爱上科学
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# 爱上科学

INTRODUCING • 科技与发明系列
INVENTION AND TECHNOLOGY

# 建筑与结构

BUILDINGS AND STRUCTURES 双语版

[英] Tom Jackson 编
陆禾禾 译
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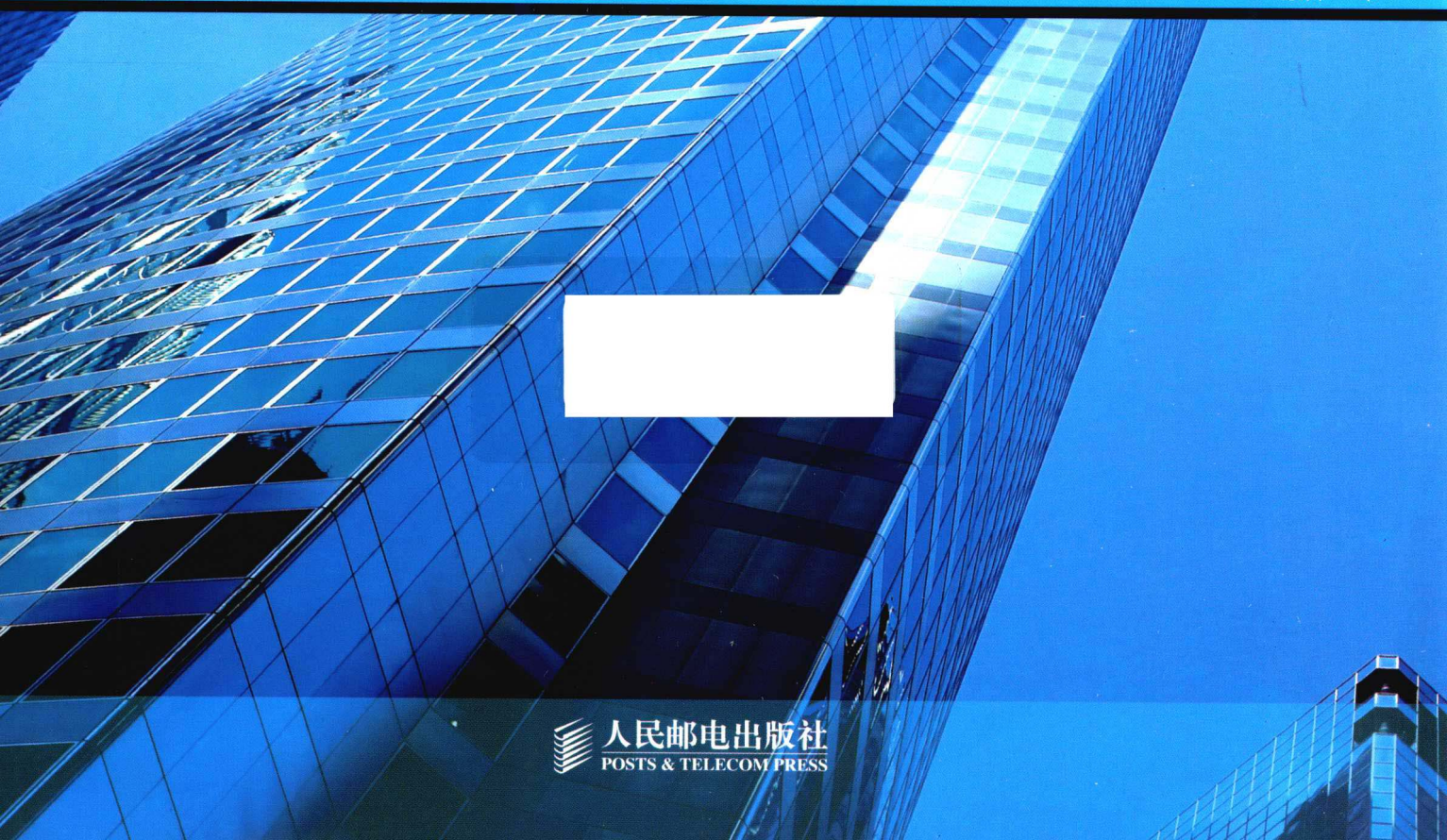

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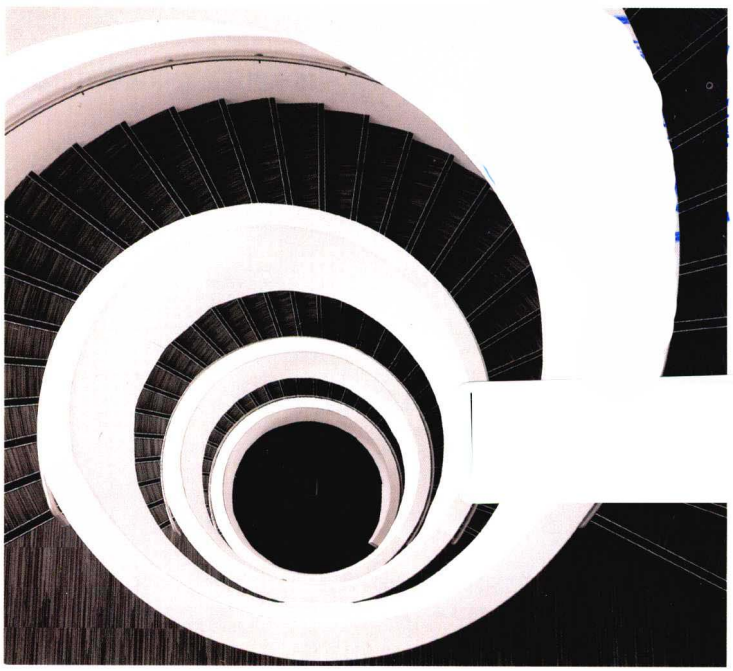

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# 内容提要

《爱上科学》系列科普丛书为读者全面地讲述了科学知识和原理，以通俗的文字、生动的图表为特色，每本书介绍一个或几个主题。从日常生活中有趣的现象出发，引导和培养读者学习的兴趣，扩宽读者的视野，同时还可以帮助读者学习英语词汇、练习英语阅读。丛书涵盖物理、化学、生物、科技与发明这4个系列。适合对科学知识感兴趣的广大科普爱好者阅读。

本书是科技与发明系列中的一本。科技与发明系列主要介绍各种科技成果以及相关发明，覆盖多个领域，包括建筑、交通、医学、军事、能源以及航空航天等，指导读者认知和学习各种科学技术，拓宽视野，引发思考，提高创新能力以及发明意识。

本书展示了各式各样的建筑，包括传统建筑、现代建筑、堤坝、桥梁以及隧道等，详尽地介绍了它们的外观、原理以及各自的特点。书中含有“科学词汇”栏目，提取每章重点知识词汇。同时还有“试一试”栏目，包含丰富有趣的家庭小实验，有助于提高大家的动手能力。

# 丛书编委会

（按姓氏笔画顺序）

# 丛书序

这是一个科技新时代，我们曾经认为遥不可及的科学，时刻围绕在我们身边。你是否曾经怀疑过所谓的“2012，世界末日”，或者好奇过在地下高速飞驰的地铁，抑或每天都在关注着PM2.5……这说明科学已然走进了你的生活。学习科学，分享科学，爱上科学，让我们共同聆听来自科学的声音。

《爱上科学》系列科普丛书是一套引进版系列科普丛书，译自英国大型出版商棕熊图书（BROWN BEAR BOOKS）有限公司出版的著名系列科普图书《Facts at Your Fingertips》，其独特的科学解读视角、生动的科普画面、优美的图文设计，得到了欧洲读者的青睐，尤其是得到了欧洲青少年的极大欢迎。本丛书为读者全面地讲述了各个领域的基础科学知识和基本事实，以精彩的主题、通俗的文字、生动的画面为特色，从我们身边的素材和现象出发，激发和培养读者学习的兴趣。

丛书涵盖物理、化学、生物、科技与发明四大系列。物理系列阐释和说明了物理学知识及其发展史，包含对物理学发展史许多重大的物理发现以及著名的物理学家的介绍。化学系列主要阐释现代化学的基本概念，涵盖化学反应、有机化学、生物化学、金属、非金属、分子、原子、物态等多方面内容。生物系列主要阐释生命科学的基本概念，并探讨有关生物学的各个方面，包括植物学、微生物学、动物和人类、遗传学、细胞生物学以及生命形式等。科技与发明系列主要介绍各种科技成果以及相关发明，覆盖多个领域，包括建筑、交通、医学、军事、能源以及航空航天等，指导读者认知和学习各种科学技术，拓宽视野，引发思考，提升创新能力以及发明意识。

本丛书还具有中英双语的独特设计，让读者在阅读中文时，能对照性地阅读英语原文，为他们提高科学领域的英文阅读能力以及扩展科学类英语词汇量提供了很好的帮助。

丛书中还有“试一试”栏目，该栏目包含了丰富有趣的家庭小实验，为大家在生活实践中验证科学知识提供了更多的选择。

学无止境，让我们一起爱上科学！

# 目录 CONTENT

# TRADITIONAL STRUCTURES

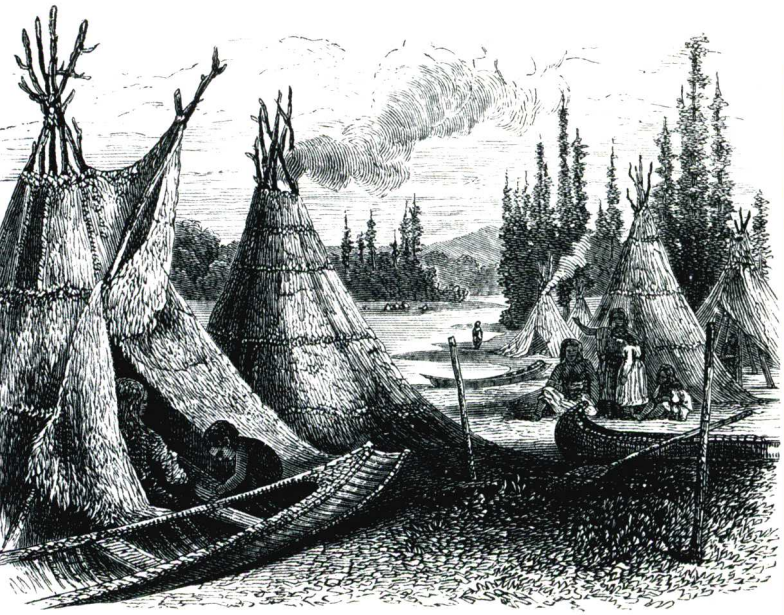
Since the dawn of history people have constructed their buildings from the materials available to them in their local environment, and until the invention of engines 200 years ago, building materials were made and lifted using muscle power alone.

**Nowadays most buildings** are made from bricks, steel, and concrete, with glass windows and shingled roofs. However, in the earliest days of humanity people built temporary dwellings out of easily available materials such as grass, mud, and sticks, using very primitive tools. In many places the earliest humans lived in caves and therefore didn't have to build shelters at all, while herders simply lived under the open sky.

Many ancient peoples had no fixed homes. Instead, they would travel from place to place, moving either when the seasons changed or when they needed fresh pastures for their herds. These people were called nomads. Many of these tribes lived in tents, which they dismantled and took with them whenever they moved. Nomadic societies still exist on many continents.

There is a theory that the continent of America was first populated by people who walked across the Bering Strait (which separates

*Traditional building techniques worked very well, and many old buildings still stand, such as St. Paul's Cathedral in London, which was completed in 1710. In 2000, a new bridge was built to connect the south of the city to the cathedral. However, it took engineers nearly two years more to stop the high-tech suspension bridge from wobbling.*



*The tents used by many Native American groups are called tipis. The rawhide tents had holes at the top to allow fire smoke to escape from inside.*

Asia from Alaska) when a land bridge emerged there during the last Ice Age. This is evident not only in the genetic characteristics of the Native people but also in comparisons of their dwellings. The typical dwelling of many Asian peoples, called a *yurt*, *jirga*, or *ger*, is similar to a type of tent used by some Native Americans.

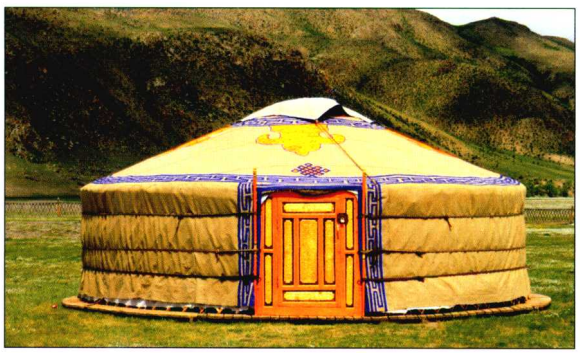
Gradually people settled and adapted to their environment. As a result, the wooden frames that formed the basis of their buildings became more robust, and the animal hides and woven fabrics that had previously been used as coverings were replaced by sturdier, heavier materials such as wood, grass, and mud. This change gave the structures a new strength and durability. Eventually, the wooden frameworks would become stronger and stronger as the dwellings grew in size.

## SOCIETY AND INVENTIONS

### Mobile homes

While some nomadic people traditionally built new shelters wherever they went from local materials, other groups took their homes with them. The shelters of these people had to be reliable, weatherproof, mobile, and versatile. In order to meet these needs, a variety of basic tent designs were created.

Some of these styles have not changed for many hundreds of years. The Bedouin people of the Middle East and North Africa, for example, live in the same style of tent as their ancestors. Their tents are made from woven cloth that is pulled tight over poles, with only one wall and a roof to protect the occupants from the wind. The Mongolian *ger* (or *yurt*, below), on the other hand, is more like a portable house than a tent. The walls are made from criss-crossed fences, while poles stretching over the top form the roof. This frame is then covered by a thick blanket of felt that keeps the heat of the fire inside the home.



*Everything needed to make a family's ger—and the beds and furniture inside—are transported on dozens of camels, yaks, and horses. Everything can be packed away into tight bundles—except the ger's solid wooden front door.*

# 传统结构

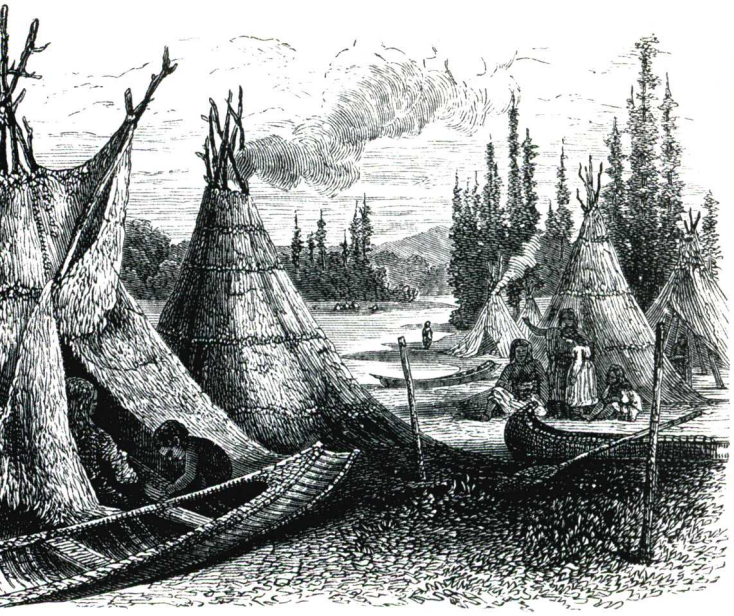
**从历史的黎明开始，人类就利用当地环境中触手可及的材料来构造建筑。200年前，当人们尚未发明发动机时，建筑材料全部依靠人类肌肉的力量进行搭建、抬升和运输。**

如今大部分的建筑都是由砖块、钢材以及混凝土建成的，配有玻璃窗户和木瓦屋顶。在人类社会的最早期，人类利用最原始的工具，选用方便获取的材料，如青草、泥土、木棍等来建造临时的住所。在很多地方，最早期的人类生活在山洞中，所以他们无需遮蔽的居所。游牧者则更简单，他们生活在蓝天白云下。

很多古代人类没有固定的住所。他们从一个地方搬迁至另一个地方，随着季节的变更，或为自己的牧群寻找新鲜的牧草地而不断迁移。这些人我们称为游牧民。大多数游牧民部落居住在帐篷里，在搬迁时，他们会将帐篷拆卸并随身携带。游牧部落社会在很多大陆中至今依然存在。

有一种理论表明美洲大陆这一片处女地在最后一个冰河时代陆桥出现后，是由步行穿越白令海

传统建筑技术相当优秀，很多古老的建筑至今依然矗立，例如于1710年建成的伦敦圣保罗大教堂。2000年的时候，伦敦新建了一座桥梁，将教堂和城市南部地区连接了起来。但是工程师们花费了两年多的时间来防止这座高科技的吊桥出现晃动的情况。



很多北美土著居民群使用的帐篷被称为提皮斯。印第安人在这种帐篷的顶部打了孔，这样可以使帐篷内部的烟雾散发出去。

峡。（把亚洲和阿拉斯加分割开的海峡）的人类首先居住的。这一点不仅在土著民的基因特征中得以显示，还在与他们的居所进行比较后得到了证实。很多亚洲人的典型居所，称为圆顶帐篷，都类似于某些北美土著居民使用的帐篷类型。

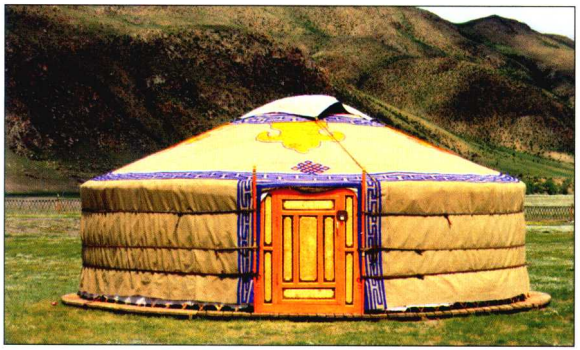
慢慢地人类选择了定居，并逐渐适应了他们生活的环境。因此，构成建筑基础的木制结构框架变得更为坚固，之前用作覆盖物的动物毛皮以及纤维编织物被一些更牢固、厚重的材料，如木材、青草以及泥块所取代。这些材料上的变化使房屋的结构增加了强度和持久性。最终，随着居所面积的不断增大，木制结构框变得越来越牢固。

## 社会与发明

### 移动的房屋

一些传统的游牧民随着自己的迁移不断从当地选择材料来建筑新房屋，然而一些其他群体在迁移过程中，房屋是随时携带的。供这些群体遮蔽的场所必须可靠、不受天气影响、可移动且多样化。为了满足这些需求，一系列基本的帐篷设计应运而生了。

有一些帐篷的款式在数千年的历史过程中都未发生改变。例如中东与北非的贝都因人，至今仍居住在与他们祖先同样类型的帐篷中。他们的帐篷由编织布制成，杆顶被紧紧拉伸，帐篷只有一面墙和一座屋顶，为居住者挡住寒风。蒙古人的帐篷（见下图中的圆顶帐篷），从另一个角度看，与其说是帐篷，不如说更像一间可以移动的房子。它的四壁是由相互交错的栅栏搭成的，杆子在帐篷顶部拉伸组成了屋顶。这种框结构被厚厚的毛毡毯覆盖，以便保持室内的温度。

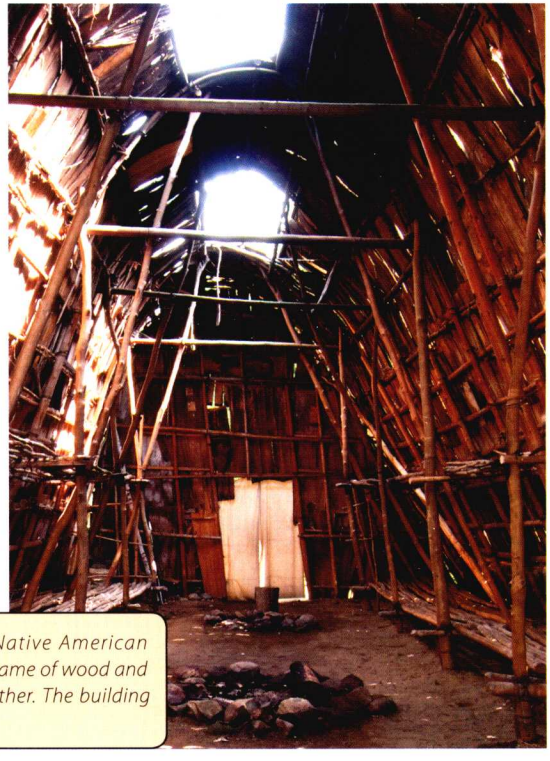


所有搭建家庭帐篷的物品，包括室内的床和家具，都是通过大量的骆驼、牦牛和马来运输的。除了帐篷中坚硬的木质前门外，所有的东西都可以被紧紧地打包成捆。

## Building materials of the world

In different parts of the world people had different materials available to them. To a great extent this defined the type of buildings that they constructed. In the marshes of southern Iraq, for example, reed rushes and mud from the wetlands were used to make long pillars that were inserted into holes dug in the ground in two parallel lines. The tops of the pillars were then bent over and fastened together with the opposite pillar, making a row of arches. These arches were attached together by thin bundles of reeds, and reed matting then covered the entire building. These techniques are 6,000 years old and are still used today.

In places such as Scandinavia, the Swiss Alps, and the Himalayas, where timber has generally been plentiful, people have tended



*This longhouse made by the Native American people of eastern Canada has a frame of wood and was covered in skins in cold weather. The building could house 20 families.*

## MORE THAN MUD HUTS

Mud has been used for building all over the world. Mud was used by the Pueblo people of North America as well as in Mali, West Africa, where many mud buildings still stand. Made well, mud houses can be sturdy and also very beautiful. The great ziggurats (raised platforms) of ancient Mesopotamia were made from mud bricks. Despite being about 4,000 years old, the ruins of these mud constructions can still be seen.

*The Great Mosque at Djenne, in Mali, West Africa, is made of mud and wood and is nearly 800 years old, although it has been rebuilt several times.*

## THE IGLOO

The Inuits, who live in the Arctic, still use snow to make temporary shelters, called igloos, in the same way they have for centuries. Igloos are made from huge blocks of frozen snow and are formed in the shape of a dome, a design that offers great natural strength. Loose snow is then packed over the top, filling in gaps. When the dome has been made, the builder goes inside, tightly sealing the igloo from the cold air outside. A lamp is then lit. The hot air, having no way to escape, begins to melt the blocks of snow. Then, when cold air is allowed in again, the melted snow quickly freezes. This process cements together the blocks and forms a smooth surface of ice on the inside of the igloo. The structure may be further strengthened by sleet, which freezes as it runs down the sides of the building. Igloos can be linked to one another via roofed passages, forming community dwellings of between three and five rooms capable of housing 15 to 20 people.

*Igloos are not used as permanent housing, just as temporary shelters while Inuit people are hunting for seals far from home in the summer. Blocks of clear ice are fitted between the slabs of white snow to make windows.*

to make their houses from wood. Tall, straight-trunked trees such as pine, fir, and beech are particularly suited to this use. The log cabins of these areas are often made by flattening two sides of the long trunks and cutting the ends so that they fit together. Houses are still often built completely out of timber today.

## Building in stone

Buildings constructed from stone are strong because it is such a hard and durable material. Some of the earliest stone buildings date back as far as 2770 B.C.—that means they have survived for almost 5,000 years. One civilization that used stone to spectacular effect was that of ancient Egypt.

## WATTLE AND DAUB

One of the oldest building materials is wattle and daub. This material has been found in some of the oldest settlements know, such as Çatalhöyük, a 9,000-year-old ruined city in central Turkey. Wattle and daub is a composite material, making use of two very different substances to create a sturdy structure. The wattle is a fence made by weaving thin branches around timber supports. This inner structure is then filled in and covered by the daub, a soft material made of whatever is available—mud, straw, horsehair, and even dung.

## 世界各地的建筑材料

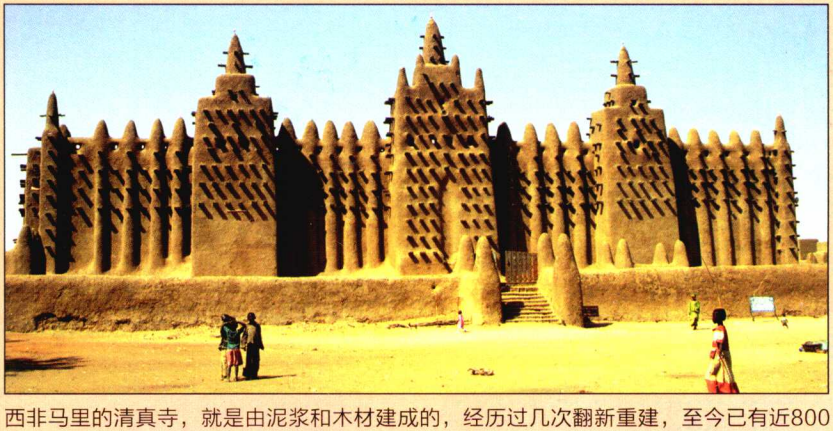
在世界上不同的地区，人们使用身边不同的材料来建造房屋。在很大程度上，这也决定了他们所建筑的房屋类型。比如说，在伊拉克南部的沼泽地上，人们使用芦苇和泥浆制成长长的芦苇束柱子，以两根平行线的方式插入地面的坑中。柱子的顶部向下弯曲，与相对的另一根同时弯曲的柱子稳定地结合在一起，形成了一排拱形。一排排的拱形由细细窄窄的芦苇束捆在一起，最后在整个建筑上覆盖一层苇箔。这项技术已有6 000年的历史，一直沿用至今。

在斯堪的纳维亚半岛、瑞士阿尔卑斯山脉、喜马拉雅山这些木材充沛的地方，人们更多地使用

这个由加拿大东部的土著居民建成的长方形房屋有着木结构框架，冬季来临时，由方覆盖。这座房屋可以容纳20户人家同时居住。

### 它们可不是简单的泥屋

泥浆广泛地应用在世界各地的建筑中。北美的印第安人村庄和西非的马里都使用泥浆来建造房屋，很多建筑至今仍然存在。由于建筑工艺完善，泥浆制的房屋既牢固又美观。古美索不达米亚及巴比伦之金字塔（顶上有神殿）就是由泥砖建成的。虽然它已有4 000年的历史，当年泥浆建造的遗迹至今仍然可以辨识。



西非马里的清真寺，就是由泥浆和木材建成的，经历过几次翻新重建，至今已有近800年的悠久历史。

### 依格鲁

生活在北极地带的因纽特人现在仍然使用积雪来建造临时的庇身棚，称为依格鲁，这一建筑方式已沿用了数个世纪。依格鲁由冻雪堆成的巨大雪块建成，形状像一个圆顶，这样的设计可以产生很大的自然强度。顶部会随后堆放一些松散的雪来填补空隙。圆顶建好后，施工者钻进其中，对依格鲁进行紧密的封合，防止外部冷空气进入，随后，在依格鲁里点燃油灯取暖。热空气无处可逃，开始融化内部的雪块。随后，当雪门打开冷空气再次进入时，融化的积雪又很快地结成了冰。这一过程对雪块进行了粘合，在依格鲁内壁上形成了光滑的冰面。这一结构可以在雨夹雪或冰雹来临时得到更一步的强化，雨和雪在沿着建筑外围下滑时慢慢结冰。通过有屋顶的通道，不同的依格鲁可以彼此连接，把可以容纳15～20个居民的3～5个房间构成一个居住团体。

依格鲁不是一个永久性的居所，它们仅在夏季因纽特人远离家乡猎捕海狮时临时搭建而成。在白雪的平板之间填充了块状的透明坚冰可当作窗户使用。

木头来建造房屋。这些树杆高大笔直的树木，如松树、冷杉、山毛榉等都特别适合这一用途。这些地方的很多木质房屋都是将长树杆的两边削平，去除头尾，将两块木料拼合在一起建成的。至今仍有相当数量的房屋完全由木材建成。

## 石块建筑

用石块建造的建筑十分坚硬，因为石块是一种坚固耐久的材料。某些最早的石块建筑可以追溯到公元前2 770年，这就意味着它们已经存在了近5 000年了。使用石块创造出令人叹为观止奇观的便是古

### 抹灰篱笆墙

抹灰篱笆墙是最古老的建筑材料之一。这种材料在现存的一些最古老的聚居区内仍可发现，如土耳其中部的一座9 000年的废墟城市哈塔尔赫尤克。抹灰篱笆墙是一种合成材料，它使用了两个完全不同的材料来创造一种坚固的结构。篱笆墙是由枝条编成的篱笆围着木头支撑物组成的。这种内部结构由抹灰，一种由周围便于获得的材料，如泥块、稻草、马毛甚至动物粪便混合而成的柔软的材料进行填充覆盖。

In order to extract the stone from the quarry, the Egyptians used pickaxes to chip away at the rock until five sides of a rectangular block were exposed. They then drilled holes along the sixth face and filled them with wooden wedges. Doused with water, the wedges would expand, breaking the block from the stone face. The masons then used mallets and chisels to shape the block into a smooth rectangle, checking their work with straight edges, set squares, and plummets (pieces of lead attached to a line used to check the alignment of vertical surfaces). Such simple tools remained in use right up until the Industrial Revolution.

## INCA WALL

The Incas of South America built very strong stone walls (below, in Cuzco, Peru). The walls were dry—the stones were not glued together with cement. Instead, each stone was cut to fit together so exactly that you could not fit a knife blade between them. This was all the more amazing since the Incas only had cutting tools made from soft metals, such as bronze and gold, and stone axes.

*The Lycian people cut tombs out of the rocky cliffs of western Turkey about 2,400 years ago.*

## Temples and tombs

Because it was quite costly to quarry and maneuver, stone was mainly used for state or royal buildings. The most famous ancient structure made from stone is the Great Pyramid of the pharaoh Cheops (or Khufu) at Giza, Egypt. Built over 4,000