection between interior walls
- 宽度大于1.5m的门洞两边
  Door openings larger than 1.5m long should have columns at both sides
- 隔墙的端部
  The end of a partition wall
- 横墙超过6m加设构造柱
  Column in walls longer than 6 meters



门窗洞口 Openings

- 每道墙体上尽量只设一个门洞或窗洞
- 如果洞口临近结构墙，洞口两边应设置构造柱
- Maximum one opening per wall panel
- If opening is adjacent to a structural shear wall, the opening should be confined by tie columns at both sides

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砌体结构条形基础 Masonry Strip Footing

修筑毛石混凝土基础时要保证混凝土能够填满所有毛石间的空隙

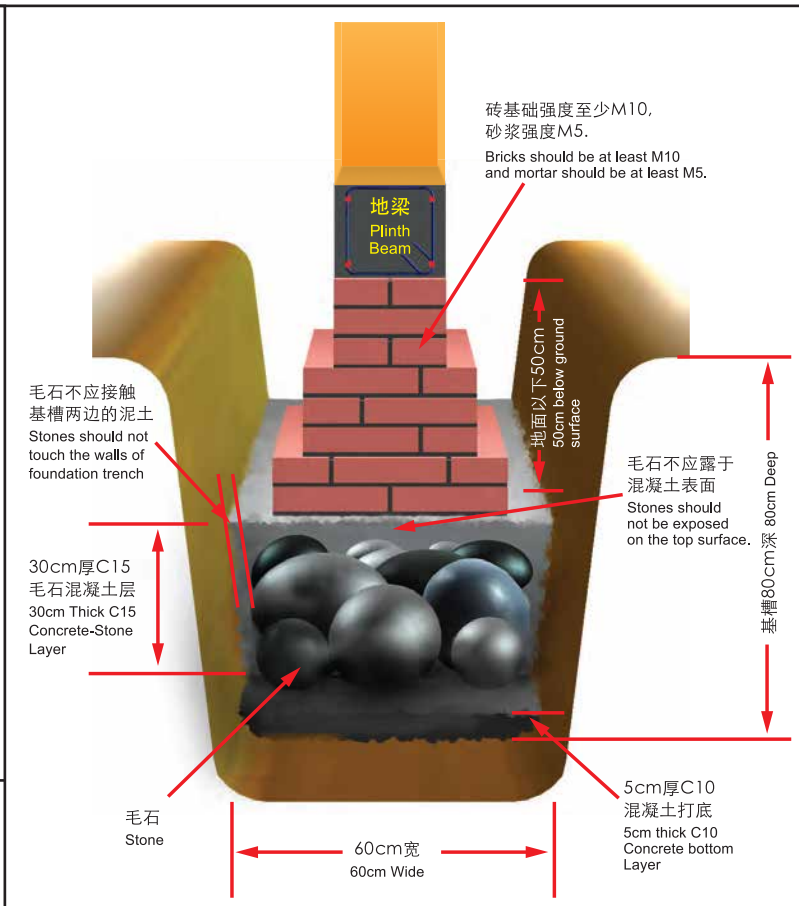
When building the stone masonry for the foundation, it is important to fill all the gaps between the stones

旧址重建时，若挖出旧基础，松土，大树根，井或沼气池等应妥善处理，否则会引起新的地基沉降。应该先把它们清理掉，再用小颗粒细石混凝土回填。

Loose soils, leftover foundations, tree roots, or underground tanks will not support the foundation properly. They should be excavated and filled with pea gravel (small gravel with diameter 1cm or less).

毛石不应太大或太小，平均直径应为15cm最好。毛石表面要干净，不应有泥沙。泥沙会破坏基础。

The average size of the stones should be 15cm. Do not use stones that are too large or too small. Stones covered with sand or mud will weaken the foundation, use only clean stones.



建议用于一层或两层的砖混结构

Recommendation for 1 or 2 story confined masonry house

在构造柱处，砌砖基础应建有马雅槎。构造柱中钢筋应该延伸至砖基础底部，端部弯勾长度至少36cm。

The long bars from the column should extend to the base of the foundation and terminate with anchors that are at least 36cm long.

基槽深度按土质决定，推荐砖基础底部离地面不少于50cm。最低要求基础总埋深不少于50cm。

Depth of foundation trench depends on soil strength, but the base of the brick foundation should be at least 50cm below the ground surface. The minimum requirement for the foundation trench depth in Sichuan is 50cm.

毛石间的空隙不够，混凝土无法注满。

Insufficient space between stones, spaces not completely filled with concrete.

毛石之间不要互相接触，要留10cm的间距。毛石间的空隙要注满混凝土。

Stones should not be touching each other. Leave at least 10cm space between each stone and fill the gap completely with concrete.

配置混凝土时不能使用连沙石。

When mixing the concrete for the foundation, do not use gravel that is already mixed with sand, Instead, use clean sand and gravel.

应使用振捣棒振捣，帮助混凝土流到毛石之间的缝隙里去。

Use a concrete vibrator to fill the gaps between stones completely with concrete.

浇筑毛石基础混凝土后要做7天左右的养护。用胶布覆盖并每天浇水。

Cure the concrete for about 7 days by covering with a tarp and sprinkling with water.

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合格的材料 Recommendations for Good Quality Materials

石头 Stone

建议:

如有条件建议使用坚硬的，有棱角的石头做基础（不是风化的或圆滑的卵石）。

RECOMMENDATION:

Use **HARD, ANGULAR STONE** (not weathered or rounded) for foundation.

砂 Sand

建议:

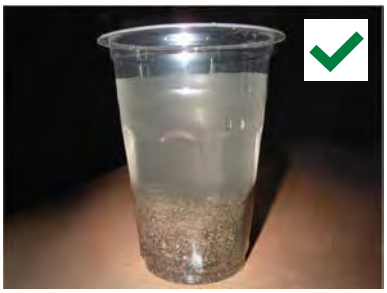
使用干净砂子做砂浆和混凝土，含泥重量要小于5%。

简单测试：抓一把砂子放到塑料杯子或瓶子里，加水摇晃，水越脏，含泥量越大。

RECOMMENDATION:

Use **CLEAN SAND** for mortar and concrete. The requirement is less than 5% mud content.

Simple Test: take a handful of sand and put it in a plastic cup or bottle. Add water and shake it up. The dirtier the water is the more mud is in the sand.



石子 Gravel

建议:

使用压碎的石子做混凝土（不是圆的）。

用和测验砂子同样的方法测验石子是否干净。石子粒径不应超过5cm。

RECOMMENDATION:

Use **CRUSHED GRAVEL** for concrete (not rounded).

Use the same simple test as sand to make sure the gravel is clean. Maximum gravel size = 5cm.

钢筋 Steel

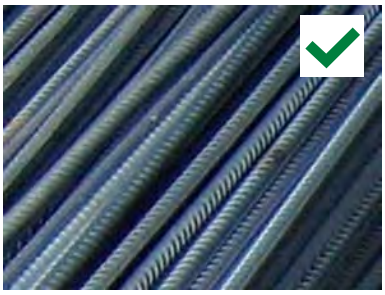
建议:

在砖混结构中，螺纹钢对房屋的粘结要好过圆钢。如果您选择圆钢，建议搭接长度要更长。不要用生锈或旧钢筋。

RECOMMENDATION:

RIBBED STEEL is best for reinforcing confined masonry homes.

If you use smooth steel, longer overlap connections are recommended. Never use recycled or rusty steel.



砖 Bricks

建议:

如何检查砖的质量:

- 砖外表没有裂缝或碎面。
- 砖要方的，没有弯曲。
- 敲打砖时应发出清亮的响声，而不是闷响。
- 长度相差不应超过8mm，宽度和厚度不应超过6mm。

RECOMMENDATION:

How to check brick quality:

- No cracks or chips, No visible unmixed portions or divots.
- Brick is square, not warped or curved.
- When hit together, they make a clink sound, not a dull thud.
- Dimensions are consistent, length does not vary by more than 8mm, width and height 6mm.

要使用烧制足够的砖，这样的砖不易破碎或裂。**Use FULLY FIRED BRICKS that don't crumble or break.**

可以使用旧砖，但不能使用开裂或破碎的砖块。**Using recycled bricks is acceptable, but do not use cracked or broken bricks.**

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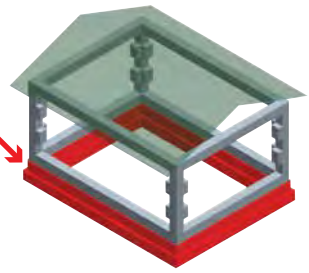
混凝土 Concrete

C15 混凝土，用于毛石混凝土层 C15 Concrete for foundation concrete and stone layer

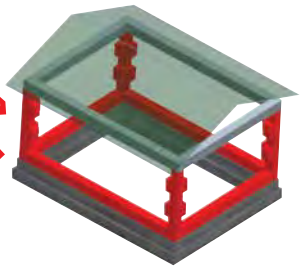


1 袋50公斤的水泥 **bag of 50kg cement**

1 小推车砂 **wheelbarrow sand**

2 小推车石子 **wheelbarrows gravel**

C20 混凝土，用于地梁和构造柱 C20 Concrete for plinth beam and tie columns

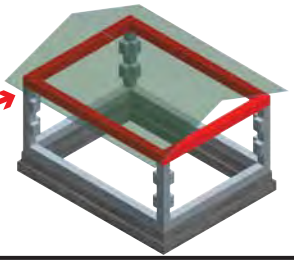


2 袋50公斤的水泥 **bags of 50kg cement**

1.5 小推车砂 **wheelbarrows sand**

3.5 小推车石子 **wheelbarrows gravel**

C25 混凝土，用于上圈梁和屋面板 C25 Concrete for ring beam and roof



1 袋50公斤的水泥 **bag of 50kg cement**

0.5 小推车砂 **wheelbarrow sand**

1.5 小推车石子 **wheelbarrows gravel**

注：小推车斗大小为0.75m长，0.5m宽，和0.3m深。体积为0.07m³。
NOTE: Wheelbarrow's bucket size is 0.75m long, 0.5m wide, and 0.3m deep. Volume: 0.07m³.

小心，别加太多的水！ Caution! Do not use too much water!

混凝土拿在手上时，水不应流出手掌。
Water should not be running down your hand, with concrete mixture in hand.

拌和的混凝土，石子的表面不应外露。
Gravel surface should not be showing through the concrete mixture.

混凝土浇筑 Concrete Pouring

使用混凝土垫块隔离模板与钢筋。
Use concrete spacer to ensure adequate cover over steel.

在浇筑前要侵润模板与钢筋。
Pour water on formwork and steel before pouring concrete.

轻敲模板并且用杆振捣混凝土使其密实。
Compact concrete by ramming with rod or tapping formwork with hammer.

推荐在地梁上做拉毛，使其与砖墙结合的更好。
Recommendation:
Scarify the top of the foundation beam for good contact with masonry.

混凝土养护7天左右，拆模后检查有无钢筋暴露，混凝土开裂。
Cure the concrete for about 7 days and check for exposed steel and cracks after removing formwork.

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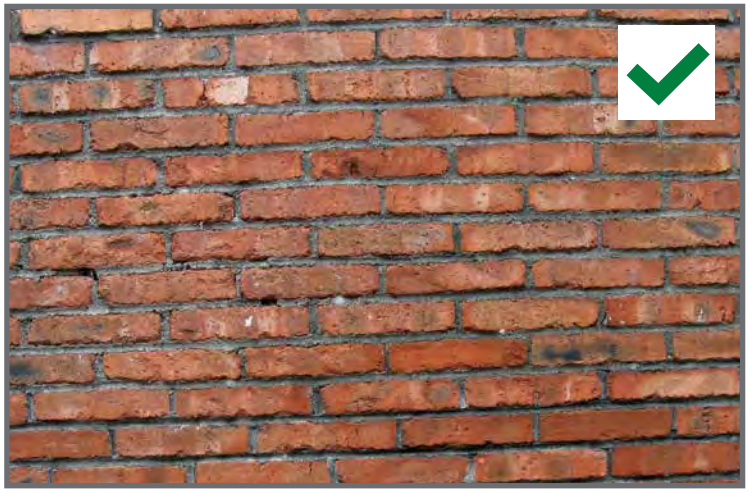
高质量砖墙 Good Quality Masonry

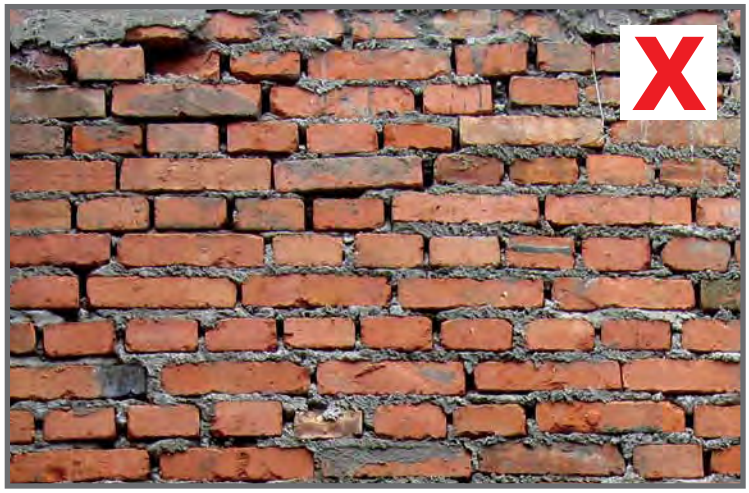
建造一个高质量的砖墙最重要的原因，是为了保护你的房屋在下一次地震中不会被破坏。

Building Good Quality Masonry is one of the most important things you can do to help ensure your confined masonry house doesn't collapse in the next earthquake.

好的做法 Good Practice

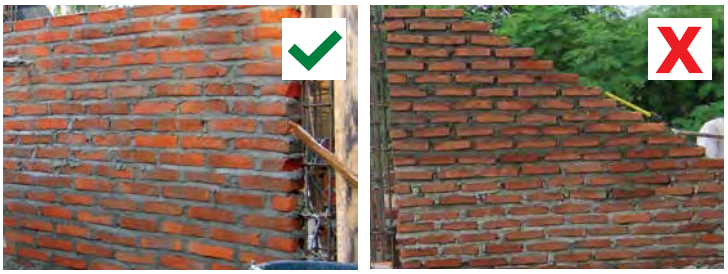


不好的做法 Bad Practice

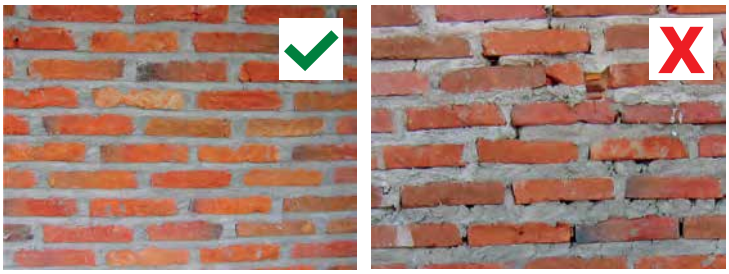


高质量砌筑的诀窍 Tips for Good Quality Masonry

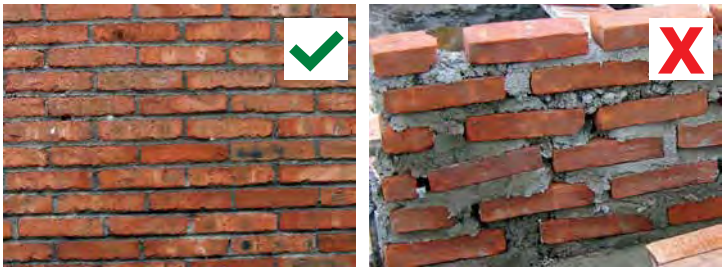
1. 砌砖时一次一层并且使用准线和皮数尺
Lay Bricks one course at a time using line and deadman



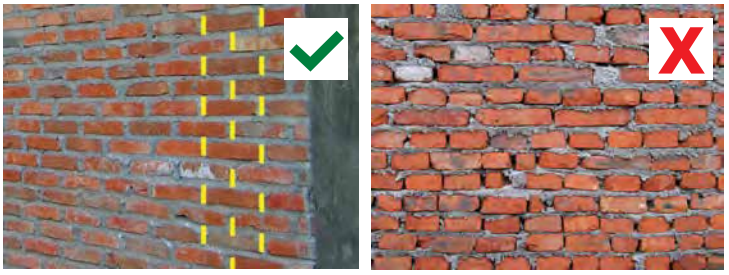
2. 砌砖时砂浆充填饱满
Fill joints completely with mortar at the time bricks are laid



3. 灰缝厚度应是0.8cm到1.2cm，厚度要一致
Joint spacing between bricks should be consistent and between 0.8cm and 1.2cm

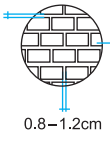


4. 错开竖缝且不要使用坏砖
Stagger vertical joints and do not use broken or half bricks



5. 垂直 Plumb

水平和垂直接缝
Horizontal and vertical joints



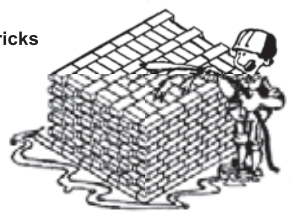
不要让砖墙接缝的厚度超过1.2cm，接缝太厚将会削弱整体强度。
Do not leave joints more than 1.2cm thick, Joints that are too thick will weaken the wall.

水准测量控制
Level control

在砌筑每一层的时候，可以用铅锤来确保墙体垂直。
Use the plumb bob at every layer to make sure the wall is vertical.

6. 用水浸透砖
Soak bricks in water

准备砖块
Prepare the bricks



在砌墙的前一天，清理砖块并用水浇淋20分钟。之后放置一段时间。
The day before building the walls, clean the bricks and water them for 20 minutes. Then let them rest.

插图取至於农民自建抗震屋图解手册 Illustrations from Construction And Maintenance Of Masonry Houses

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圈梁和柱的钢筋搭接 Connections Between Tie Columns and Bond Beams

搭接钢筋时要保证有足够的锚固长度与有足够的箍筋在加密区里

When tying the tie columns and bond beams together, care must be taken to ensure adequate anchor length and additional stirrups near every joint.

锚固要达0.26m长，相对弯曲正确。

Anchors should be at least 0.26m long and turned toward each other.

锚固长度过短。相反弯曲同样满足规范要求，但建议用相对弯曲更安全，如上图。

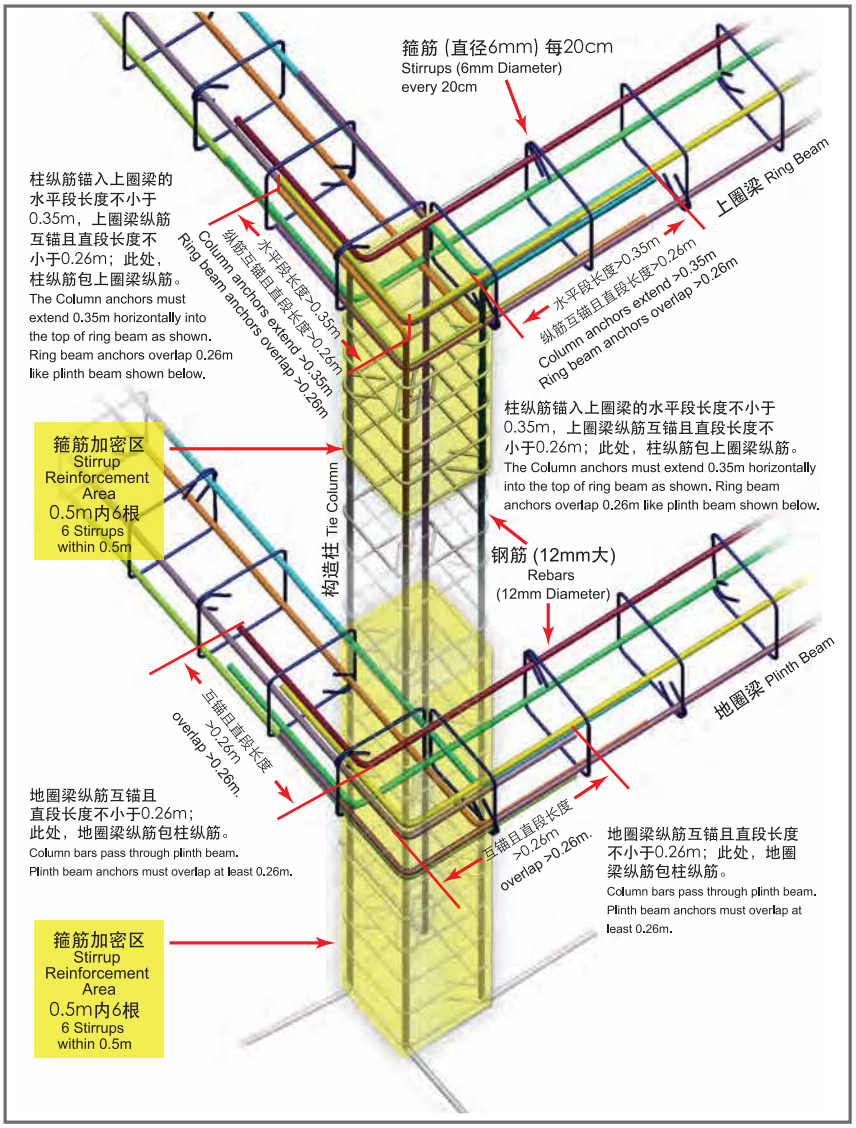
Anchors are too short. Although this connection meets the requirements in Sichuan, it is better to make the anchors face each-other as pictured above.

锚固过短，没绑到圈梁上。

Anchors are too short, and the beams are not tied to each other.

搭接长度过短。依据四川省农村居住建筑抗震设计技术图集（2008修订版）规定，直径12mm的热轧螺纹钢搭接长度为0.57m，直径14mm的热轧螺纹钢搭接长度为0.66m。

Overlap is too short. In Sichuan the splice length must be at least 0.57m for 12mm diameter ribbed steel and 0.66m for 14mm diameter ribbed steel bars to meet requirements.



柱的钢筋至少要高于墙顶0.56m，用于搭接上圈梁。

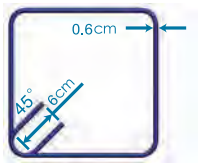
Steel reinforcement in the tie column should extend at least 0.56m above the top of the wall to have enough anchor length.

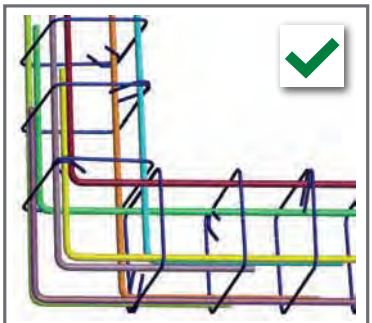
钢筋太短，圈梁与柱子会容易脱离。

Steel reinforcement is too short; the ring beam and tie column may easily separate.

箍筋直径为6mm大，箍筋帮扎弯钩至少6cm长，并向内45度弯曲。

Use 6mm diameter bars for stirrups with hooks at least 6cm long, turned inward at a 45 degree angle.





最好的方式：8根钢筋全锚固到外筋上。

Best when all 8 rebars are anchored to the outside bars.

转角无锚固。

The corner lacks any anchor.

加密区外箍筋间距为20cm，弯钩不要在同一纵筋上，应错开放置，如上图。

Away from the joint, stirrup spacing should be no more than 20cm, and stirrup hooks should be rotated.

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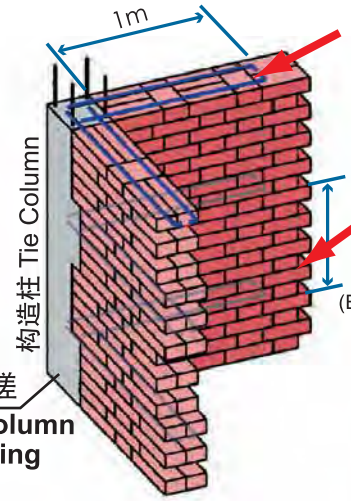
构造柱与墙体的结构 Tie Column and Wall Connection

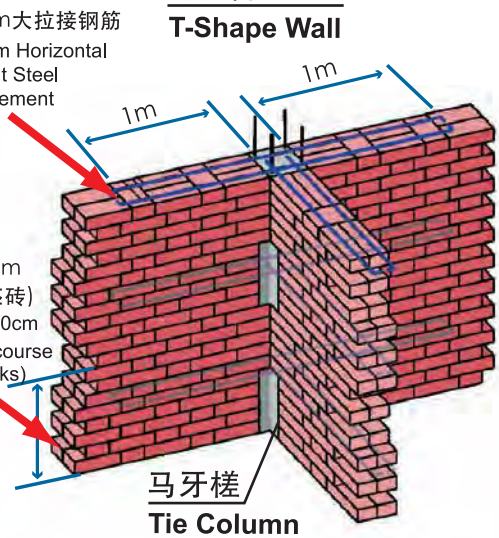
墙与构造柱之间需要用马牙槎和拉接筋来防止构造柱与墙体在地震中分裂。

Tie column toothings and horizontal steel reinforcements in the masonry bed joint are needed to prevent separation of the walls from the tie columns during earthquakes.

L形转角 L-Shape Corner



T形墙 T-Shape Wall

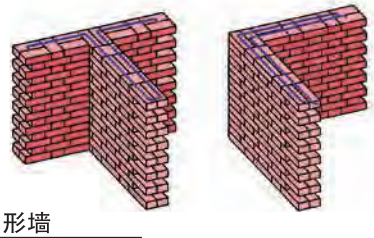


马牙槎高不大于30cm(5匹砖厚)，凹进宽度不要小于6cm。

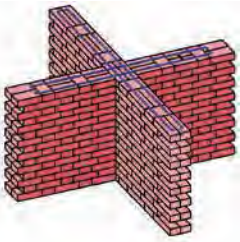
Tie Column toothings height should not be higher than 30cm (every 5 courses of bricks), and the width no less than 6cm.

T形墙 T-Shape Wall

L 形转角 L-Shape Corner

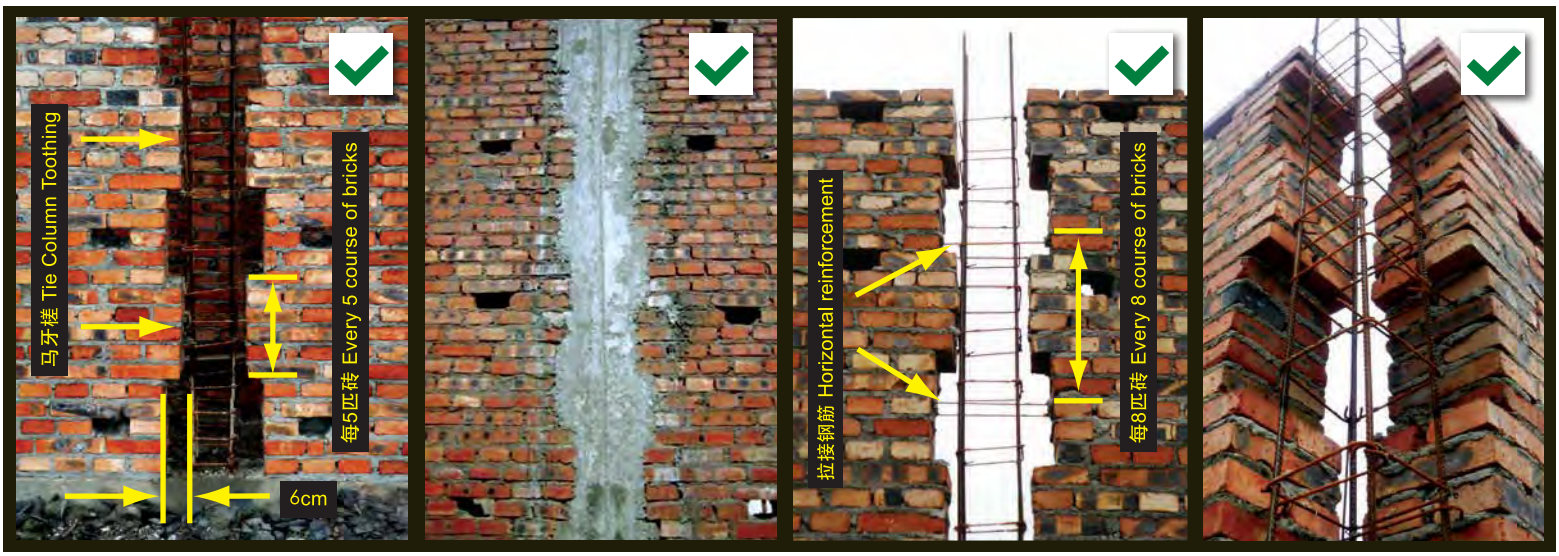


+字形墙 Cross-Shape Coner



最好是在每个转角处都设置构造柱。若有未设置构造柱的转角，也应每隔50cm(每8匹砖)高设置转角拉结筋。

It is better to use a tie column at every corner and wall intersection, but if there is no tie column, make sure to put the same steel reinforcement in the horizontal bed joint of the masonry at every 50cm (every 8 courses of bricks).



Images of wall separation from China Academy of Building Science

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门窗过梁 Doors, Windows and Lintel Beams

过梁是建筑上的横梁，用于支持窗户或门上的砖块重量。如不用过梁的话，窗门上的墙与屋顶会很容易在地震中倒塌。最常见的过梁有两种，预制过梁和现浇过梁。在修建一层两层的砖混结构民房时，门窗洞口上可用预制过梁。但如果门窗过大，洞口之间距离太近，或洞口离柱距离太近时应该使用使用现浇过梁。

Lintels are horizontal beams used in construction. They usually support masonry above a window or door. If lintels are not used, walls and roof over the doors and windows will easily collapse from an impact such as an earthquake. The most common kind of lintels in Sichuan are Pre-Cast and Cast-In-Place Lintels. For one and two story confined masonry buildings, Pre-Cast Lintels can be used on the openings for the windows and doors, but when the openings are too large or if the openings are too close together, or when any of the openings are located close to the column, a cast-in-place lintel should be used.

单个门窗洞口 Single Opening

预制过梁 Pre-Cast Lintels

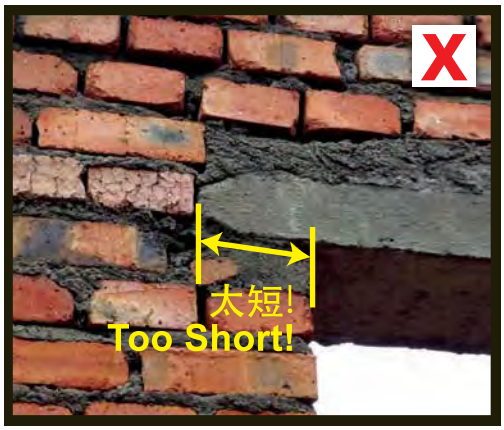
在门窗洞口宽度少于1.5m时，可以选用预制过梁。过梁两端至少要伸入墙里24cm(一匹砖的长度)。

If single openings are 1.5m or smaller, a pre-cast lintel beam may be used. The lintel beam must extend into the wall at least 24cm (length of a brick) on both sides.

现浇过梁 Cast-in-Place Lintels

门窗洞口宽度最好是少于1.5m。在宽度大于1.5m时，必须使用现浇过梁，过梁两端至少要伸入墙里24cm(一匹砖的长度)，并把过梁钢筋锚固到两边的柱内。

The best practice is to have single openings that are 1.5m or smaller. If a single opening is larger than 1.5m, then a cast-in-place lintel beam must be used. The cast-in-place lintel beam must extend into the wall at least 24cm (length of a brink) on both sides with its rebars tied into the column on both sides.



两个门窗洞口 Double Openings

预制过梁 Pre-Cast Lintels

若两个门窗洞口之间的距离超过0.8m，可以分别使用预制过梁。过梁两端至少要伸入墙里24cm(一匹砖的长度)。

If doors and windows are 0.8m or more away from each other, then a pre-cast lintel beam may be used. The lintel beam must extend into the wall at least 24cm (length of a brick) on both sides.

现浇过梁 Cast-in-Place Lintels

两个门窗洞口之间的距离最好超过0.8m。在距离少于0.8m时，必须使用通长现浇过梁，过梁两端至少要伸入墙里24cm(一匹砖的长度)，并把过梁钢筋锚固到两边的柱内。

The best practice is to have doors and windows 0.8m or more away from each other. If they are closer than 0.8m to each other, then a cast-in-place lintel beam must be used. The cast-in-place lintel beam must extend into the wall at least 24cm (length of a brink) on both sides with its rebars tied into the column on both sides.

门窗洞口在柱旁 Openings Next to Columns

预制过梁 Pre-Cast Lintels

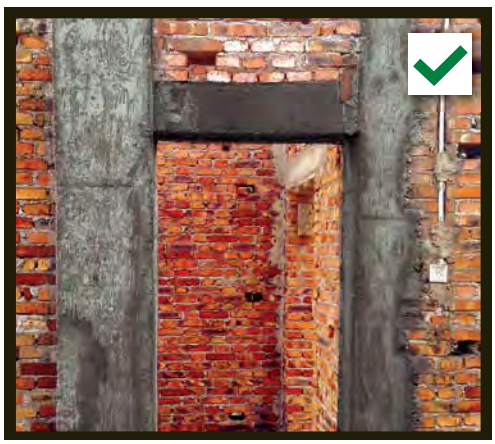
在门窗洞口离构造柱的距离超过0.8m时，可以选用预制过梁。过梁两端至少要伸入墙里24cm(一匹砖的长度)。

If doors and windows are 0.8m or more away from the column, than a pre-cast lintel beam may be used. The lintel beam must extend into the wall at least 24cm (length of a brick) on both sides.

现浇过梁 Cast-in-Place Lintels

门窗洞口离构造柱最好是超过0.8m。在距离少于0.8m时，必须使用现浇过梁，过梁两端至少要伸入墙里24cm(一匹砖的长度)，并把过梁钢筋锚固到两边的柱内。

The best practice is to have doors and windows 0.8m or more away from the column. If they are closer than 0.8m to the column, then a cast-in-place lintel beam must be used. The cast-in-place lintel beam must extend into the wall at least 24cm (length of a brink) on both sides with its rebars tied into the column on both sides.



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