高等学校试用教材

港口及航道工程专业英语

朱梅心 编著

人民交通出版社

港口及航道工程专业英语

Professional English of Port & Channel Engineering

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前　　言

按国家教委规定，专业外语阅读应列为必修课而纳入教学计划。在加快改革开放的今天，其必要性更其明显。交通系统各专业均已出版有各自的专业英语教材，唯独尚无《港口及航道工程专业英语》。目前各校港航专业使用的专业英语教材有取材涵盖的面不宽或缺少港与航的核心内容等问题存在，确有编写的必要。为扩大管理和监理方面的词汇量，本书稿又增加了第四部分的四课课文。读者通过本书学习可达到顺利阅读专业书刊的要求。

译文及词条经刘光文教授逐字逐条反复审阅和修改，由顾家龙教授审稿，特此致谢。

由于编者水平有限，错误和不妥之处在所难免，恳请读者多加指正。

编　者

1993年3月

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Section I　Basic knowledge for Port & Channel Engineering

Lesson 1　Careers in Civil Engineering

Engineering is a profession, which means that an engineer must have a specialized university education. * Many government jurisdictions also have licensing procedures which require engineering graduates to pass an examination, similar to the bar examinations* for a lawyer, before they can actively start on their careers.

In the university, mathematics, physics, and chemistry are heavily emphasized throughout the engineering curriculum, but particularly in the first two or three years. Mathematics is very important in all branches of engineering, so it is greatly stressed. Today, mathema tics includes courses in statistics, which deals with gathering, classifying, and using numerical data, or pieces of information. An important aspect of statistical mathematics is probability, which deals with what may happen when there are different factors, or variables, that can change the results of a problem. Before the construction of a bridge is undertaken, for example, a statistical study is made of the amount of traffic* the bridge will be expected to handle. *

Because a great deal of calculation is involved in solving many problems, computer programming is now included in almost all engineering curricula. Computers, of course, can solve many problems involving calculations with greater speed and accuracy than a human being can. But computers are useless unless they are given clear and accurate instructions and information — in other words, a good program.

The last two years of an engineering program include subjects within the student's field of specialization. For the student who is preparing to become a civil engineer, these specialized courses may deal with such subjects as geodetic surveying, soil mechanics, or hydraulics.

The civil engineer may work in research, desgin, construction supervision, maintenance, or even in sales or management. Each of these areas involves different duties, different emphases, and different uses of the engineer's knowledge and experience.

Research is one of the most important aspects of scientific and engineering practice. A researcher usually works as a member of a team with other scientists and engineers. He or she is often employed in a laboratory that is financed by government or industry. Areas of research connected with civil engineering include soil mechanics and soil stabilization techniques, and also the development and testing of new structural materials.

Careful study is given to each project even before design work begins. The study includes a survey both of topographical and subsoil features of the proposed site. It also includes a consideration of possible alternatives, such as a concrete gravity dam or an earth-fill embankment dam. The economic factors involved in each of the possible alternatives must also be weighed. Today, a study usually includes a consideration of the environmental impact of the project. Many engineers, usually working as a team that includes surveyors, specialists in soil mechanics, and experts in design and construction, are involved in making these feasibility studies.

Construction is a complicated process on almost all engineering projects. It involves scheduling the work and utilizing the equipment and the materials so that costs are kept as low as possible. Safety factors must also be taken into account, since construction can be very dangerous. Many civil engineers therefore specialize in the construction phase.

After the structure has been completed, it must be kept from falling into disrepair; therefore many engineers specialize in maintenance. This is often a function of the privately owned utility or governmental agency that will ultimately be responsible for the completed structure. A large system like the California State Water Project obviously requires a large maintenance staff under the supervision of qualified engineers.

Much of the work of civil engineers is carried on outdoors, often in rugged and difficult terrain or under dangerous conditions. In addition, the work must also progress under all kinds of weather conditions. The prospective civil engineer should be aware of the physical demands that will be made on him or her.

New Words and Expressions

1. Career 业务
2. civil engineering 土木工程
3. profession 专业
4. government jurisdiction 政府行政区
5. license 发许可证
6. bar examination 律师合格考试
7. mathematics 数学
8. physics 物理学
9. chemistry 化学
10. curriculum 全部课程
    （复 curricula ）
11. statistics 统计学
12. data 数据
13. information 资料、信息
14. probability 概率论
15. traffic 交通，运输
16. handle 处理，承受
17. computer programming 编制计算机程序
18. geodetic surveying 大地测量学
19. soil mechanics 土力学
20. hydraulics 水力学
21. research 研究
22. design 设计
23. construction 施工
24. supervision 管理，监督，监理
25. maintenance 维修
26. management 经营、管理
27. team 队，组

28. finance 资助
29. stabilization 稳定
30. structural material 建筑材料
31. project (n.)项目,计划,方案,工程设计
(v.)投影
32. survey 调查,勘查
33. topographical features 地形特征
34. subsoil 底土,基土,下层土
35. proposed site 预定的现场
36. alternatives 比较方案
37. earth-fill embankment dam 填土坝
38. concrete 混凝土
39. gravity dam 重力坝
40. environment 环境
41. surveyor 测量人员
42. feasibility 可行性
43. schedule 日程安排
44. disrepair 失修
45. privately owned utility 私营公用事业公司
46. be responsible for 对……负责
47. rugged 崎岖的
48. terrain 地带,地域
49. prospective 未来的

Notes

1. which means that...:这是个非限定性定语从句。关联词 which 代表的是前面整个主句 engineering is a profession.
2. bar:法庭中的围栏;法庭;律师的职业;律师界。
3. of the amount of traffic:这个介词短语作定语用,修饰 a statistical study,因为它比较长而谓语动词较短,为了使句子意义一目了然、句子结构匀称,所以将它移到谓语之后。
4. the bridge will be...:这是个定语从句,用以修饰 traffic,此处省略了关联词 which.
5. It also includes a consideration of...:it 代替上句中的 study.
6. fall into disrepair:失修,需要修理。
7. that will be made on him or her:是定语从句。用以修饰 physical demands.

Lesson 2 Hydrologic Cycle

"Hydrology treats of the waters of the Earth, their occurrence, circulation, and distribution, their chemical and physical properties, and their reaction with their environment, including their relation to living things. The domain of hydrology embraces the full life history of water on the Earth". Engineering hydrology includes those segments of the field pertinent to planning, design, and operation of engineering projects for the control and use of water. * The boundaries between hydrology and other earth sciences such as meteorology, oceano graphy, and geology are indistinct, and no good purpose is served by attempting to define them rigidly. Likewise, the distinctions between engineering hydrology and other branches of applied hydrology are vague. Indeed, engineers owe much of their present knowledge of hydrology to agriculturists, foresters, meteorologists, geologists, and others in a variety of fields.

The concept of the hydrologic cycle is a useful, if *academic*, point from which to begin the study of hydrology. This cycle is visualized as beginning with the evaporation of water from the oceans. The resulting vapor is transported by moving air masses. Under the proper conditions, the vapor* is condensed to form clouds, which in turn may result in precipitation.' The precipitation which falls upon land* is dispersed in several ways. The greater part is temporarily retained in the soil near where it falls* and is ultimately returned to the atmosphere by evaporation and transpiration by plants. A portion of the water find its way over and through the surface soil to stream channels, while other water penetrates farther into the ground to become part of the groundwater. Under the influence of gravity, both surface streamflow and groundwater move toward lower elevations and may eventually discharge into the ocean. However, substantial quantities of surface and underground water are returned to the atmosphere by evaporation and transpiration before reaching the oceans.

The discussion of the hydrologic cycle should not give an impression of a continuous mechanism through which water moves steadily at a constant rate. The movement of water through the cycle is erratic, both in time and over area. On occasion, nature provides torrential rains which tax surface-channel capacities to the utmost. At other times it seems that the machinery of the cycle has stopped completely and, with it, precipitation and streamflow. In adjacent areas the variations in the cycle may be quite different. It is precisely these extremes of flood and drought that are of most interest to the engineering hydrologist, for hydraulic engineering projects are designed to protect against the ill effect of extremes. The reasons for these climatic extremes are found in the science of meteorology and should be understood, in broad detail at least, by the hydrologist.

Hydrologists are interested in more than obtaining a qualitative understanding of the hydrologic cycle and measuring the quantities of water in transit in this cycle. They must be able to deal quantitatively with the interrelations between factors so that they can predict the influence of human activities on these relationships. They must concern themselves with the frequency with which extremes of the cycle may occur, for this is the basis of economic analysis, an important determinant for all hydraulic projects.

New Words and Expressions

1. hydrologic cycle 水文循环
2. hydrology 水文学
3. treat of 探讨
4. occurrence 存在
5. circulation 循环
6. distribution 分布
7. domain 范围,领域
8. embrace 包括
9. segment 部分
10. pertinent to 有关
11. planning 规划
12. operation 运营,操作,经营
13. earth science 地球科学
14. meteorology 气象学

15. oceanography 海洋学
16. geology 地质学
17. no good purpose 无必要
18. rigid 严格的
19. vague 模糊的
20. owe much of... to 归功于
21. in a variety of 种种
22. visualize 设想,想象
23. evaporation 蒸发
24. air mass 气团
25. condense 冷凝
26. in turn 从而,又
27. result in 导致
28. precipitation 降水
29. disperse 分散,扩散
30. temporarily 暂时地
31. retain 保留,保持
32. ultimately 最终地
33. transpiration 散发
34. surface soil 表土
35. find its way... to(或 into)到达,设法到达
36. stream 溪流,河道
37. channel 槽,渠,水道,航道
38. penetrate 渗透
39. groundwater 地下水
40. eventually 最终地
41. substantial 大量的
42. constant 不变的,常数
43. steady 恒定的
44. erratic 不稳定的
45. on occasion 有时
46. torrential rain 骤雨
47. tax 受压
48. with it 相随
49. adjacent 邻近的
50. extremes 极值,极端情况
51. flood 洪水
52. drought 干旱
53. of interest to 对感兴趣
54. hydraulic engineering project (或 hydraulic project)水利工程
55. ill effect 恶果
56. broad detail 概括性的
57. in transit 在运输中
58. predict 预测
59. concern themselves with 关心
60. determinant 决定因素

Notes

1. for the control and use of water:介词短语作定语,修饰 engineering projects.
2. resulting:系分词作定语,修饰 vapor.
3. which in turn may result in precipitation:为非限制性定语从句,修饰 clouds.
4. which falls upon land:为限制性定语从句,修饰 precipitation.
5. near where it falls:定语从句,修饰 soil.
6. for hydraulic engineering projects are designed to protect against the ill effect of extremes:为原因状语从句。

Lesson 3 The Grand Canyon

The canyons of America's southwest are deep, ancient openings in the Earth. They look as if they formed as * the Earth split apart. But the canyons did not split. They were cut by rivers. The rivers carried dirt and tiny picecs of stone that slowly ate away at the surrounding rock. For millions of years, the rivers turned and pushed, cutting deeper and deeper into the Earth. * In their paths, they left great rocky divides in the Earth that extend for hundreds of kilometers.

A canyon is almost the opposite of a mountain. Narrow at the bottom; wider at the top. It is as if a mountain were turned over, pushed into the Earth, and removed. Only its form remains. The Grand Canyon in Arizona is one of the largest and most beautiful of all canyons. It extends 450 kilometers.

When you come upon the canyon, walls of rock fall away sharply at your feet. In some places, the canyon walls are more than a kilometer deep. Far below is the dark, twisting line of the Colorado River.

On the other side, sunshine lights up the naked rock walls in colors of red, orange and gold. The bright colors of the canyon's walls are the result of minerals in the rocks. Their appearance changes endlessly... with the light, the time of year, and the weather. At sunset, when the sun has moved across the sky, the canyon walls give up their reds and golds. They take on quieter colors of blue, purple and green.

Hundreds of rocky points rise from the bottom of the canyon. Some are very tall. Yet they are all below the level of an obsrever on the edge, looking over. *

Looking at the Grand Canyon is like looking back in time. Forty-million years ago, the Colorado River began cutting through the area. * At the same time, the surrounding land was being pushed up by forces deep within the Earth. Rain, snow, ice, wind and plant growth rubbed away at the top of the new canyon. And below, the flowing river continued to uncover more and more levels of ancient rock. Some of Earth's oldest rocks are seen here. Level upon level of granites, schists, limestones and sandstones.

The Canyon has several different weather environments. The top is often much different from the bottom. On some winter days, for example, you may find cold winds and snow at the top. But at the bottom, you may find warm winds and flowers.

The Indians left no records of their knowledge of the Grand Canyon. Much of what we know today was recorded by John Wesley Powell. In 1869, he became the first white American to explore much of the Canyon. Powell and his group traveled in four boats. They knew very little about getting over the rapid, rocky water of the Colorado River. In many areas of fast-flowing water, a boat could be turned over by a wave as high as a house. Powell and his group spent more than three months on the river. They soon lost some of their food and equipment. At one especially dangerous rapids, three members of the group left. As they walked up and out of the Canyon, they were murdered by Indians. The rest of Powell's group was lucky to survive. Starving and tired, they finally reached the end of the Canyon.

Powell's reports and maps from the trip made him famous and greatly increased interest in the Grand Canyon. But visitors did not begin to go to the Canyon in large numbers until 1901. That was when a railroad reached the area.

Today, the Grand Canyon is known as one of the seven wonders of the natural world. In 1989, almost four-million people visited the Canyon. Many were from other countries. Most visitors walk part way down into the Canyon along small, steep paths. It takes several hours to walk to the bottom. It takes two times as long to get back up. Some visitors ride mules to the bottom and back.

About 30,000 people see the Canyon by air each year. They pay a helicopter or airplane pilot to fly them above and around the Canyon. About 17,000 people a year see the Grand Canyon from the Colorado itself. They ride air-filled rafts of other boats over the rapid, rocky water. These trips last from one to three weeks.

America's National Park Service is responsible for protecting the Grand Canyon from the effects of so many visitors. All waste material must be carried out of the Canyon. All rocks, historical objects, plants and wildlife must be left untouched. As the National Park Service tells visitors:"Take only photographs. Leave only footprints."

Many writers have tried to describe the wonder of the Grand Canyon. Yet writers recognize that it is impossible to put human meaning in such a place. * Writer and scientist Larry Stevens says the almost overpowering silence and deepness of the Canyon shakes people-at least briefly-out of their self-importance. He says it makes us remember our place in the nature world.

New Words and Expressions

1. canyon 峡谷
2. ancient 古代的
3. split 裂开
4. dirt 泥土
5. tiny 微小的
6. twisting 曲折的
7. naked 裸露的
8. mineral 矿物
9. appearance 外观
10. purple 紫色
11. rocky point 石笋
12. granite 花岗岩
13. schist 片岩
14. limestone 灰岩,石灰石
15. sandstone 砂岩
16. explore 勘探,探险
17. rapids 急流,急滩
18. survive 幸存
19. mule 骡
20. helicopter 直升飞机
21. raft 筏
22. overpower 压倒,制服

Notes

1. look as if:看着象是,they formed 为表语从句,后面的 as 表示原因。
2. cutting deeper and deeper into the Earth: 为分词短语作状语,deeper and deeper 和 into the Earth 又都是修饰 cutting 的状语。

3. looking over：为分词作状语，修饰 an observer.
4. cutting through the area：为 began 的宾语，cutting 为动名词。
5. that it is impossible to put human meaning in such a place：为宾语从句，it 为引导词，动词不定式 to put 才是真正的主语。

Lesson 4 River

River is a large natural stream of fresh water that flows across land in a definite channel for all or part of the year. Rivers range widely in their physical characteristics from narrow, roaring mountain torrents to vast expanses of silently gliding water. The integral part rivers have played in the development of civilization is undisputed. *

Rivers always have transportation routes, both on the water and along the adjacent banks. Rivers are also suppliers of water and energy, and waste carriers for man and nature. Through their flood deposits they have provided fertile level land. The land supplies much of the world's food, often with the aid of irrigation from the stored floodwaters. For these reasons, in spite of repeated catastrophic floods, river valleys have been cradles of civilization and routes of exploration throughout time.

Supplying water is probably the most important economic role of rivers. Water, a renewable resource, is both the least expensive and most essential commodity-except for air-that man uses. As is the usual case where cost is not a major consideration, water is often used carelessly. * The Cuyahoga River at Cleveland, Ohio (USA), for example, actually caught fire because of the quantity of hydrocarbon wastes dumped in it. Such visible pollution is not as frightening as the other industrial wastes that may become even more toxic when chlorine is added at a water treatment facility downstream.

In the developed nations major efforts are being made to clean up sewage and industrial wastewater before it is discharged into rivers and streams so that the water may be used again downstream. Farming and mining practices are being modified to yield less sediment and fewer pollutants. As a result of these efforts, many streams are running cleaner than they have since about 1930.

The rich, irrigated farmlands of river floodplains, terraces, and alluvial fans in such countries as Egypt, Pakistan, China, India, and Mexico and in the southwestern United States are essential to feeding a major part of the world's people. One indicator of the value of a river's contribution to fertile soil is the increased need for artificial fertilizer for Egyptian fields no longer enriched each year by the floods of the Nile. Perhaps the extreme example of a people adjusted to living with a river is the tens of thousands of people who take to boats each year during the floods of the Ganges-Brahmaputra in Bangladesh. As the newly formed bars in the river become islands during the recession of the floodwaters, the new land is planted with a crop. The tops of the bars are said to be green with crops before the flood is over.

New Words and Expressions

1. fresh water 淡水
2. characteristic 特征
3. roar 吼叫,呼啸
4. mountain torrent 山洪,山溪,荒溪
5. vast expanse 广阔水域
6. glide 滑动,滑行
7. integral 组成的
8. civilization 文明,文化
9. undisputed 毫无疑问
10. route 线路,航路
11. supplier 供应者
12. deposits 沉积物
13. irrigation 灌溉
14. in spite of 尽管,不管
15. catastrophic 灾害性的
16. river valley 河谷
17. cradle 摇篮,发源地
18. exploration 探险
19. renewable resource 可更新资源
20. commodity 商品
21. catch fire 着火
22. hydrocarbon 碳氢化合物
23. dump 倾倒
24. visible 可见的
25. pollution 污染物
26. frighten 可怕
27. toxic 有毒的
28. chlorine 氯
29. water treatment facility 净水处理厂
30. sewage 污水
31. discharge 泄放,排放
32. modify 更改
33. sediment 沉积物,泥沙
34. pollutant 污染物
35. as a result of 作为……的结果
36. irrigated farmland 灌溉农田,水田
37. floodplain 滩地
38. terrace 阶地
39. alluvial fan 冲积扇
40. indicator 指示物,指标
41. fertile 肥沃的
42. fertilizer 肥料
43. adjust to 适应……
44. bar 沙洲
45. recession 消退
46. crop 庄稼,作物

Notes

As is the usual case where cost is not a major consideration: 是由关系代词 as 引出的非限制性定语从句,修饰整个主句;as 在从句中作主语。从句中又含有一个由 where 引出的同位语从句,其语法功能相当于定语从句。

Lesson 5 Properties of Fluids

1. Density, Specific weight, and Specific gravity

The density ρ of a fluid is its mass per unit volume. In the international system of units

(SI units), density ρ will be in kg/m^3, which may also be expressed as units of N · s^2/m^4. *

Specific weight γ represents the force exerted by gravity on a unit volume of fluid and therefore must have the units of force per unit volume, such as N/m^3.

Density and specific weight of a fluid are related as follows:

$$\rho = \frac{\gamma}{g} \quad \text{or} \quad \gamma = \rho g$$

Since the physical equations are dimensionally homogeneous, the dimensions of density are

$$\frac{dimensions\ of\ \gamma}{dimensions\ of\ g} = \frac{\mathrm{N/m^3}}{\mathrm{m/s^2}} = \frac{dimensions\ of\ mass}{dimensions\ of\ volume} = \frac{\mathrm{kg}}{\mathrm{m^3}}$$

It should be noted that density ρ is absolute * since it depends on mass which is independent of location. Specific weight γ, on the other hand, is not absolute for it depends on the value of the gravitational acceleration g which varies with location, primarily latitude and elevation above mean sea level.

Specific gravity s of a liquid is the ratio of its density to that of pure water at a standard temperature. In the metric system the density of water at 4°C is 1.0 g/cm^3, equivalent to 1000kg/m^3, and hence the specific gravity (which is dimensionless) has the same numerical value for a liquid in that system as its density expressed in g/cm^3 or in Mg/m^3.

2. Viscosity

The viscosity of a fluid is a measure of its resistance to shear or angular deformation. The friction forces in fluid flow result from the cohesion and momentum interchange between molecules in the fluid. As the temperature increases, the viscosities of all liquids decrease, while the viscosities of all gases increase. This is because the force of cohesion, which diminishes with temperature, predominates with liquids, while with gases the predominating factor is the interchange of molecules between the layers of different velocities. Thus a rapidly moving molecule shifting into a slower-moving layer tends to speed up the latter. And a slow-moving molecule entering a faster-moving layer tends to slow it down. This molecular interchange sets up a shear, or produces a friction force between adjacent layers. Increased molecular activity * at higher temperatures causes the viscosity of gases to increase with temperature.

Consider two parallel plates (Fig. 5.1), sufficiently large so that edge conditions may be neglected *, placed a small distance Y apart, the space between being filled with the fluid. The lower surface is assumed to be stationary, while the upper is moved parallel to it with a velocity U by the application of a force F corresponding to some area A of the moving plate.

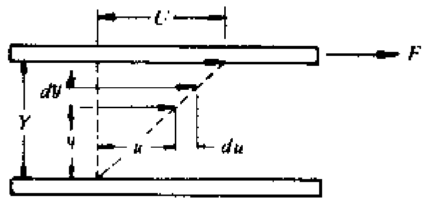


Fig. 5.1

Particles of the fluid in contact with each plate will adhere to it, and if the distance Y is not too great or the velocity U too high, the velocity distribution will be a straight line, and the velocity gradient is a constant.

$$F \sim \frac{AU}{Y}$$

It may be seen from similar triangles in Fig. 5.1 that U/Y can be replaced by the velocity gradient du/dy. If a constant of proportionality μ is now introduced, the shearing stress τ between any two thin sheets of fluid may be expressed by

$$\tau = \frac{F}{A} = \mu \frac{U}{Y} = \mu \frac{du}{dy} \tag{5-1}$$

Equation (5-1) is called Newton's equation of viscosity, and in transposed form * it serves to define the proportionality constant

$$\mu = \frac{\tau}{du/dy}$$

which is called the coefficient of viscosity, the absolute viscosity, the dynamic viscosity (since it involves force), or simply the viscosity of the fluid.

An ideal fluid may be defined as one in which there is no friction, that is, its viscosity is zero. Thus the internal forces at any internal section are always normal to the section, even during motion. Hence the forces are purely pressure forces. Such a fluid does not exist in reality.

The dimensions of absolute viscosity are force per unit area divided by velocity gradient. In SI system the dimensions of absolute viscosity are as follows:

$$\text{Dimensions of } \mu = \frac{\text{N/m}^2}{\text{s}^{-1}} = \frac{\text{N} \cdot \text{s}}{\text{m}^2}$$

In many problems involving viscosity there frequently appears the value of viscosity divided by density. This is defined as kinematic viscosity υ, so called because force is not involved, the only dimensions being length and time, as in kinematics. Thus

$$\upsilon = \frac{\mu}{\rho}$$

In the metric system the units of υ are cm^2/s.

New Words and Expressions

1. property 特性
2. fluid 流体
3. density 密度
4. specific weight 重度(容重)
5. specific gravity 相对密度
6. system of units 单位制
7. homogeneous 一致的
8. dimension 量纲,维
9. latitude 纬度
10. elevation 高程
11. mean sea level 平均海平面
12. metric system 米制
13. equivalent 相当于
14. Mg=megagram 10^6 克
15. viscosity 粘滞性,粘度
16. measure 量度

17. resistance 抵抗，抵抗力
18. shear 剪切，切变，剪力，切力
19. angular deformation 角变形
20. cohesion 内聚力
21. momentum 动量
22. interchange 交换
23. molecule 分子
24. diminish 减小
25. predominate 占优势的，居支配地位的
26. parallel 平行的，类似的
27. edge condition 边界条件
28. application of force 施力
29. particle 质点
30. adhere 粘附
31. velocity gradient 速度梯度
32. similar triangles 相似三角形
33. proportionality 比例
34. coefficient 系数
35. internal force 内力

Notes

1. density ρ will be in... which may also be expressed as... 为两并列句。
2. It should be noted that density is absolute：句中 It 为引导词，that density ρ... 为主语从句。其中 absolute 意为绝对的，因 ρ 虽不随纬度、高程变化，但它仍随温度而变，故不可译"不变的"。
3. increased molecular activity：molecular 是名词作定语修饰名词 actvity。increased 为过去分词作定语，修饰 activity。
4. sufficiently large so that edge conditions may be neglected：句前省略了 which are，为非限制性定语从句，修饰 two parallel plates.
5. in transposed form：介词短语作状语。

Lesson 6 Prestressed Concrete

The rapid growth from 1945 onwards in the prestressing of concrete shows that there was a real need for this high-quality structural material. The quality must be high because* the worst conditions of loading normally occur at the beginning of the life of the member, at the transfer of stress from the steel to the concrete. Failure is therefore more likely then than later, when the concrete has become stronger and the stress in the steel has decreased because of creep in the steel and the concrete, and shrinkage of the concrete. Faulty members are therefore observed and thrown out early, before they enter* the structure, or at least before it becomes inconvenient to remove them.

The main advantages of prestressed concrete in comparison with reinforced concrete are:

(a) The whole concrete cross-section resists load. In reinforced concrete about half the section, the cracked area below the neutral axis, does no useful work. Working deflections* are smaller(Fig. 6. 1).

(b) High working stresses are possible. In reinforced concrete they are not usually possible because they result in severe cracking which* is always ugly and may be dangerous if it causes rusting of the steel.

(c) Cracking is almost completely avoided in prestressed concrete.

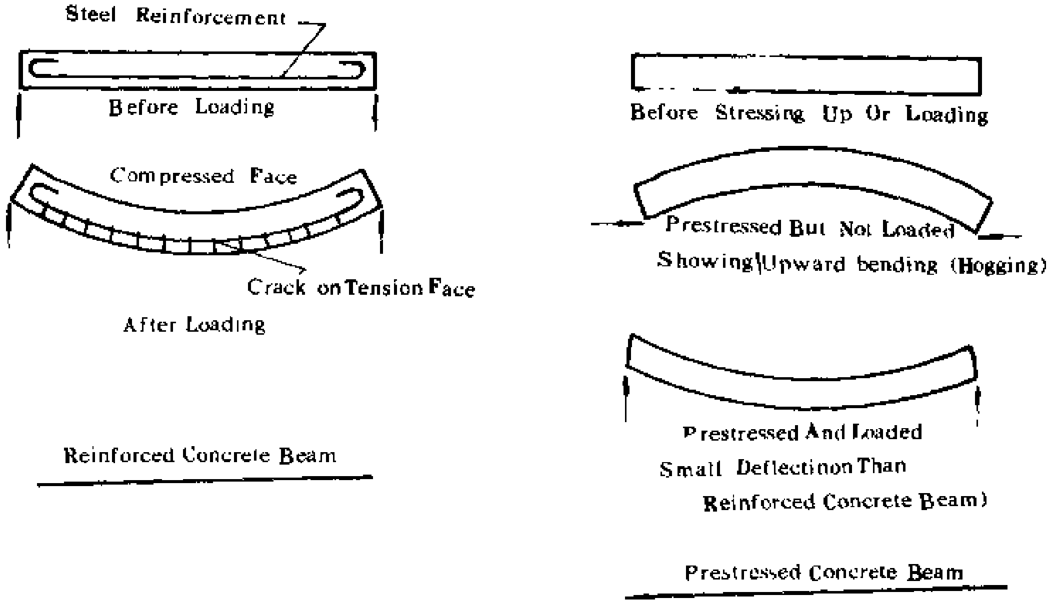


Fig. 6.1 Prestressed concrete and reinforced concrete

The main disadvantage of prestressed concrete is that much more care is needed to make it than reinforced concrete and it is therefore more expensive, but because it is of higher quality less of it* needs to be used. It can therefore happen that a solution of a structural problem may be cheaper in prestressed concrete than in reinforced concrete, and it does often happen that a solution is possible with prestressing but impossible without it.

Prestressing of the concrete means that it is placed under compression* before it carries any working load. This means that the section can be designed so that it takes no tension or very little under the full design load. It therefore has theoretically no cracks and in practice very few. The prestress is usually applied by tensioning the steel before the concrete in which it is embedded* has hardened. After the concrete has hardened enough to take* the stress from the steel, some of the stress is transferred from the steel to the concrete.

The most important part of a precast prestressed concrete beam are the tendons and the concrete. The tendons, as the name implies*, are the cables, rods or wires of steel which are under tension in the concrete. Before the concrete has hardened (before transfer of stress), the tendons are either unstressed (post-tensioned prestressing) or are stressed and held by abutments outside the concrete (pre-tensioned prestressing). While the concrete is hardening it grips each tendon more and more tightly by bond along its full lentgth. End anchorages consisting of plates or block are placed on the ends of the tendons of post-tensioned prestressed units, and such tendons are stressed up at time of transfer, when the concrete has hardened sufficiently. In the other type of prestressing, with pre-tensioned tendons, the tendons are released from external abutments at the moment of transfer, and act on the concrete through bond or anchorage or both, shortening it by compression, and themselves also shortening and losing some tension.

Further shortening of the concrete (and therefore of the steel) take place with time. The concrete is said to creep. * This means that it shortens permanently under load and spreads the stresses more uniformly and thus more safely across its section. Steel also creeps, but rather less. The result of these two effects is that prestressed concrete beams are never more highly stressed than at the moment of transfer. *

New Words and Expressions

1. prestressed concrete 预应力混凝土
2. from... onwards 从…以来
3. loading 荷载
4. transfer 传递
5. failure 破坏
6. creep 蠕动,徐变
7. shrinkage 收缩
8. faulty 毛病
9. reinforced concrete 钢筋混凝土
10. cross-section 横截面,断面,剖面
11. crack 开裂,裂缝
12. working stress 资用应力,工作应力
13. neutral axis 中性轴
14. deflection 挠度
15. severe 严重的
16. ugly 丑的
17. rust 锈
18. compression 压缩
19. tension 张力,拉力
20. design load 设计荷载
21. embed 埋置
22. harden 变硬
23. precast 预制的
24. beam 梁,船宽(指船只最大宽度)
25. tendon 钢筋束,悬索
26. cable 缆
27. rod 杆
28. wire 金属丝,钢丝绳
29. post-tensioned 后张的
30. abutment 支座,墩座
31. pre-tensioned 先张的
32. grip 裹紧,夹紧
33. bond 粘合力
34. anchorage 锚固
35. permanently 永久地

Notes

1. because 是连接词,引入原因状语从句。下句中的 because of 是介词,后面接介词宾语 creep. life of member:构件的使用期限,使用寿命。
2. enter 在此=become a member of;成为…的一个成员,一个组成部分。
3. working deflection:工作挠度,转译为"使用阶段的挠度"。
4. which is...限制性定语从句,修饰 cracking。一般限制性定语从句不用逗号分隔,多作为它所修饰的先行词的定语译出,但此定语从句太长,故拆成两句译出。
5. of higher quality:介词短语作表语。less of it 即 a smaller quantity of it, it 仍[illegible] press-

ressed concrete.

6. place something under compression：使某物受到压缩（压力）。

7. in which 引入的定语从句说明 concrete，which 指 concrete，it 指 the steel.

8. ...enough＋to＋不定式：…到足以，…足够…可以…。has hardened enough to take：已经硬化得足以...to take...是 enough 的结果状语。

9. as the name implies：顾名思义。

10. ...is said to creep：（人们）称…产生了除变。

11. ...is that...that 引入表语从句。never more highly stressed than at the moment of transfer：直译："永远不受到比传递预加应力时还高的应力"。也可改译为："预应力…梁中的应力永远不会高于传递预加应力时刻的应力"。

Lesson 7　Surveying

Surveying may be defined as the art of making measurements of the relative positions of natural and man-made features on the earth's surface, and the plotting of these measurements to some suitable scale to form a map, plan or section. *

In practice, however, the term "surveying" is often used in the particular sense of meaning those operations which deal with the making of plans, i. e. working in the two dimensions which form the horizontal plane, and the term "leveling" covers work in the third dimension, namely the dimension normal to the horizontal. * Thus we have——

Surveying: Operations connected with representation of ground features in plan.

Leveling: Operation connected with the representation of relative difference in altitude between various points on the earth's surface.

The work of the surveyor can be divided into four parts:

Field work: Making and recording measurements in the field.

Computing: Making the necessary calculations to determine locations, areas, and volumes.

Mapping: Plotting the measurements and drawing a map.

Stakeout: Setting stakes to delineate boundaries or * to guide construction operations.

There are many types of surveys, each so specialized that a man proficient in one branch may have little contact with the other branches. * The more important classifications, described briefly, are:

Plane surveying: Surveying in which the curvature of the earth is neglected. It is applicable for small areas.

Geodetic surveying: Surveying in which the curvature of the earth is considered. It is applicable for large areas and long lines and is used to precisely locate basic points suitable for controlling other surveys.

Topographic surveys: Surveys made for the purpose of preparing maps showing locations of natural and artificial features, and elevations of points on the ground.

Route surveys: Surveys of and for* highways, railroads, pipelines, transmission lines, canals, and other projects which do not close upon the starting points.

Hydrographic surveys: Surveys of lakes, streams, reservoirs, and other bodies of water.

Construction surveys: Surveys to provide locations and elevations of structures.

Photogrammetric surveys: Surveys in which photoraphs, either terrestrial and aerial*, are used.

It can be unconditionally stated that (a) no measurement is exact, (b) every measurement contains errors, (c) the true value of a measurement is always unknown, and therefore (d) the exact error present is always unknown.* These facts are demonstrated by noting the following two statements: No matter how* large a number a person selects, there is always a larger one; regardless of how small a number is chosen, a still smaller one exists. When a distance is scaled with a rule divided into tenths of an inch, the distance can be read only to hundredths of an inch (by interpolation). If a better rule graduated in hundredths of an inch is available, however, the same distance might be estimated to thousandths of an inch. As better equipment is developed, recorded measurements will more closely approach their true values.

Mistakes are caused by a misunderstanding of the problem, by carelessness, or by poor judgment. Large mistakes are often referred to as blunders, and are not considered as errors, they are detected by systematic checking of all work, and must be eliminated by redoing part or all of a job. It is very difficult to detect small mistakes, because they merge with errors. When not detected, these small mistakes must therefore be treated as errors, and will contaminate the various types of errors.

New Words and Expressions

1. surveying 测量学,测量
2. features 特征,地物
3. plotting 作图,绘图,标绘
4. plan 平面图
5. section 断面图
6. leveling 水准测量
7. horizontal 水平面,水平线,水平的
8. representation 表示
9. altitude 高度
10. field work 野外作业,外业
11. stakeout 放样,定线,桩定
12. stake 桩
13. delineate 描绘,勾画
14. proficient 精通
15. classification 分类
16. curvature 曲率
17. transmission line 输电线
18. hydrographic surveys 水道测量
19. terrestrial 陆地的,地面的
20. aerial 空中的,航空的
21. error 误差
22. demonstrate 表明
23. interpolation 内插法
24. approach 接近,方法
25. judgment 判断
26. blunder 大错

27. detect 察觉

28. merge 合并

29. contaminate 混淆，沾染

Notes

1. Surveying may be defined as. . . , plan or section. :这句虽长，却是个简单句。surveying 是主语。may+be+defined(及物动词的过去分词)为复合谓语，as the art 是主语补足语。of making. . . section 是修饰 art 的定语。
2. In practice,. . . to the horizontal. :此长句为由 and 连接的两个并列句。前一句从 the term "surveying" is often used in the ... horizontal plane，是个主从复合句，其中 which deal with. . . plans，是个定语从句，修饰 operation. i. e. working in. . . plane 是 making of planes 的同位语。
3. to delineate boundaries or to guide construction operations: 是用 or 连接的两并列的不定式短语，用作目的状语。
4. There are many types of surveys, each so specialized that. . . other branches. each. . . 是省略了某些成分的非限制性定语从句。each so specialized=each type of which is so specialized 修饰 types.
5. of and for:意为"属于并为了"表示这两方面兼而有之。但翻译时可灵活运用，不必把两层意思都照字面直译出来。
6. in which photographs. . . are used 是由 in which 引导的定语从句，修饰 surveys. 而形容词词组 either terrestrial and areial 是用来修饰 photographs 的后置定语。
7. It 为引导词，后面从属连词 that 引出的(a)，(b)，(c)，(d)四个并列的分句为真正主语。(d)句中的 present 作定语，修饰 error.
8. No matter 和 regardless of 均为从属连词，由它们分别引出后面的让步状语从句。

Lesson 8 Soil Particles

Partical size. Many soil descriptions and classfications are based on the size of the soil particles. This is the simplest criteria for soil description. Soils are commonly named gravel, sand, silt and clay, on the basis of the particle size. The dividing line between these categories is arbitrary, and as is common to arbitrary definitions.

It is obvious that natural soils most frequently consist of particles from more than one size group. * In such a case, the soil is named after the principal constituent. For example, a soil that is predominantly clay but also contains some silt is called a silty clay. One convenient method of naming mixed soils* is the Public Roads Administration system, shown in Fig. 8. 1. The triangular graph has three coordinate axes representing* the percentages of clay, silt, and sand that constitute the soil. Special names are assigned to various combinations of the three components, as designated by the areas within the triangle. Thus if a soil is composed of 40 percent sand, 35 percent silt, and 25 percent clay, it is called a clay loam. This is shown as point A in Fig. 8. 1.

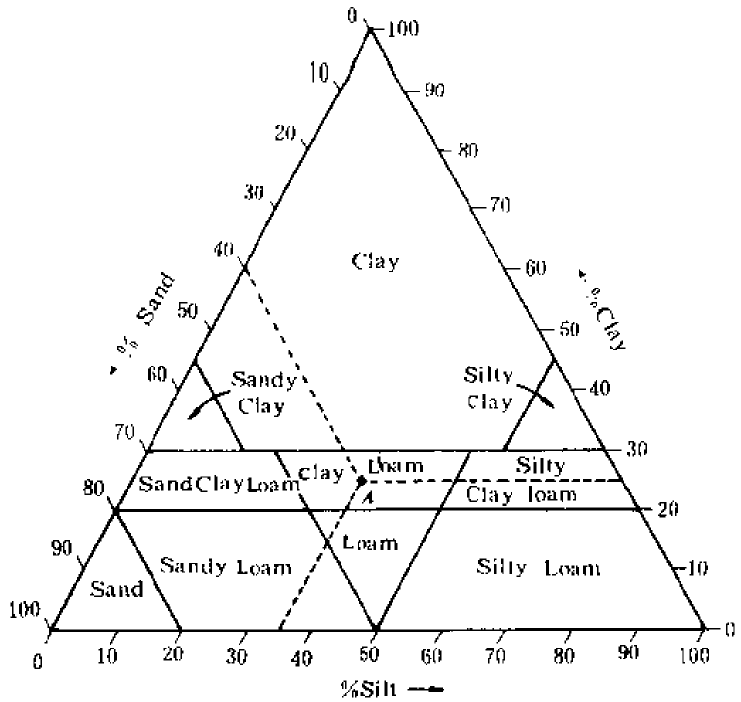


Fig. 8. 1 Public Roads Administration system of soil classification.

Particle-size distribution. An adequate description of the particle-size characteristics requires the determination of the percen tages of the soil that * fall into the different size ranges.

SIEVE ANALYSIS. The particle-size distribution is determined by means of sieve analysis if the particles are sufficiently large. The specimen is shaken through a set of sieves with progressively smaller openings. As an example the results from a sieve analysis are given in Table 8-1. The amount retained on a particular sieve represents the fraction that is larger than the sieve size on which it is retained but smaller than that of the preceding sieve. * The result may be presented in the form of a frequency diagram, as shown in Fig. 8. 2(a). The vertical axis denotes the percentage of the soil that falls within a particular size range. In engineering practice, the cumulative percentage (Fig. 8. 2. b) is more commonly used. In this graph the ordinate is the percentage of the soil that is smaller thar a given size. Thus the values on the cumulative graph are obtained by summation of the values on the frequency curve. To obtain the percentage finer than a given size, say 0. 149mm(No. 100 sieve), we sum up all the percentages on the frequency curve for all size ranges below 0. 149mm, beginning with the smallest fraction (see last column in Table 8-1). In practice, the cumulative graph is usually drawn as a smooth curve.

Table 8-1 Sieve Analysis Data

Sieve no.	Opening, mm	% retained	% finer	Sieve no.	Opening, mm	% retained	% finer
8	2. 38	0	100	100	0. 149	40	21
16	1. 19	1	99	200	0. 074	16	5
30	0. 590	11	88	400	0. 037	5	0
50	0. 297	27	61				

HYDROMETER ANALYSIS. The finest sieve has an opening of about 0. 04mm. Hence for particles finer than 0. 04mm, it is necessary to use the hydrometer analysis. In the hydrome-

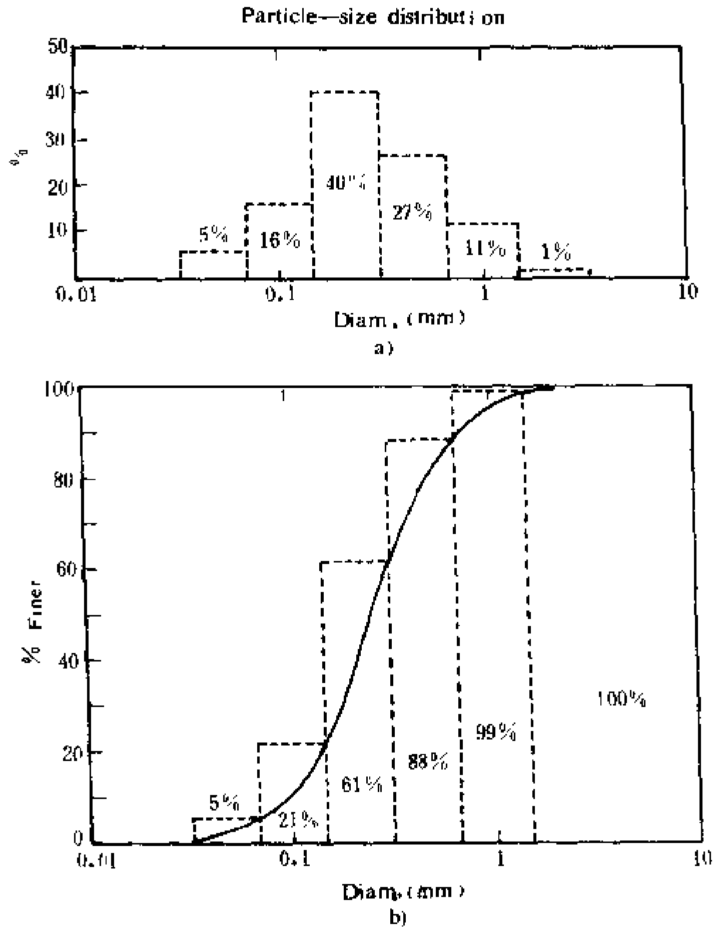


Fig. 8.2 Particle-size-distr bution curves

ter analysis, a specimen of soil is dispersed in water and made into a thin suspension. When left standing, the particles settle to the bottom at velocties which are related to their sizes by Stocks'law.

The large particles settle out first. After a given time interval t, only particles finer than a certain size still remain in suspension. According to Stocks'law, the velocity of a spherical particle falling through water (through distance y during time t) is

$$V = \frac{y}{t} = \frac{\gamma_s - \gamma_w}{18\mu}D^2$$

in which μ denotes the viscosity of water, D the diameter, γ_s and γ_w the unit weights of the soil particles and water respectively, and y the distance traveled. From this we get

$$D = \sqrt{\frac{18\mu}{\gamma_s - \gamma_w}}\sqrt{\frac{y}{t}} \tag{8-1}$$

Thus above a depth y and after a time t, all particles have a diameter smaller than D as given by Eq. (8-1).

The amount of soil particles that remain in suspension at depth y is determined by the hydrometer are calibrated to read directly the number of grams of soil in suspension.

From the particle-size-distribution curve, two frequently used constants can be obtained. One is the diameter at 10 percent finer, which means that 10 percent of the soil particles are finer than this size. This is known as the effective diameter, D_{10}. The other constant is the uniformity coefficient, which is the ratio of the diameter at 60 percent, or D_{60}, to D_{10}. The effective diameter is of considerable practical significance because it may be used to estimate the permeability of the soil. The uniformity coefficient (as the name implies) is an index of the uniformity of particle size. For a soil in which the particles are of about the same size, D_{60} and D_{10} are close to each other and the uniformity coefficient is closed to 1. For a soil with a wide range in particle size, D_{60} is much greater than D_{10}, and the uniformity coefficient is large.

New Words and Expressions

1. criterion (criteria 复)准则,判据
2. particle size 粒径,颗粒大小
3. gravel 砂,砾,砾石
4. silt 粉砂
5. clay 粘土
6. category 种类,科目
7. arbitrary 任意的,人为的
8. constituent 成份
9. constitute 组成
10. assign 分配,指派,赋予
11. combination 组合
12. designate 标示
13. loam 壤土
14. percentage 百分率
15. sieve analysis 过筛分析,筛分析
16. specimen 试样
17. fraction 级分,粒级,部分
18. preceding 前面的
19. frequency diagram 频率直方图
20. cumulative 累积的
21. ordinate 纵坐标
22. summation 总和
23. frequency curve 频率曲线
24. hydrometer 比重计
25. suspension 悬浮,悬浮体
26. time interval 时段
27. spherical 球形的
28. calibrate 校准,率定,检定
29. effective diameter 有效粒径
30. index 索引,指标
31. uniformity 均匀性
32. permeability 渗透性,渗透率

Notes

1. one size group:一种粒径。
2. ...method of naming mixed soils:动名词 naming 为介词宾语,mixed soils 又是它的宾语。
3. has three coordinate axes representing...:分词 representing 为宾语补足语。
4. the percentages of the soil that fall into the different size ranges. 从关系代词 that 至句尾为定语从句,修饰 soil. that 在从句中相当于 which,作主语,故不可省略。
5. larger than the sieve size on which it is retained but smaller than that of the preceding sieve. on which it is retained 为定语从句,修饰 size. that 在此代替 sieve size.

Lesson 9 Probability and Statistics

The purpose of this book is to introduce two important branches of modern applies mathematics: Probability Theory and Statistics. Both of these are relatively new subjects, the main developments having taken place within the last century, and both are rapidly expanding in theory and application. Indeed, it has now reached the point where some knowledge of these subjects is necessary if one is to read newspapers and magazines intelligently.

The study of probability was initially stimulated by the needs of gamblers, and games of chance are still used to provide interesting and instructive examlples of probability methods. Today, probability theory finds applications in a large and growing list of areas. It forms the basis of the Mendelian theory of heredity, and hence has played a major part in the development of the science of Genetics. Modern theories in Physics concerning atomic particles make use of probability models. The spread of an infectious disease through a population is studied in the Theory of Epidemics, a branch of probability theory. Queueing theory uses probability models to investigate customer waiting times under the provision of various levels and types of service (e.g. numbers of checkout counters, telephone operators, computer terminals, etc.). Although it is impossible to deal thoroughly with such diverse and complex applications in an introductory book, it is possible to lay the ground work and present some of the simpler applications. The first part of this book deals with methods of building probability models and handling them mathematically. This provides the foundation for the statistical methods described in later chapters, as well as for advanced study on Probability Theory itself.

Statistics was originally used to refer to the collection of data about the state or nation, such as size of the population, or the levels of trade and unemployement. Many statisticians are still involved in the important task of providing government with accurate statistical information on the basis of which* the need for and effectiveness of their actions may be judged. However, the domain of application for statistical methods has increased rapidly during the twentieth century, and* now includes virtually all areas of human endeavour where data are collected and analysed. The data may come from census results, questionnaires, surveys, or planned experiments in any field. There may be large quantities of data, as from a population census, in which case methods of accurately summarizing and simplifying the data are required. At the other extreme, many years of work and great expense may be necessary to obtain a few measurements in a scientific experiment. One may then wish to determine whether the data are in agreement with some general theory, or perhaps use the data to estimate physical constants. Because data are so difficult to obtain, it is important to extract the maximum possible amount of information from them.

This book deals primarily with problems of the latter type, where it is desired to draw general conclusions on the basis of a limited amount of data. Because they are based on limited data, such conclusions will be subject to uncertainty. The branch of Statistics which attempts to quantify this uncertainty using probability and related measures* is called Statistical Inference. The last half of this book deals with two different problems in Statistical Inference: model testing and estimation. Having formulated a probability model, we will first wish to know whether it is in agreement with the data, and if not, which of the assumptions underlying the model require modification. Such questions may be investigated using Tests of Significance. Then assuming that the model is satisfactory, one may wish to form estimates of unknown quantities, called parameters, which appear in the model.* Such estimates will be subject to error. Determination of the likely magnitude of error in an estimate is an essential part of the estimation problem.

Statisticians are also concerned with the design of appropriate methods of data collection, so that upon analysis the data will yield the greatest possible amount of information of the type desired. Great care must be taken so that the data are free from unsuspected biases which might invalidate the analysis or cloud the interpretation. In many cases, asking a statistician to analyse improperly collected data is like calling the doctor after the patient has died: the most you can expect to learn is what the patient died of.

Statistical Decision Theory is a branch of Statistics which has received much attention since World War Two. It deals with the problem of selecting one among several possible courses of action in the face of uncertainties about the true state of nature. Both the costs of incorrect decisions and the information available from data and other sources are taken account in arriving at a course of action which minimizes expected costs.

Many statistical problems involve both inferences and decisions. First we decide what data to collect. Having obtained the data, we try to learn as much as possible from it (Statistical Inference). The information obtained might then be considered in deciding upon future courses of action. Nevertheless, it is important to distinguish carefully between the inferential and decision theoretic components. In decision problems, one is interested in learning from the data only if the information obtained can be used to reduce the anticipated cost of the particular action being considered. In Statistical Inference, one is interested in learning for its own sake, without reference to any particular decision problem in which the information obtained might subsequently be used.

New Words and Expressions

1. intelligent 聪明的，理解的
2. stimulate 促进，激发
3. gamble 赌博
4. game of chance 碰运气的游戏
5. heredity 遗传
6. genetics 遗传学
7. infectious disease 传染病
8. epidemic 流行病
9. queueing theory 排队论
10. waiting time 等待时间
11. provision 供应
12. diverse 多种多样的

13. involve in 专心,卷入
14. judge 判断
15. virtual 实际的
16. endeavour 努力
17. census 人口普查
18. question(n)aire 调查表
19. extract 抽、取
20. uncertainty 不确定性,误差
21. statistical inference 统计推断
22. test of significance 显著性检验
23. parameter 参数
24. appropriate 适当的
25. unsuspected 意料外的
26. bias 偏倚,偏差,偏离,偏斜
27. invalidate 使…无效
28. interpretation 解释,释意
29. statistical decision 统计判定,统计决策
30. course of action 行动步骤
31. in the face of 面对
32. take into account 考虑,重视
33. arriving at 到达,得出
34. anticipated cost 预期费用,预计成本
35. without reference to 不论

Notes

1. on the basis of which the need for and effectiveness of their actions may be judged: 为定语从句,修饰前面的 task. on the basis of which 在从句中作状语。
2. and 连接两个并列句,后一句子的主语仍是 domain.
3. which attempts to quantify this uncertainty using probability and related measures:为定语从句,其中 to quantify 为句中 attempts 的宾语。using... 为分词短语作状语。
4. unknown quantities, called parameters, which appear in the model... :called parameters 为 unknown quantities 的同位语,which appear in the model 为定语从句,修饰 unknown quantities.

Lesson 10 Introduction to Experimental Techniques

10.1 Type of Experiment

Although it is generally agreed that laboratory work forms an essential part of any course in hydraulics, it is very often the case that students carry out the specified steps of an experiment and process the results without grasping the fundamentals of the associated theory.

It goes without saying that, * whenever possible, the basic theory should be covered in class before undertaking the experimental investigation. This is particularly important in hydraulics, where in many cases assumptions are made regarding fluid properties and boundaries, in order to make possible a theoretical solution.

In such cases, experimentation must be resorted to in order to provide a correlation between the theoretical and actual behaviour.

In the field of fluid statics and in a small number of field flow situations, it is possible to develop accurate mathematical relationshipss which do not require any experimentally derived adjustment. An example of this is the analysis of laminar flow through pipes.

Certain fluid configurations defy any sort of mathematical analysis and in such cases the engineer must rely entirely on experimental methods.

We can now list any expermintal investigation under one of the following categories:

(a) to confirm a relationship which has been derived completely from a sound mathematical analysis.

(b) to evaluate coefficients which will enable a partially completed theoretical analysis (or one based on doubtful assumptions) to be completed.

In many cases the theoretical approach assumes an inviscid fluid and neglects all energy losses. By measuring the actual performance in the laboratory a relationship can be developed of the form.

$$\text{Actual performance} = \text{coefficient} \times \text{theoretical performance}$$

(c) to investigate the relationship between variables when the configuration and flow pattern make any form of theoretical solution impossible*. In this case the technique known as dimensional analysis enable the variables to be organized in such a way as to rationalize the experimental procedure.

Although not covered in detail in this book, mention must be made of the technique whereby scale models of hydraulic structure are tested in order to predict the behaviour in the prototype or full-scale structure. Such laboratory model permit visual observation of the flow patterns, and measurements taken on the model enable the engineer to finalize his design or to specify improvements to existing structures.

10.2 Aims of laboratory work

The primary aims of any laboratory investigation are as follows:

(a) to set up equipment which accurately represents the specified conditions:

(b) to provide all necessary instrumentation for the measurement of the variables (flowrate, fluid levels, pressure, etc.);

(c) to carry out the experiment in such a way that a sufficient number of accurate measurements are taken in order to produce meaningful results;

(Note: three points will not produce a reliable graphical relationship!)

(d) to present the results in a clear and concise fashion;

(e) to discuss and interpret the results and to draw conclusions.

10.3 Laboratory Reports

At the start of a laboratory work programme, guidance is needed as to the format and contents of a laboratory report. Requirements vary from college to college and it is not our intention to attempt to standardize. Nevertheless, it is hoped that the following discussion will highlight the basic principles and suggest ways of avoiding some of the problems associated with the preparation of reports.

Paragraph headings provide a framework for any report and a list which will satisfy most requirements is given below:

Title of experiment

Object of experiment

Apparatus

Theory

Experimental procedure

Observations

Analysis

Conclusions.

New Words and Expressions

1. grasp 掌握
2. go without saying 不言而喻
3. experimental investigation 试验研究
4. resort to 凭借，诉诸
5. adjustment 校正
6. configuration 结构
7. defy 使不能
8. confirm 进一步证实
9. sound 正确的
10. evaluate 把…定值
11. enable...to 使…能够
12. inviscid 无粘性的
13. performance 性能
14. rationalize 使…合理地处理
15. finalize 最后定下
16. format 组成
17. intention 意图
18. standardize 标准化，使统一
19. highlight 着重，突出
20. framework 框架
21. title 题目
22. apparatus 仪器设备

Notes

1. It goes without saying that...：不言而喻，当然不用说。
2. make...impossible：impossible 为宾语补足语。

Section I Channel Engineering

Lesson 11 The Yangtze

The main paradox (there are many others: we are dealing with China, population one billion) * is that there is no Yangtze river. The name is unknown to most Chinese, who call it Ta Jiang, 'Great River' or Chang Jiang, 'long Rvier', unless they live above Chongqing——there, the swift silt——filled waters are referred to as Jin-sha Jiang, 'The River of Gold Sand'. That is only a misnomer now. As recently as fifty years ago, in the winter months when the level dropped, the Chinese squatted at its edge and panned for gold, sluicing the mud and gathering gold dust. * European travellers reported seeing washerwomen wearing * thick gold bangles, made of the metal that had been carried from where the river-let us call it The Yangtze-rises in Tibet. *

But it has more moods than names. I am careful to give the date of each day's notes'. Archibald Little wrote in Through the Yangtze Gorges(1887), The river varies so wonderfully at different seasons that any description must be carefully understood only to apply to the day upon which it is written'. Captain Little was overwhelmed by it: he compared it to the Mississippi and the Amazon; he said it was indescribable. It has in many stretches a violent magnificence. It is subject to murderous floods, and its winter levels create rapids of such turbulence that the river captain steers his ship through the foam and travels down the tongue of the rapid, praying * that no junk will lie in his path, as it is impossible for him to stop or reverse. But it is not all so dramatic. Its four divisions are like four separate rivers; above Chongqing, it is mythic and still associated with gold and landslides; the Upper River (Chongqing-Yi chang)is the wildest——here are the gorges and the landscape of China's Walter Scottish classic, The Roamnce of the Three Kingdoms; the Middle River(Yichang-Wuhan) is serene and a mile wide; the lower River(Wuhan-shanghai) is slow and sticky yellow and populous.

I sailed 1,500 miles downstream, from Chongqing to Shanghai. Every mile of it was different; but there were 2,000 miles I did not see. It crosses twelve provinces or regions. 700 rivers are joined to it——all Yangtze statistics are hoplessly huge and ungraspable; they obscure rather than clarify. And since words can have a greater precision than numbers, one day I asked a Chinese ship captain if he thought the river had a distinct personality. He said, The mood of the river changes according to season. It changes every day. It is not easy. Navigating the river is always a struggle against nature. And there is only one way to pilot a ship well'. He explained, It is necessary to see the river as an enemy'.

The Yangtze is China's main artery, its major waterway, the source of many of its myths, the scene of much of its history. On its banks are some of its greatest cities.

We boarded Tung Fang Hong ("The East is Red") Number 39, and were soon underway. Because of the construction of locks and a dam at Yichang, we would travel down river in two ships, the MS Kun Lun awaited us just below Yichang. Number 39 and the Kun Lun were the same size, built to carry 900 people. There were, as I say, only thirty-three of us, and a crew of 102.

No hardships for us, and it seemed at times as if, though we were travelling through the very heart of the country, China was elsewhere.

The "Blue Danube Waltz" was playing on the ship's loudspeakers as Number 39 swung between the sampans and the fishing smacks and the burdened ferries. The captain greeted us in the lounge and told us the current was moving at two metres per second and added, "As your captain, I am responsible for your safety, so please don't worry about it."

Captain Liu was sixty. He had a narrow, flat-backed head and bristly hair and large spaces between his teeth. He had always worked on the river. His father had started out as a steward, serving food on Chinese river boat, at the age of fifteen. I was the "boy" as they say in English, but I worked my way up to captain. I never went to school. You can't learn about this river in a school. You can only learn it by being on the bridge.

New Words and Expressions

1. The Yangtze 扬子江
2. paradox 怪事
3. billion (美) = 10^9 = 十亿
4. swift 快速的
5. silt-filled 充满泥沙的
6. refer to sb. (sth.) as... 称某人(物)为…
7. misnomer 使用不当的名称
8. as recently as 距今
9. level 水位
10. squat 蹲
11. pan 淘选
12. sluice 淘洗,船闸
13. mud 泥浆
14. bangle 手镯
15. Tibet 西藏
16. mood 情态
17. Three Gorges 三峡
18. be overwhelmed by 为…所倾倒
19. stretch 段
20. violent 狂暴的
21. magnificence 壮观
22. be subject to 遭受
23. murderous 凶猛的
24. steer 驾驶
25. foam 浪花
26. tongue 舌
27. pray 祈祷
28. junk 舢板
29. dramatic 戏剧性的
30. division 部分,部门,处
31. mythic 神秘的
32. associated with 伴随有
33. landslide 滑坡
34. landscape 景观,景色,地形

35. classic 古典的(作品)
36. The Romance of the Three Kingdoms 三国演义
37. serene 平静的
38. stiky 粘的
39. populous 人口众多的
40. ungraspable 不能理解的
41. obscure 模糊
42. personality 个性
43. artery 动脉
44. myth 神话
45. scene 舞台
46. board 板,登船(车,飞机)
47. sampan 舢板
48. smack 小帆船
49. burdened 重载的
50. ferry 渡船
51. lounge 休息室
52. bristly 短而硬的
53. steward 乘务员(轮船,飞机的)
54. crew 全体船员

Notes

1. 括号中的词修饰 paradox,其中 population one billion 又是修饰 China 的。翻译时可按汉语习惯把括号中的部分先译,为:我们谈论十亿人口的中国,在那儿有许多怪事,其中主要的一个是……。
2. sluicing the mud and gathering gold dust. 为现在分词短语作目的状语。
3. ...reported seeing washerwoman wearing thick gold bangles...,其中 seeing 为动名词作 reported 的宾语,washerwoman 为 seeing 的宾语,wearing 为分词作 washerwoman 的宾语补足语,washerwoman wearing 为复合宾语。
4. ...from where the river rises in Tibet=from the river which rises in Tibet.
5. praying that no junk will lie in his path, as it is... 其中 praying 为现在分词作状语。as 意思是因为。

Lesson 12 Hydraulic Engineering——Dams

Among makind's oldest works are irrigation and water supply systems; indeed, the earliest civilizations in river valleys in the Middle East were based on agriculture that * depended on irrigation. Harbor facilities and canals for navigation were also early engineering accomplishments. Such systems are usually grouped together as hydraulic engineering projects. Hydraulics is the science that deals with the flow and control of water and other fluids.

Among the most impressive modern works in hydraulic engineering are such great dams as the Aswan High Dam on the Nile in Egypt and the Hoover Dam on the Colorado River in the Southwestern United States. These dams, like most modern dams * , serve a number of different purposes. Among them are flood control, water storage, irrigation, navigation, and hydroelectric power. In addition, most dams are also links in a highway system, with a roadway running across them. The lakes behind them, like Lake Mead * which is backed up by the Hoover Dam, also serve as recreational areas.

Before design and construction of a dam can begin, an extensive survey and study of the site must be made. This survey examines not only topographical features of the area, but also soil and rock samples to determine the geological factors that may affect it. * The hydraulic features of the stream or river that is being dammd must also be determined—the rate of volume of flow of the river at different seasons, and the volume of water that will be backed up by the dam. Engineers use this information to calculate potential water pressure. It is also necessary to study the site to see whether the dam can be constructed with the use of cofferdams or whether the flow of the river must be diverted. Cofferdams, are watertight piles that form an enclosure from which water can be pumped. When it is necessary to divert the river, one technique is to dig tunnels for the channel; another is to excavate a temporary channel for the river around the dam site.

Even after the site has been thoroughly investigated and the designs have been made preliminary work is still not complete. Scale models of the dam are often made so that they can be tested under simulated conditions. Computers are also used extensively to calculate all the differnet stresses to which * such huge structures can be subjected, including those that may be caused by earthquakes.

Basically there are two types of construction for dams, masonry and embankment. Before the invention of Portland cement, huge blocks of cut stone were ordinarily used to build dams, but today masonry dams are constructed with reinforced concrete. Masonry dams are most often built to control swift-flowing streams in narrow valleys where there is good rock for the foundations. An excellent example is the Hoover Dam. Embankment dams are essentially great mounds of earth across a stream. In addition to compacted earth, embankment dams can be built with crushed rock or sand. This kind of dam is usually built across wider streams where the water flows rather slowly. The Aswan High Dam is a good example of an embankment dam.

The velocity and pressure of the water that is being blocked are important factors in the design of dams. Another factor is the possibility of seepage under the foundations, often requiring special protective features in the design. Seepage is the slow leaking of water through a porous material, such as earth or some kinds of rock like limestone or sandstone.

Many dams have other auxiliary structures, depending on the reason why the dam was constructed. One feature is a spillway that allows flood water or excess water from the reservoir behind the dam to be released downstream. With embankment dams, the spillway are ordinarily constructed at one side of the dam. With concrete gravity dams, the sloping downstream face often acts as the spillway. In this case some kind of footing or special device must be placed at the bottom of the dam so that the water is projected out into the stream where it cannot erode the dam's foundation.

Other openings are necessary when the dam is used for irrigation or for generating electricity. Gates are built in dam through which water can be released for these purposes. The gates are equipped with screens so that floating objects cannot pass through them. The ducts that carry water from the gates to turn turbines in a powerhouse are called penstocks. Some dams also have fish ladders that allow fish in the river to travel past the dam to or from their breeding grounds.

New Words and Expressions

1. water supply 给水工程
2. facility 设施,设备
3. accomplishment 成就
4. flood control 防洪
5. water storage 蓄水
6. recreational area 旅游地
7. sample 样本,样品
8. cofferdam 围堰
9. divert 改道,转向
10. watertight 不漏水的
11. pile 桩,堆
12. enclosure 围栏
13. tunnel 隧洞,隧道
14. temporary 临时的
15. preliminary 预备的,初步的
16. scale model 缩尺缩型,比例模型
17. simulate 模拟
18. earthquake 地震
19. masonry 圬工
20. embankment 填土堤坝,路基
21. cement 水泥
22. cut stone 琢石
23. embankment dam 填筑坝,土石坝
24. mound 土墩,土堆
25. compact 压实
26. crush 碎
27. seepage 渗透,渗流
28. leak 漏
29. porous 多孔的
30. auxiliary 辅助的
31. footing 基脚
32. screen 滤网,格栅,屏幕
33. duct 导管,通道
34. penstock 压力管道
35. fish ladder 鱼梯
36. breeding ground 繁殖场,育种场

Notes

1. that depended on irrigation. that 为关系代词引出一定语从句,修饰 agriculature, that 在从句中作主语。
2. like most modern dams 为同位语。
3. like lake Mead... 为同位语。
4. that may affect it 为由关系代词引出的定语从句,修饰 factors。句中的 it 代替 a dam.
5. ...stresses to which such huge structures can be subjected, which 为关系代词引出定语从句,修饰 stresses. 从句中 which 是 be subjected to 的介词宾语。

Lesson 13 Hydraulic Engineering——Canals and Locks

Among the most famous accomplishments of modern hydraulic engineering are the three great international canals. The Kiel Canal in Germany connects the Baltic and North Sea, a distance of 95 kilometers. The Suez Canal in Egypt connects the Mediterranean Sea with the Red Sea, providing a passageway between Europe and Asia that eliminates the voyage around Africa. It is 169 kilometers long and has no locks. Locks are sections of a canal that are enclosed by gates; the level of water within the lock can be regulated so that shipping can be raised or lowered to different elevations. * The Suez Canal was originally opened in 1869, closed in 1967 because of warfare in the area, and reopened in 1975. Engineers currently plan to widen and deepen the Suez Canal to accommodate the supertankers that carry oil from the oil fields on the Persian Gulf.

Canals are rivers that have been dredged, straightened, embanked or otherwise controlled so that they are navigable. Both the Romans and the Chinese in ancient times built canals. The Grand Canal in China that connects the Yangtze River with Peking is one of the greatest engineering works of any age; it is still used today. In Europe a new age of canal-building began in the seventeenth century, long before railroads began to spread across he landscape. An important canal that dates from this period is the Canal de Languedoc, which connects the Atlantic Ocean with the Mediterranean Sea across the length of southern france.

Freight can be carried by water much more cheaply than on land; therefore, canal-building has continued up to the present time despite the attention given to railroads in the nineteenth century and to highways in the twentieth. Most of the rivers and ports of Europe are connected by a network of canals that carry a large proportion of the commerce of this highly industrialized region. In the United States, canals have been less important than in Europe and China. One noteworthy nineteenth century project, however, was the Erie Canal, which connected Albany on the Hudson River with the Great Lakes across the length of northern New York State. New York City in large part owes its commercial preeminence to the Erie Canal.

One of the most important canal-building projects of recent times was the St. Lawrence Seaway, constructed* jointly by the United States and Canada. This great system of rivers, canals and lakes makes the entire distance from the Atlantic to Duluth Minnesota, on Lake Superior, navigable for oceangoing ships. The St. Lawrence Seaway connects with the Mississippi-Missouri-Ohio River system by means of the Chicago Sanitary and Ship Canal; indeed, it open up the entire center of the North American continent to shipping.

New Words and Expressions

1. Baltic Sea 波罗的海
2. North Sea 北海
3. Suez Canal 苏伊士运河
4. Mediterranean Sea 地中海
5. eliminate 排除
6. voyage 航程
7. passageway 过道,通道
8. warfare 战事

9. accommodate 接纳
10. supertanker 超级油轮
11. The Grand Canal 大运河
12. Atlantic Ocean 大西洋
13. freight 货运
14. a large proportion of 大部分
15. noteworthy 值得注意的
16. preeminence 卓越，杰出
17. seaway 通海水道

Notes

1. so that shipping can be raised or lowered to different elevations. 为结果状语从句，shipping 为动名词。
2. constructed 系过去分词作状语，因 seaway 是 construct 的行为对象，故此处不能用现在分词。

Lesson 14 Erosion

The Erosion Process

Soil can be eroded, i.e., moved from its current location, by the action of wind, water, gravity(landslides), and human activity. Water erosion may be viewed as starting with the detachment of soil particles by the impact of raindrops. The kinetic energy of the drops can splash soil particles into the air. On level ground the particles are redistributed more or less uniformly in all directions, but on a slope there is a net transport downslope(Fig. 14. 1). If overland flow is occuring, some falling particles will be entrained in the flowing water and moved even farther downslope before settling to the soil surface. Overland flow is predominantly laminar and cannot detach soil particles from the soil mass, but it can move loose particles already on the soil surface. The splash and overland-flow processes are responsible for sheet erosion, the relatively uniform degradation of the soil surface. Sheet erosion is difficult to detect except as the soil surface is lowered below old soil marks on fence posts, tree roots are exposed, or small pillars of soil capped by stones remain.

Raindrops vary in diameter d from 0.5 to 6 mm(0.02 to 0.25in) and terminal velocity v varies with diameter from about 2 to 9 m/s(7 to 30 ft/s). Since* kinetic energy is proportional to d^3v^2, the erosive power of the largest drops may be 10,000 times that of the smaller. This conforms with the obsrevation that a few intense storms account for most of the erosion. The effect is augmented by the fact that overland flow is more likely to occur during intense rains.

At some point on the slope sufficient overland flow may accumulate to cause a small rivulet. If turbulence in the flow is strong enough to dislodge particles from the bed and banks of the channel, gully erosion may occur. As the gully deepens, its profile is steepest near its head(Fig. 14. 2). Erosion is most rapid in this region, and the gully tends to grow headward.

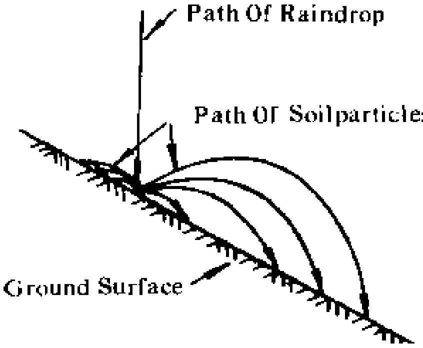


Fig. 14.1 Downhill transport a soil particles by splash

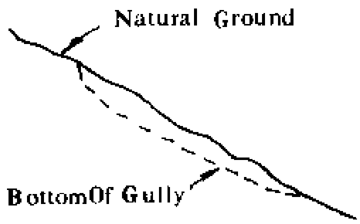


Fig. 14.2 profile of a typical gully

Mass movement of soil, as* either the slow downward creep of the soil mass or the rapid collapse of a slope (landslide), is an important mechanism delivering soil to the streams in steep canyons with unstable side slopes. Landslides occurring as the result of earthquakes or the saturation of the slopes during heavy rains may create temporary dams whose subsequent overtopping and erosion may create critical flood waves downstream.

Factors Controlling Erosion

The most important factors controlling erosion are rainfall regime, vegetal cover, soil type, and land slope. Because of the important role of raindrop impact, vegetation provides significant protection against erosion by absorbing the energy of the falling drops and generally reducing the drop sizes which reach the ground. Vegetation may also provide mechanical protection to the soil against gully erosion. In addition, a good vegetal cover generally improves infiltration capacity through the addition of organic matter to the soil. Higher infiltration capacity means less overland flow and consequently less erosion.

A cohesive soil will resist splash erosion more readily than loose soil. Generally, splash erosion increases with an increasing fraction of sand in the soil because of the loss of cohesion. Splash erosion decreases with an increasing percentage of water-stable aggregates. A soil whose individual grains do not tend to form aggregates will erode more readily than one in which aggregates are plentiful.

Rates of erosion are greater on steep slopes than on flat slopes. The steeper the slope the more effective splash erosion is in moving soil downslope. Overland-flow velocities are also greater on steep slopes, and mass movements are more likely to occur in steep terrain. Length of slope is also important. The shorter the slope length, the sooner the eroded material reaches the stream, but this is offset by the fact that overland-flow discharge and velocity increase with length of slope.

Land use is also an important factor in fixing the rate of erosion. Poor cropping practices or careless construction of roads may greatly accelerate erosion. Removal of vegetation by fire or lumbering may also increase the erosion hazard. Proper soil conservation practices may greatly reduce erosion losses. The universal soil loss equation attempts to combine all these factors, but it is difficult to express the rainfall regime in a single index number, and field determination of soil erosibility is not yet generally available. Hence, this equation and others of a similar nature are, at best, approximate.

New Words and Expressions

1. detachment 分离
2. impact 冲击
3. kinetic energy 动能
4. splash 溅击,飞溅
5. downslope 顺坡而下
6. entrain 拖,带走
7. predominantly 主要地
8. detach 分离
9. sheet erosion 片蚀
10. degradation 剥蚀,陵削
11. fence 篱笆
12. post 杆,柱
13. pillar 柱
14. terminal velocity 沉降速度
15. be proportional to 与…成正比
16. conform with 与……一致
17. storm 风暴
18. account for 是…的原因
19. augment 增大
20. rivulet 溪流,小河
21. dislodge 冲走
22. gully erosion 沟蚀
23. profile 纵剖面图
24. headward 向源的,溯源的
25. saturation 饱和,浸透
26. overtop 漫顶
27. critical 临界的,危急的
28. regime 情势
29. infiltration capacity 下渗容量,下渗能力
30. organic matter 有机物,有机质
31. cohesive 粘性的,粘结的,内聚性的
32. resist 抗,防
33. splash erosion 溅击侵蚀
34. readily 容易地
35. water-stable aggregate 水稳性团粒
36. plentiful 丰富的
37. mass movement 块体运动
38. offset 抵消
39. removal 排除
40. lumber 伐木
41. index number 指标
42. at best 充其量,至多

Notes

1. Since kinetic energy is..., since 在此意为:因为。
2. as either the slow downward creep...or the rapid collapse...as 在此意为:例如。
3. The steeper the slope the more effective splash... 此乃 the...the... 结构,意为:愈…愈…。

Lesson 15 Stream Patterns and Floodplains

Stream Patterns

When viewed in plan * , stream channels may be described as meandering, braided, or straight. A meandering stream flows in large, more or less symmetrical loops, or bends. The median length of meandering streams appears to be about 1.5 times the valley length; i.e., the sinuosity averages about 1.5. The wavelength of meanders ranges from 7 to 11 times the channel width, and the radius of curvature of the bend usually ranges between 2 and 3 times the channel width. The amplitude of the meanders or width of the meander belt varies considerably and seems to be controlled more by the characteristics of the bank material than by other factors. Amplitude usually ranges from 10 to 20 times channel width.

A braided stream consists of many interwined channels (anabranches) separated by islands. Braided streams tend to be very wide and relatively shallow with coarse bed material. No formal statements about the geometry of braided streams are possible. * Few long straight channels exist in nature, but many lack sufficient curvature to be called a meandering stream. A straight stream is commonly defined as one with a sinuosity of less than 1.25.

The important question is to explain why * a channel adopts one of the patterns described above. Braided channels are usually found in reaches where the banks are easily erodible-sandy material with little vegetal protection. Bed material is relatively coarse and heterogeneous particle sizes. The slope of the braided reach is greater than that of adjacent unbraided reaches. Hydraulically, the braided reach is less efficient than the unbraided reach. The total width of branches in a braided reach may be 1.5 to 2 times that of an undivided channel, and the depth of flow is correspondingly less. Braiding is thus a way of dissipating energy when stream slop steepens. * Velocity increases that would otherwise lead to erosion are thus avoided. *

An initially straight channel, either in a laboratory flume or in the field, will usually develop meanders as water flows through it if the bank material is erodible. A meandering channel may be 1.5 to 2 times as long as a nonmeandering channel. Its slope is correspondingly reduced, but head losses are increased both because of the longer channel length and because of the bend losses. Without these losses, velocities would be higher, with corresponding tendency to downcut the channel. Many meandering streams cannot downcut because they discharge into a water body with fixed elevation. If downcutting cannot occur, some other device is required to dissipate the available energy.

Thus both braiding and meandering * can be explained as means of energy dissipation. Braiding will occur when bed material is coarse and heterogeneous and banks easily erodible. Meandering is likely to occur on flatter slops where the material is finer and the banks somewhat more cohesive.

In either case the stream is in a kind of equilibrium-equilibrium in the sense that it will maintain its grade but obviously not in the sense that there will be no channel changes. In the braided channel there is continual shifting and changing between individual anabranches, and meanders undergo a more or less continuous process of erosion in the concave bend and deposition at the subsequent point bar, so that the meanders seem to be constantly moving downstream. Any attempt by man to change the natural pattern of a stream requires careful planning and usually costly revetment work to prevent erosion of banks and return to the original pattern.

Floodplains

The floodplain of a river is the valley floor adjacent to the incised channel, which may be inundated during high water. The river tends to swing back and forth across the valley bottom, reworking the floodplain deposits and eroding first one valley side and then the other. Floodplains are built up primarily from deposition of sediment in the river channel and deposition of fine sediments on the floodplain when flooded. Additionally, organic materials may accumulate in cutoff meander loops (oxbow lakes). Often a natural levee will form along the banks of the incised channel caused by the deposit of coarse sediment as * the water from the stream invades the floodplain. Sediment deposition in the channel plus natural levees on the bank can lead to a situation in which the stream flows at a higher elevation than its floodplain. This condition develops quite frequently in streams flowing across and alluvial cone.

As suggested earlier, floodplains tend to be flooded at fairly low recurrence intervals. Leopold et al. report numerous evaluations of the flow magitude required to overflow the floodplain. Return periods generally range between 1 and 2 years, and a generally statement that floodplains of the eastern and central United States are inundated by floodwaters in 2 out of 3 years is quite reasonable. The universality of this finding is questionable, however, Nixon made a similar analysis of British streams and found that flooding occurred on the average about twice each year. There is some difficulty in defining precisely what the floodplain is and a problem in defining precisely the bankfull stage. Thus it is not clear if Nixon's data indicate conditions substantially different from those in the United States. In any case it is clear that the floodplain is subject to frequent flooding, and hence its use for buildings and other purposes should be carefully regulated. Transverse slope of a floodplain is usually quite small, and it is often difficult to detect natural levees by visual inspection. Consequently in studies for which the floodplain characteristics are important, one must have either adequately detailed maps or special field surveys which satisfactorily define the information needed.

New Words and Expressions

1. stream pattern 河流类型
2. meandering 蜿蜒,蜿蜒型的
3. braided 分汊的
4. symmetrical loop 对称环线
5. bend 弯道
6. median 中位线,中位的
7. sinuosity 蜿蜒度
8. meander 曲流,河曲
9. radius of curvature 曲率半径
10. amplitude 振幅
11. interwined channel 交织水道
12. anabranches 重汇支流
13. formal 正式的
14. geometry 几何形态

15. heterogeneous 非均匀的,非均质的
16. correspondingly 相应地
17. dissipate 消散,消耗
18. flume 水槽
19. downcut 下切
20. in the sense that 指的是
21. shift 移位,移动
22. undergo 经受
23. concave 凹的
24. point bar 边滩
25. revetment work 护岸工程
26. valley floor 谷底平原
27. incised channel 深切河槽,主槽
28. inundate 淹没
29. rework 改造
30. oxbow lake 牛轭湖
31. levee 堤岸
32. invade 入侵
33. recurrence interval 重现期
34. return period 重现期
35. evaluation 估计值,评价
36. universality 普遍性
37. bankfull stage 漫滩水位
38. transverse 横向的
39. visual inspection 目检
40. adequately 充分地,适当地

Notes

1. When viewed in plan 是过去分词作状语,因 stream channels 是 view 的宾语,有被动的意思,故用过去分词 viewed. 分词短语所表示的动作与谓语动词所表示的动作同时发生,所以在分词短语前加连词。
2. No... are possible. 这是为强调而将句子进行倒装。一般如否定词 nothing, never, nor 和副词 only, little 等开头的句子都属倒装。
3. to explain 为动词不定式作表语,而以连词 why 开头的是 explain 的宾语从句。
4. Braiding is thus a way of dissipating... 句中的 Braiding 和 dissipating 分别在句中作主语和介词宾语,均为动名词,有较强的动作意义。
5. Velocity increases that would otherwise lead to erosion are thus avoided. 从 Velocity 至 erosion 为句中主语。
6. Thus braiding and meandering can be... 中 braiding 和 meandering 均为有较强动作意义的动名词。
7. as the water from the stream invades the floodplain. 其中 as 意为:当。

Lesson 16 The Sediment Production and Utilization

Since early fifties, plot studies have been set up and comparisons between the regulated and unregulated small watersheds by various soil conservation experimental stations for the purpose of determining the amount of sediment production under slopes of inclinations and lengths, soils, vegetative covers, modes of cultivation and precipitations have been made. From the data thus collected, we have gained some insights into the sediment production intensity from different parts of a watershed, and* how effective the various soil conservation measures are in checking the erosion. In the vast loess hills and gullies there is a lack of areas with gentle slope susceptible to sediment accumulation at the confluence of arroyo and tributary or tributary and the main stream. Sediment erosion modulus for different watersheds (with an area from 0.18 to 1.89 sq km) of Chaba Ravine varies from 16,800 to 25,600 ton/km^2/year, and depends little on the watershed area, indicating that the surface-and gully-erosion come very close to the sediment transported by the tributary and the delivery ratio is close to unity. This is quite different from what has been found in foreign countries. *

The characteristics of a river depends very much on the characteristics of the watershed in which the river forms an integrating part. The northwestern part of the loess-plateau is in the neighbourhood of the deserts of the E'erduosi Plateau. Owing to the intrusion of the wind-blown sand, the loess is mixed with certain amount of sand, resulting in a relatively coarse composition. Some of the rivers there have downcut to the sandstone stratum, and the latter is highly susceptible to weathering. The weathering products are also of coarse grains. There is ample evidence that the rapid aggradation of the Lower Yellow River is caused essentially by the material coming from this coarse-grain supplying area. There is an area of 430,000 sq km of the Yellow River basin in which the soil erosion is very severe, and yet 80% of the coarse grain material come from only 100,000 sq km. If concentrated efforts could be made in checking the sediment supply from this area, the danger created by the constant silting up of the river channel in the lower reaches * will be much relieved.

In China, although the sediment has brought about much troubles, yet it is a natural resource which can be used to advantage. The loess material contains many kinds of fertilizers, and by diverting it into the land the production will be raised significantly. Through long practice the broad masses of the labouring people have gained much experiences in the way to improve the soil by irrigating with muddy flood water. Irrigation and reclamation by silty water at Zhaolaoyu has a history over one thousand years, and there has been quite a development in the techniques as how to do that in recent years in the provinces of Shannxi and Shanxi and the Inner Mongolia Autonomous Region. One of the important policies in curing the Yellow River problem is to put * the water-and sediment-resourses in full use for the benifits of agricutural and industrial development along the river courses.

New Words and Expressions

1. utilization 利用
2. soil conservation 土壤保护
3. slope of inclination 斜度
4. cultivation 耕作
5. insight into 认识,看透
6. intensity 强度
7. loess 黄土
8. susceptible to... 易遭…
9. confluence 汇合点,汇流点
10. arroyo 旱谷
11. modulus 模数
12. ravine 沟壑

13. delivery ratio 递送比
14. plateau 高原
15. desert 沙漠
16. intrusion 入侵
17. wind-blown sand 风积沙，风沙
18. composition 组成，级配
19. stratum 地层
20. weathering 风化
21. evidence 证据
22. aggradation 填积
23. silt up 淤填，淤积
24. relieve 缓和，解除
25. irrigating with muddy flood water 引洪淤灌
26. reclamation 开垦
27. cure 治愈

Notes

1. and 连接的 the sediment production intensity from different parts of a watershed 和 how effective the various soil conservation measures are... 分别是 into 的宾语和宾语从句。后句中的 how effective 是表语，为强调它而倒装。
2. what has been found in foreign countries. 为宾语从句，what 在此被动句中作主语。
3. created by the constant silting up of the river channel in the lower reaches 为分词短语作定语，修饰 danger. 分词是非限定动词的一种，它可以带有状语(by the constant silting up of the river channel 为方式状语，in the lower reaches 为地点状语)。
4. to put 为动词不定式作表语。

Lesson 17 Mechanics of Sediment Transport

Combining the stochastic treatment with the principles of mechanics is an important trend in the modern development of fluvial dynamics and sediment transport. Scientists in this country have developed formulas for vertical distribution of both the time-averaged velocity and the intensity of turbulence which * hold true not only in the main flow zone but also in the boundary layer as well from a stochastic analysis of the turbulent open channel flow. Studies have also been made on certain aspects of the stochastic theory of motion of a single particle, including the time of rest, the distance of travelling covered by a single step, the height of movement, the time requried for leaving the bed and the transition from one mode of motion to another. Stochastic models and statistical theories of bed-load transport and sediment diffussion have also been offered.

Measurements have been made on the forces acting * on a gravel at various spots on the bed surface, the data thus obtained emphasize the equal importance of the lift force and the drag force in initiating the sediment motion. In Chinese practice, the average velocity is used more frequently in designating the threshold condition. For the fine particles, cohesion between particles must be taken into consideration. Universal laws for the inception of motion including both the coarse-and fine-particles have been developed by various investigators and agree well with the measurements.

As the present bed-load formulas are not accurate enough in engineering practice * , the following procedure is sometimes adopted in determining the bed-load transport of gravel river in the southwestern mountainous district. A model without scale distortion (or with small distortion) is first built for the river to be studied. The bed-load transport rates at different flows obtained from the model are then converted to the prototype according to the proper scale ratios. The sediment-rating curve thus determined * agrees quite well with the field data. In areas where there is no data available, the relative amount of gravels coming from different tributaries can be estimated by an analysis of petrography. This method has been used satisfactorily in estimating the gravel supply of the Sanxia district of the Yangtze River.

For the sediment in suspension the vertical distribution of suspended load based on the diffusion theory gives a zero concentration at the water surface which is in contradiction with the reality. * This is due to the fact that in the process of derivation the mixing length is taken as zero at the water surface. This is a disputed assumption if the theory is corrected in this respect, it will give a better answer as far as the concentration at the water surface is concerned. Whenever there exists a relatively high sediment concentration gradient near the bed, the von Kármán's constant in the logarithmic velocity distribution depends very much on the Richardson Number. It is ncessary to take into consideration the effect of sediment concentration on the settling velocity of the falling particles in the integration process while in deriving the vertical distribution of suspended matter.

The sediment concentration of the rivers in northwestern part of China is usually very high. The annual average sediment concentration of some of the tributaries is well over 500kg/m^3 and the maximum concentration ever measured can be as high as 60% by volume. The flow with such high concentration behaves quite differently from the ordinary sediment-bearing flow. Some advances have been made in recent years on the mechanism of the flow with sediment at hyperconcentrations.

New Words and Expressions

1. stochastic 随机的
2. fluvial dynamics 河流动力学
3. formula 公式
4. time-averaged velocity 时均流速
5. intensity of turbulence 紊动强度
6. hold true 适用
7. boundary layer 边界层
8. time of rest 休止时间
9. single step 单步
10. time required for leaving the bed 脱离床面时间
11. diffussion 扩散
12. lift force and drag force 举力和拖力
13. initiate 起始
14. threshold 门限值,起动
15. inception 开始
16. district 地区
17. distortion 变态

18. convert 转换
19. prototype 原型
20. sediment-rating curve 水沙曲线(输沙量-流量关系曲线)
21. petrography 岩相学
22. in contradiction with 与…相矛盾
23. reality 现实
24. mixing length 混合长度
25. dispute 争议,争论
26. as far as 就…而言,至于
27. logarithmic velocity distribution 对数流速分布
28. sediment-bearing flow 挟沙水流
29. hyperconcentration 超高浓度

Notes

1. which hold true... 其中代词 which 代的是 formulas.
2. forces acting on... 中 force 是的行为主体,故在此以现在分词 acting... 作定语,修饰 forces.
3. As the present... formulas are not accurate enough in..., 为原因状语从句,as 意为:由于。
4. The sediment-rating curve thus determined... 其中 curve 是 determine 的宾语,故在此以过去分词 determined 来作定语,修饰 curve.
5. For the sediment in suspension on the vertical distribution... gives a zero concentration... which is in... 中主句的主语为 vertical distribution,谓语为 give,zero concentration 为宾语。which is... 为定语从句,修饰 zero concentraction.

Lesson 18 Fluvial Processes

As regards the problem of channel pattern, it is usually classified into three categories, namely, the meandering, the braided and the straight by most of our foreign colleagues. From what we have observed in rivers in China, the middle and lower reaches of the Yangtze River which have one (or, a few) mid-stream island with relatively stabilized branches are quite different in behavior than the braided stream of the Lower Yellow River whereas the central islands are dispersed and unstable and the river channels are in the process of everlasting wandering. So far as the fluvial processes are concerned, these two types of river should be classified into two different channel patterns. In China we reserve the name "braided stream" for those such as the middle and lower reaches of the Yangtze River and a specialized name "wandering stream" is used to designate the channel pattern as that of the lower Yellow River.

The formation of meandering stream depends to a large degree on the relative erodibility of the bank material (or, more precisely, the material forming the flood plain). Early in the sixties, we have succeeded in moulding typical meandering stream in laboratory by stabilized the banks with vegetation or by overflooding with clayey material. From the observations taken in the Lower Jingjiang River loops, the importance of the circulating flow in determining the fluvial processes of a meandering stream is generally recognized. Hydrological agencies have also made detailed observations and measurements on the river morphology of meandering stream in Lower Jingjiang and Lower Weihe River, and valuable informations are available. Artificial cut-offs have been made on the Lower Jingjiang and the South Grand Canal for the needs of the navigation and flood control, and detailed observations have been made on the evolution of the pilot channel, the deterioration of the old river and the effect of cut-off on both the upstream and downstream.

The Lower Yellow River is distinctive in its abundance of sediment, large extent of aggradation and degradation, and the frequent shifting of the river channel. As such, it is an idealized situation in studying the fluvial processes of wandering stream. In the sixties, we summed up the experiences gathering up to that time, and based on which, predictions were made on the possible changes had occured downstream and has been duly reported in literature. For wandering stream with large sediment content, it is necessary in flood routing to consider the channel storage of the flood plain both on water flow and on sediment and the effect of aggradation or degradation of the main channel. A few semiempirical methods have been developed in this respect. The flood created by the ice-jam of the Lower Yellow River is a constant threat to the safety of levees in Shantong province, and a comprehesive summing up of the past experiences have been carried out. Besides the Lower Yellow River, the Yongding River near Beijing is another typical wandering stream. After the completion of the Guanting dam across the river channel upstream, a coarsening of the river bed has manifested Itself in a distinct way. The flood plain has been washing out to a large extent, resulting in a widening of the river channel and an increasing threat of flood against the levee system.

In the middle and lower reaches of the Yangtze River, in addition to the regulating effect of the control points located at the inlet and the outlet of a braided stream, the small variance in flood discharge may also play a part in forming the braided stream. Geographical groups have carried out laboratory studies on the bed-forming process of the braided stream. The knowledge thus obtained surely deepens our understanding of the natural process.

Considering the hydraulic geometry of the stream channel, the known conditions are the continuity equation of the flow, the equation of motion and the sediment transport equation, and the unknowns are the width, depth, slope and velocity of the flow. One additional equation is required if the problem is to be completely sloved. Numerous ideas and hypotheses have been offered in this regard, among whioh is the "hypothesis of least mobility". With this additional assumption, the hydraulic geometry of the stream channel in alluvial plain and the estuaring reach with tides can be determined to satisfaction. The channel form of an alluvial stream depends to a large degree on the relative erodibility of the bed and the banks. The ratio between the threshold velocities of the bed-material and the bank-material has been used as a parameter in correlating with the geometrical form of the river channel in the middle and lower reaches of the Yangtze River.

In planning and designing of engineering projects, one needs to make quantitative estimation of the fluvial processes. If we write down the equation of motion of flow in the form of a non-uniform and unsteady differential equation, and solve it simultaneously with the equations of continuity of the flow and of the sediment, we shall obtain three sets of characteristics which can be used to determine the variations of velocity, depth of flow and amount of aggradation and degradation with time. A set of computational methods is available to determine the coarsening effect of the bed and the hydraulic parameters and fluvial processes of the pilot channel and the old river after an artificial cut-off. In setting up the mathematical model for the Lower Yellow River, it has been found that the sediment carrying capacity of the bed material load of the flow varies with the oncoming load, as* the amount of accretion and erosion of the channel bed is so large that the channel form and effective bed composition change rapidly in accordance with the sediment load. The whole problem is rathr complicated and at the present moment we are only able to make an empirical presentation of the relationship between the discharge and the transport rate of the bed material load by using the oncoming bed material load of the upstream gauging station as a third parameter. Such a presentation reflects the well known fact that "The more the oncoming sediment load, the more the siltation of the river channel, and the more the sediment carried out to the sea" of the Lower Yellow River.

New Words and Expressions

1. fluvial processes 河床演变
2. as regards 关于
3. classify 分类
4. colleague 同行
5. mid-stream island 江心洲
6. whereas 而，却，反之
7. everlasting 无穷尽的
8. wandering 游荡
9. so far as=as far as 至于，就…而言
10. reserve 保留
11. formation 形成
12. erodibility 易蚀性
13. precisely 精确地
14. mould 模制
15. overflood 泛洪
16. clayey 多粘土的
17. morphology 形态学
18. artificial 人工的
19. evolution 演变
20. pilot channel 导河
21. deterioration 恶化
22. abundance 丰富
23. sum up 总结
24. duly 正式地
25. flood routing 洪水演算
26. channel storage 槽蓄量，槽蓄作用
27. ice-jam 冰塞
28. threat 威力
29. comprehesive 综合的
30. manifest 证明
31. wash out 冲失
32. regulating 调节
33. hydraulic geometry 河相关系（水力几何形态）
34. hypothesis 假设
35. least mobility 最小活动性

36. estuarine=estuarial 河口湾的
37. non-uniform 非均匀的
38. unsteady 非恒定的
39. differential equation 微分方程
40. simultaneously 同步地
41. characteristics 特征线
42. sediment carrying capacity 挟沙能力
43. accretion 堆积
44. in accordance with 根据
45. gauging station 水文站
46. siltation 淤积

Notes

1. As such 意为:正为比,象这样。
2. experiences gathering up to that time, and based on which... 句中 gathering 为现在分词作定语,修饰 experiences, based on which 中的 which 亦代 experiences.
3. as the amount of accretion... is so large that... 句中 as 意为:由于。

Lesson 19 Dredge

Dredging is moving material submerged in water * from one place to another in water or out of water with equipment called dredges. Dredges today come in two classifications-mechanical and hyudraulic. An excellent review is given by A. L. McKnight in Reference 15 which is abstracted in part below and supplemented with other information.

Types of Dredges

Mechanical types include the clamshell or grapple dredges. Larger dredges of that type are no longer favorites. The endless chain bucket (or bucket-ladder) dredge was used widely earlier in Europe but not in the United States, although they were employed on a few projects like the Panama Canal.

The mechanical dipper dredge with its heavy bucket moved * by a very strong arm and boom is still used for dredging relatively loose (usually not solid) rock. The bucket may be provided with special cast iron teeth. "Big Boy" in Norway has a 2.6-cubic yard bucket.

The hydraulic dredge is the most important piece of dredging equipment. The plain suction dredge has no cutter but sucks material off the bottom and discharges it through a stern connected pipe leading * to a spoil disposal area.

The cutterhead pipeline dredge has a rotating cutter on the end of the ladder and excavates the material from in situs condition and discharges it through the stern to pontoon and shore pipe. The dredge is controlled on stern mounted spuds and is swung from one side of the channel to the other by means of a swing gear.

The self-propelled hopper dredge has a large hopper in which the dredged material is loaded for later dumping through doors in the bottom. This type of dredge is normally employed where the water is too deep for a pipeline dredge or where spoil areas for such a dredge are not available within economic distances.

The development of the hydraulic dredge happened through radom trial-and-error rather than by plan. The dredging pioneers were first of all interested in the practicable aspects of making money. Only those who work directly with the dredge have more than a passing knowing of its operation or capabilities. Dredging is "a complicated and still empirical business and men spend their lives in it, learning almost wholly by experience". A great improvement introduced in 1966 by the establishment of WODCON (world Organization of Dredging Contractors) which had its first international meeting in New York in 1967 and now issuse its own periodical regularly and arranges world conferences every second year. Another organization, WODA(World Dredging Association, San Pedro), published monthly magazines and also published the 1970 Directory of world's Dredges and Their Owners.

The hydraulic dredge has, without any doubt, become the most important piece of the equipment in the entire harbor engineering field. Without the dredge, commercial navigation of waterways and rivers would be ended. Water-borne industry would collapse. Ocean shipping as it is known would be nonexistent.

Hydraulic dredges dig canals, ports and harbors, do maintenance dredging in rivers, canals and waterways, and excavate for construction of piers, wharves, docks, dams and underwater foundations. They provide spoil for the reclamation of swamps and marshes; they construct dikes and levees, and dredge sand, gravel and shell, as well as coal, gold, diamonds and many other minerals for commerical purposes. The dredge's scope of operation is broad.

Small hydraulic dredges operate in water only a few feet deep. Larger dredges require more draft but can dig to greater depths. With the aid of booster pumps, the distances solids can be pumped are unlimited.

Although the dredge's output is understandably greater in soft materials than in hard, it can excavate almost anything. It digs mud, silt, loam, clay, sand, hardpan, gravel, coral and even rock. Boulders weighting 1,000 pounds and more have been excavated and transported by dredges.

New Words and Expressions

1. dredge 挖泥船
2. abstract 摘要
3. supplement 补充
4. clamshell or grapple dredge 蛤壳式或抓斗式挖泥船
5. chain bucket(or bucket-ladder) dredge 链斗式挖泥船
6. dipper dredge 铲斗式挖泥船
7. provide with 装备有
8. cast iron teeth 铸铁齿
9. hydraulic dredge 吸扬式挖泥船
10. cutter 绞刀
11. spoil disposal area 抛泥区
12. cutterhead pipeline dredge 绞吸式挖泥船
13. ladder 桥架,梯
14. excavate 挖掘

15. in situ 就地
16. mounted 安装在…的
17. spud 桩
18. gear 齿轮,传动装置
19. self-propelled hopper dredge 自航装舱耙吸式挖泥船
20. random 随机的,偶然的
21. trial-and error 反复试验
22. issue 出版,流出
23. periodical 期刊
24. association 协会
25. water-borne 水运
26. pier 突码头
27. wharf(复 wharves)透空顺岸式码头
28. dock 船坞
29. swamp 洼地
30. marsh 沼泽
31. dike 堤
32. booster 加压
33. draft 吃水深
34. hardpan 硬质地层
35. coral 珊瑚
36. boulder 巨砾

Notes

1. submerged in water 为过去分词短语作定语,修饰 material.
2. moved by a very strong arm and boom 作定语修饰 bucket.
3. leading to a spoil disposal area. 句中 leading 为现在分词,由其引出的短语为 pipe 的宾语补足语。

Lesson 20 The Estuarine Sediment Problem

In China we have long sea coast with many rivers discharging into the sea and forming all kinds of estuaries according to the volume of run-off, the tidal action and the sediment concentration and source. These estuaries have been classified into four categories, namely, (1) estuary with strong tides and material supplied from the sea; (2)estuary with weak tides and material supplied by the run-off; (3)estuary with run-off coming from a lake and material supplied from the sea; (4)estuary with material supplied from both the sea and the land.

Qiantang estuary is a typical estuary with strong tides and material supplied from the sea. The estuary is of funnel-shape, and the annual average tidal range at Ganpu is 5.3m. Qiantang estuary is famed for its bores, with a maximum bore height at Haining of 3.7m and speed of propagation of 8～9m/sec. The strong tidal action carries the material from the sea into the estuary and formed an enormous bar with a length of 130 km and a height of 10m. The existence of such a bar within the estuary will naturally affect the fluvial processes in many ways. Based on the data collected from 22 estuaries in China and abroad, it appears that bar inside of the estuary will be formed if the ratio between the runoff and the tidal flow is less than 0.02, and mouth bar will be formed if this ratio exceeds 0.1.

Yellow River estuary is a typical example of the estuary with small tides and material supplied from the land. Here the average tidal range is only 0.5m at the outlet of Shenxiangou. Each year the Yellow River brings 1.2×10^9 tons of sediment into the Bohai Sea, among which two-thirds are deposited in the delta area and the off-shore zone, making the delta to advance rapidly. From the years 1855-1954, the coastal line advances 0.15km per year on the average, forming a land of 23sq km each year. In recent years the sea coast advances at a rate of 0.42km per year owing to the restriction in the scope of the wandering and avulsion of the river channel.

The estuaries of Yangtze River and Pearl River are those with sediment coming from both the land and the sea. Out of the necessity of discharging the flood flow, the channels on the delta of Pearl branch here and there * , forming a complicated network. The slope of the Yangtze estuary is so flat that the effect of tidal action can be felt 650km upstream in the low-flow season with strong tides. Numerous bars are formed in the neighborhood of the river mouth, and the delta under water has a tendency to shift southward as a whole.

Most of the sediment brought into the sea comes from the Yangtze River and the Yellow River. The sediment carried by these two rivers is rather fine in composition, thereby creating vast areas of muddy beaches along many of the sea coasts. The motion of mud has a great effect on the siltation of harbors and estuaries. Systematic studies on the movement of mud have been carried out in the laboratory flumes and mud transport capacity of the estuarine-and coastal-flow has been formulated.

Since the liberation many tidal barriers has ben built along the Chinese coast to prevent the intrusion of salty water and facilitate the inland drainage. The erection of the barrage changes the dynamic condition of the estuarine area and brings about serious siltation downstream of the barrage. If ample supply of river run-off is available, the sedimentation can be brought under control by operating the gate in a systematic way. One ought to make full use of the river run-off to regulate the ratio between the velocities of flood-tide and ebb-tide and to change the relative proportion of the sediment brought in by the flood-tide and that carried out by the ebb-tide. If the location of the barrage is not far away from the river mouth and the sediment accumulatad downstream of the gate is relatively fine, then by increasing the sediment concentration of the ebb flow through agitating dredging with motor boats the amount of siltation can be effectively reduced.

New Words and Expressions

1. funnel 漏斗
2. tidal range 潮差
3. fame 使闻名
4. bore 涌潮
5. propagation 推进
6. mouth bar 拦门沙
7. delta 三角洲
8. off-shore zone 近岸带
9. restriction 限制,缩小
10. avulsion 改道

11. out of 出于
12. low-flow 低水
13. as a whole 基本上
14. muddy beach 淤泥质海滩
15. facilitate 便于
16. erection 建立
17. barrage 挡潮闸
18. flood-tide 涨潮
19. ebb-tide 落潮
20. agitate 搅动

Notes

here and there 意为：到处。

Section Ⅲ Port Engineering

Lesson 21 Some Basic Definitions of Wave

Before we freely can describe the wave phenomena, we must introduce some concepts by short definitions.

A periodic surface gravity wave of permanent form pro pagating * over a horizontal bottom is fully charcterized by the wave height H, the wave length L, and the mean water depth h (distance from the bottom to the mean water level MWL), as shown in Fig. 21. 1. The MWL is so defined that the area under the wave crest equals that over the wave trough * , see Fig. 21. 2. The crest height is the distance from the MWL to the top of the wave(crest), and is also called the positive wave amplitude. Similarly we have the trough depth, which is the negative wave amplitude. For small waves (linear theory) these amplititudes * are equal, and we talk about the wave amplitude $a=H/2$.

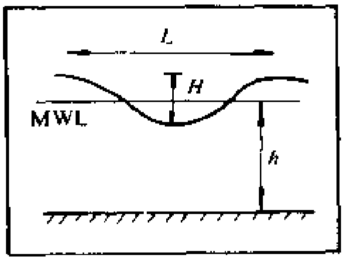


Fig. 21. 1

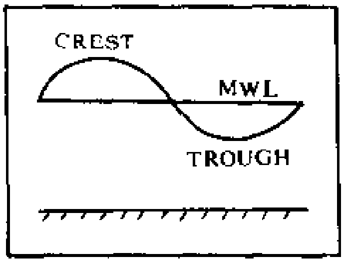


Fig. 21. 2

The time interval between the passage of two successive crest at a fixed station is denoted the wave period T. At such a fixed station the phase (or phase angle) is zero under the crest; it then increases by 360° during a wave period. Thus the phase angle of a trough is 180°.

If a wave motion in two horizontal dimensions is considered, we can distinguish a wave front which is a curve of constant phase angle. Less general, but easier to visualize, a wave front is a curve in the horizontal plane through adjacent crest points, Fig. 21. 3. The direction of the wave propagation is described by the wave orthogonals * which are orthogonal trajectories of the wave fronts, as shown in Fig. 21. 4.

A progressive wave is wave train with no(or just slight) reflection, i. e. it is 'unidirectional'. The wave front propagates with the phase velocity in the orthogonal direction. For small waves, the wave energy E(potential plus kinetic) propagates with the group velocity C_g in the same direction. The product of E and C_g is the mean energy flux * . In deep water ($h/L>1/2$) the group velocity is half the phase velocity, while in shallow water ($h/L<1/20$) the two are almost equal. If currents are present, the situation is more complex.

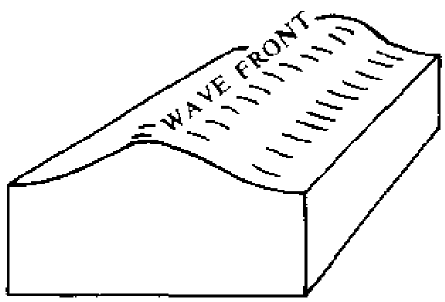


Fig. 21. 3

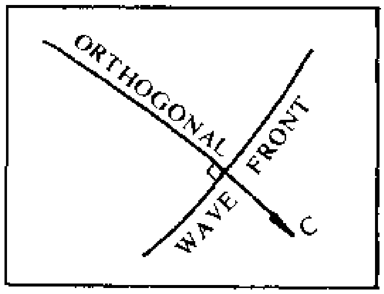


Fig. 21. 4

The motion of the surface profile of a wave gives literally speaking a superficial picture of the true fluid flow. A progressive wave transports energy and momentum, but not necessarily mass. The volume flux q per unit length of the wavefront is the time mean value of the integrated horizontal partical velocity u over total depth. If $q=0$, we have a pure wave motion. For small waves, the particle orbits are closed curves, viz. ellipses. (note that these are the particle paths, not the stream lines). At the MWL the vertical semi-axis equals $H/2$, while at the bottom the ellipses degenerate to straight lines. In deep water the particles move in circles, while in shallow water the ellipses are very much 'stretched' horizontally, as shown in Fig. 21. 5.

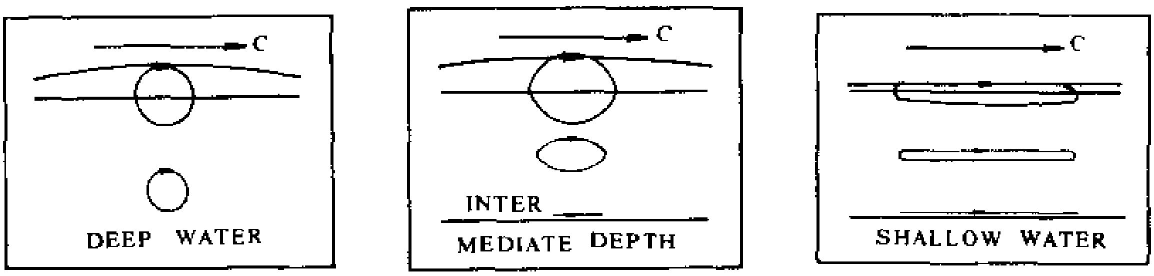


Fig. 21. 5

The particle velocity is in the direction of wave propagation under the wave crest, oppositely under the wave trough. It is a maximum under the crest. The particle velocity is generally much smaller than the phase velocity, i. e. $u<<c$. (An exception is a near-breaking wave, where the maximum particle velocity at the crest about equals the phase velocity.)

The wave steepness S is defined as the ratio between wave height and length, i. e. $S=H/L$.

New Words and Expressions

1. phenomenon(复 phenomena) 现象
2. permanent 永久的
3. wave height 波高
4. mean water depth 平均水深
5. wave crest 波顶
6. wave trough 波底
7. distinction 区别
8. positive 正的

9. wave amplitude 波幅
10. negative 负的
11. interval 间隔
12. denote 表示
13. wave period 波周期
14. two dimensions 二维，二向
15. distinguish 区别，识别
16. wave front 波前
17. unidirectional 单向的
18. propagate 推进
19. orthogonal 正交的，波向线
20. progressive wave 推进波
21. trajectory 常角轨道，轨迹线
22. wave train 波列
23. potential energy 势能
24. product 乘积
25. energy flux 能通量，能流
26. literally 确切地
27. superficial 肤浅的，粗浅的
28. orbit 轨迹
29. viz. (=namely)[拉]即
30. ellipse 椭圆
31. particle path 迹线
32. stream line 流线
33. semi-axis 半轴
34. degenerate 退化
35. exception 例外
36. wave steepness 波陡

Notes

1. propagating 为现在分词作定语，修饰 wave.
2. crest 为波顶是波峰(peak)的最高点。trough 是波谷，与 hollow 同义，本不该解释为波底，波底应该用 bottom 才妥。但由于许多书本上均将 trough 作波底用，此处估且随俗。
3. these amplitudes 指 positive and negative wave amplitude 故译为两振幅。
4. phase angle 为相(位)角，phase velocity 为相速度。
5. wave orthogonal 指与波前的正交线，可译为波向线。
6. energy flux 常译为能通量，按海洋工程中的习惯，译为波能流。

Lesson 22 Wind-generated Wave and Significant Wave Height

The waves one sees every day on the ocean*, and those primarily responsible for coastal erosion, are generated by winds blowing over the water surface. There are, of course, waves such as the tsunami that are not generated by winds, and although they can be extremely destructive their occurrence is too rare for them to be a significant factor in coast erosion and so will not be considered here.

Wind-generated waves are important as energy-transfer agents; first obtaining* their energy from the winds, transfering* it across the expanses of the oceans, and then delivering* it to the coast zone where it can be the primary cause of erosion or* can generate a variety of nearshore currents and sand transport patterns. The generation of the waves is primarily dependent upon three storm factors: the speed of the wind, the duration of the storm, and the fetch area over which the storm occurs. The duration is important in that the longer the winds have been blowing, the greater the amount of energy that can be transferred to the growing waves. The fetch area has a similar effect, once the waves travel out of the storm area they no longer acquire additional energy, so that the larger the fetch area, the more energy the waves can potentially obtain.

The simplest type of wave is characterized by a height, H, length, L, and period, T, however, waves in the storm area, do not fit this ideal picture but instead are a complex pattern of wave crests and troughs, with no two waves seeing to have the same height or priod. If an individual wave crest is followed it often is observed to progressively decrease in height and eventually disappear. This complex pattern of waves results because a storm does not simply generate waves of one fixed height and period, but instead, a whole range or spectrum is generated. When the wind first blows across an initially quiet body of water only small ripples are formed with period less than 1 second and heights of only a couple of centimeters. As time passes, waves with longer and longer period will be formed* , but small ripples will continue to be present and waves with a range of periods will now exist. The longer-period waves have longer wave lengths, and this also permits them to achieve greater heights without breaking and thereby losing energy. Concomitant with the progressive increase in wave periods present in the area of generation is an increase in wave heights.

Characterizing the waves in the area of generation is obviously more difficult than in the case of the simple sinusoidal wave which could be defined by one height and period. Once a record is otained of the water-surface elevations, determined by a variety of techniques including waterpressure sensors, wave staffs, surface "glitter" and other remote sensing methods, the analysis usually takes one of two possible paths (Figure 22. 1). A statistical analysis of wave heights can be performed, noting* the maximum wave height in the record, the average height, or a root-mean-square wave height. A commonly used statistical wave height is the significant wave height, H_s, defined as the average of the highest one third of the waves. Its choice was based on the impression that in many applications the larger waves are more important than the small waves, and H_s thereby provides a more representative wave measure than, for example, the average wave height. It has also been shown that H_s roughly corresponds to a visual estimate of a representative wave height in that the observer naturally tends to weight his observation toward the larger waves. It has been demonstrated theoretically and by measurement that under fully developed storm waves these statistical wave heights form well-defined ratios.

For example, the ratio of H_s to the average wave height is approximately 1. 56, and its ratio to the root-mean-square wave height is 1. 42. The maximum wave height observed in a wave record depends on the length of that record, so there is no fixed value for its ratio with the other wave statistics. One can also define a significant wave period or average wave period, but these have somewhat less physical reality than the corresponding wave heights, and as well see, their use can lead to mistaken results.

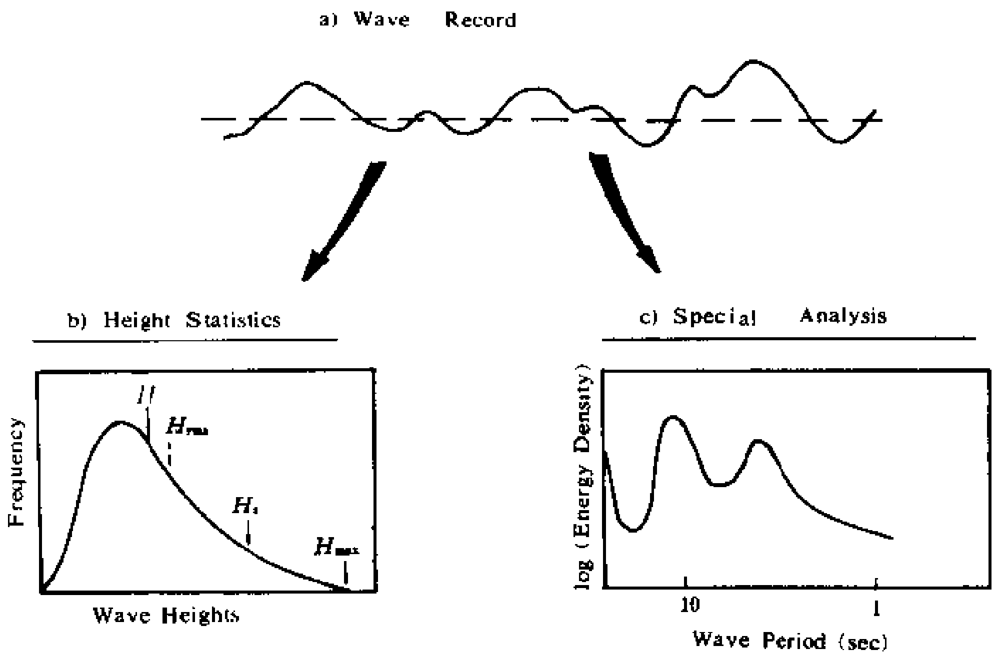


Fig. 22.1 The analysis of a wave record

(a)usually involves a consideration of statistics of the wave heights (b) or a spectral anlysis approach

New Words and Expressions

1. tsunami 海啸
2. destructive 破坏性的
3. wind-generated wave 风成波
4. energy-transfer 能量传递
5. expanse 浩瀚，广阔
6. coast zone 海岸带
7. duration 历时
8. fetch area 受风水域
9. acquire 获得
10. a range of 一系列的
11. sepctrum 谱
12. ripple 细波，涟漪
13. a couple of 几个，二、三个
14. permit 允许
15. concomitant with 与…相伴的
16. sinusoidal 正弦的
17. a variety of 种种
18. water-pressure sensor 水压传感器
19. wave staff 测波杆
20. glitter 闪烁装置
21. remote sensing 遥感
22. root-mean-square 均方根
23. significant wave height 有效波高
24. spectral analysis 谱分析
25. impression 观念

Notes

1. The waves one see every day on the ocean,... one see every day...，为定语从句，连词 that 在从句中作宾语，故可省略。

2. obtaining...,transfering it...,delivering it to the coast zone where it...三个分词短语均作状语用,句中的 it 均代表 energy.
3. 接上句 where it can be...or can...这里关系付词 where 引起的是定语从句,where 在从句中作状语。or 连接两个 can,它们的主语均是 it(energy).
4. waves with longer and longer period will be formed. 其中介词短语 with longer and longer period 作定语,修饰 waves.
5. noting the maximum wave height...为分词短语作状语。

Lesson 23 Area Requirements in Site Selection

The choice of a particular location for the establishment of a port depends upon many factors including land requirements and requirements to depth and space and to protection of the harbor against wave action, current action and sedimentation to the extent possible. *

Area requirements depend upon the character of the port and the corresponding needs for areas for transportation, storage (dry and open) and industry. No general rules for land requirments can be given, but a modern container berth generally needs about 8 hectares of land area. Recent developments have increased this figure to 10-12 hectares. The use of harbors for industry is often a main factor in planning. Many harbors have a considerable part of their income from lease of industrial areas, while port operations themselves may run at a deficit. Consequently, many factors are involved in planning of land facilities.

It is possible to plan with a reasonable degree of accuracy the transportation and storage areas and facilities when the expected inputs-outputs and throughputs have been defined by basic criteria. Such analyses are now common in all comprehensive port planning.

Site selection and layout of port structures involve basic problems that are dealt with in considerable detail by the Permanent International Association of Navigation Congresses(PIANC) in its Committee for the Reception of Large Vessels(ICORELS). Results have been published in various reports.

PIANC ICORELS Group I, 1979, reported on "Methods for Analyzing Wind, Wave, and Swell Data to Estimate on an Annual Basis the Number of Days and the Maximum Duration of Periods During Which Port and Ship Operations Will Be Impeded by These Elements".

Group IV established general guidelines for the dimension of channels; basins, including turning circles and safety requirements; navigational aides; and ship handling problems, including models. In addition, dredging problem for construction and maintenance was dealt with by Group IV, and evironmental effects of dredging and disposal are reported on by the PIANC Committee on "Study of Environmental Effects of Dredging and Disposal of Dredged Materials" published as annex to Bulletin No. 27(Vol. II,1977) of the PIANC.

Site selection is related to exposure by waves, currents, and sediment transport. To the extent possible a marine structure on a sea coast should be placed in a sheltered area, such as:

1. Behind an island or shoal.

2. In a deep natural bay or fiord on the coast.

3. In a sheltered lagoon, tidal entrance, or estuary.

With respect to littoral drift problems, allowance must be given for gradual modifications of the sea bottom and shoreline that may result from building a structure on the coast.

Because of the vast capital investment involved in the construction of large marine structures, it is important that planning considers future developments, including the general increase in ship sizes, with particular reference to drafts of bulk, and container vessels.

Site selection is highly dependent upon a variety of environmental parameters as dealt with in detail by PIANC's ICORELS Committee No. 1. The so-called "operational limit conditions" depend on the following site conditions:

1. Astronomical tide.

2. Wind.

3. Changes of water level caused by meteorological conditions, in particular storm surges and the so-called negative surges.

4. Waves (amplitude, period, direction).

5. Currents.

6. Visibility.

7. Ice.

8. Sediment transport.

The operational limit conditions are established in each case after a comparative economic survey of the different possibilities in which investment costs, maintenance costs, and the necessary requirements for safe navigation are taken into account. *

In order to determine these requirements, it is necessary to make a statistical survey of the site conditions mentioned above. * The resulting operational limit conditions are affected by the environmental conditions in general, as well as by economic considerations, certain practical aspects, for example the availability of tug assistance, and other necessary services.

New Words and Expressions

1. site selection 选址
2. to the extent possible 在尽可能的范围内
3. container berth 集装箱泊位
4. hectare 公顷
5. income 收入
6. lease 出租
7. deficit 亏损
8. be involved in 包括
9. input-output 吞吐量
10. throughput 中转量
11. layout 布置
12. congress 会议
13. impede 阻碍
14. guideline 准则
15. turning circle 徊转圆
16. navigational aids 航运设施

17. annex 附录
18. bulletin 公告
19. exposure 方位
20. shelter 掩蔽
21. fiord = fjord 峡湾(尤其指挪威海岸边的)
22. lagoon 环礁湖
23. with respect to 关于
24. littoral drift 沿岸流
25. allowance 余地、容许量
26. modification 改变
27. capital 资本
28. investment 投资
29. with reference to 与…有关的
30. bulk vessel(=bulk carrier) 散装货船
31. container vessel 集装箱船
32. astronomical 天文的
33. storm surge 风暴潮(涌波)
34. visibility 能见度
35. comparative 相当的
36. availability 有效性
37. tug 拖轮

Notes

1. 本文第一段句子虽长,但是个简单句,掌握了主语是 choice,谓语是 depends upon 就不难译出。
2. in which investment costs,... costs, and the ... requirements... are taken into account. 为限制性定语从句,修饰 possibilities.
3. mentioned above 意为:上述的,在文章和信件中常见。

Lesson 24 Harbor Entrances and Channels

The design of harbor entrances, channels and turning basins is dictated by the size of the largest vessel anticipated to enter the harbor. Although meteorological and oceanographical factors are important in harbor design, primary importance lies in determining the size of the design vessel which should be realistic, bearing in mind that* the recent trend in ship construction is toward larger and faster ships.

Figure 24.1 shows the projected size of the largest tankers, bulk carriers and freighters up to the year 2040 as seen by the U.S. Department of Commerce, Maritime Administration. The numbers indicated certain arbitrarily chosen practical limits of ships shown in Figure 24.2, based upon an assessment of the current and potential state-of-the-art. The limit of ship sizes indicated in Figure 24.1 shows the possibility of a 1,000,000 dwt tanker by 1982, a 400,000 dwt bulk carrier and a 50,000 dwt freighter by 1995. The above dwt average is assumed to be a practical upper limit.

For the benefit of those who may think that the above judgment is too conservative, Kray extended the curves by extrapolation beyond so-called practical upper limits without regard to reliability and practicality.

Entrance and Channel Depths

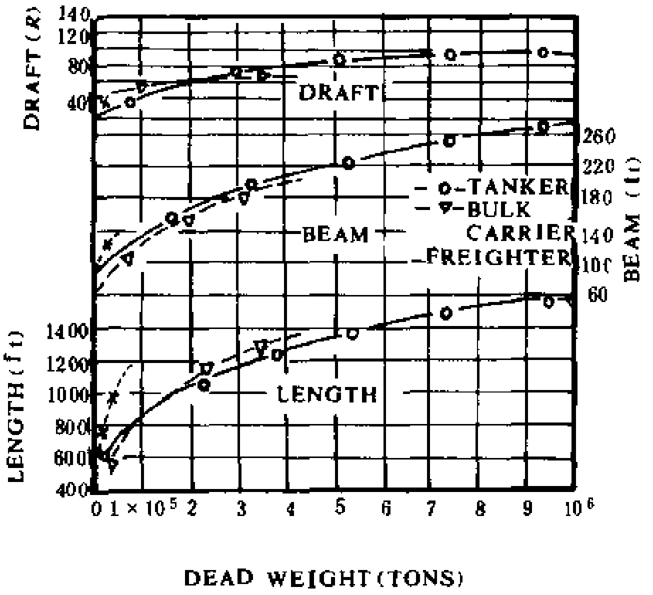


Fig. 24.1 Projected dwt of largest tanker. bulk carriers and frieg hters to the year 2040

The differentation between entrance and channel depths is made to suggest that these depths need not be the same. A harbor entrance is usually exposed to larger waves than those which occur within the harbor. Consequently, the scend or pitching of vessel may be larger at the entrance to a channel than within the channel. The anticipated scend is a factor which is included in the determination of the required depth.

The Permanent International Association of Naviational Congresses recommends that the minimum design depth should be the static summer saltwater draft of the design vessel plus 5 to 8 feet (1.5 to 2.5 meters). While this criterion is useful in estimating the required channel depth, a detailed calculation of the required depth could be based upon a summation of the following factors:

1. Load Draft
2. Tide
3. Density
4. squat
5. Pitching and rolling
6. Trim
7. Empirical factors(shoaling rate)

Channel Widths

The channel width is usually measured at the toe of the side slopes or at the design depth. The channel width depends upon the following factors: (a) the beam, speed and meaneuverability of the design vessel; (b) whether the vessel is to pass another vessel; (c) the channel depth; (d) the channel alignment and whether the channel is in a restricted or wide waterway; (e) the stability of the channel banks; (f) the winds, waves, currents and crosscurrents in the channel. There are no formula which explicitly include all these factors, but some criteria have been established based upon the beam of the design vessel which include these factors implicitly. The permanent International Association of Navigation Congresses recommends that if there is no passing of vessels, the channel width should be three to four times the beam of the design vessel; if vessels pass, the channel width should be six to seven times the beam of the design vessel. They suggest these criteria would be for ideal conditions and that cross winds and crosscurrents should be considered. *

Another method of determining the required channel width is based upon investigations made during studies of the sea level of Panama Canal during which model and prototype vessels were observed in motion. The opinion of pilots and navigators were included in the criteria presented. This method divides the total channel width into (a) width of the maneuvering lane, (b) width of the ship clearance lane and (c) width of bank clearance.

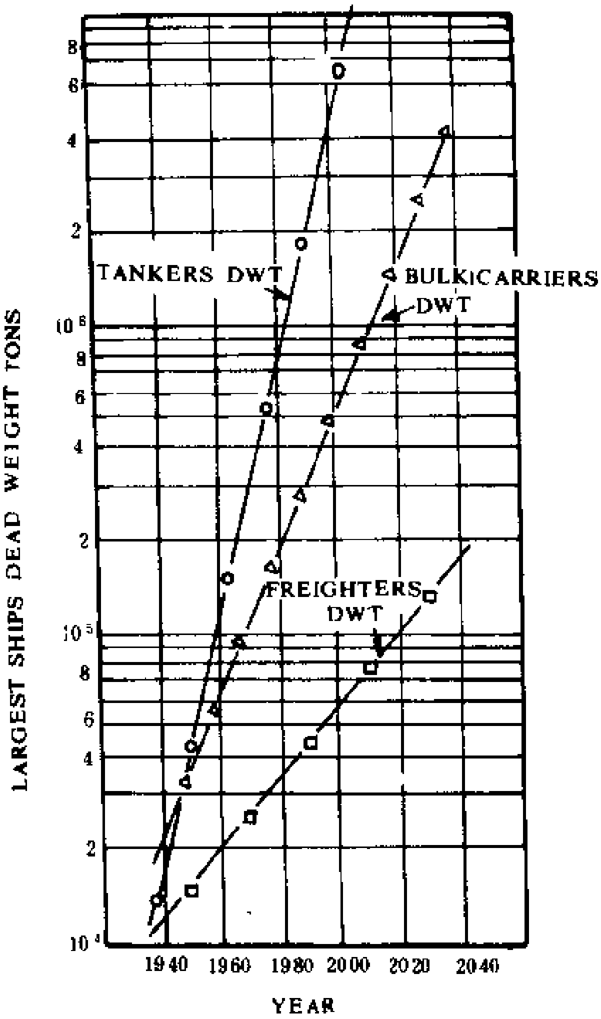


Fig. 24. 2 Projected dwt of largest tankers, bulk carriers and frieghters to the year 2040

New Words and Expressions

1. harbor entrance 港湾口门
2. turning basin 回转水域
3. dictate 支配
4. anticipate 预期
5. bear in mind 记住
6. tanker 油轮
7. dead weight(=dwt) 载重吨位,载重量
8. freighter 杂货船
9. Department of Commerce 商业部
10. Maritime Administration 海运局
11. practical limit 实际限度
12. state-of-the-art 工艺水平
13. reliable 可靠的
14. incline to 倾向于
15. for the benefit 为了,为了…的利益
16. conservative 保守的
17. extrapolation 外延,外推
18. differentation 区别
19. be exposed to 受到
20. scend (=send) 抬升、上颠
21. pitch 纵摇
22. saltwater 海水
23. load draft(=loaded draft) (船舶的)满载吃水

24. rolling 横摇
25. trim 纵倾
26. shoaling rate 变浅速率
27. maneuverability 操纵灵敏性
28. alignment 定线
29. crosscurrent 横流
30. explicitly 明显地
31. cross wind 横风
32. clearance 净空

Notes

1. bearing in mind that... 中以分词 bearing 为首的是句中的状语,其中 that 为首的从句是 bearing 的宾语。
2. should be considered 本可译为:须加考虑,鉴于上文之中有 for ideal conditions...,于是增词译为:须另加考虑。

Lesson 25 Breakwaters and Jetties

Breakwater and jetty are not entirely synonymous, and there is a difference in American and British definition of jetty. In the United States as well as in the United Kingdom, a breakwater is a structure protecting a harbor, anchorage or basin from waves, thereby preventing these from* exerting their destructive influence upon* the area enclosed for shipping reception. A jetty in the United States is a structure extending into a body of water to direct and confine the stream or tidal flow to a selected channel or to prevent shoaling. Jetties are built at the river mouth or bay entrance to help deepen and stabilize a channel and thus facilitate navigation. In the United Kingdom, jetty is synonymous with wharf and pier.

In order to avoid any confusion caused by the two terminologies, the term breakwater will be used.

Breakwaters

Basically, there are two main types of breakwaters: the vertical (or almost vertical) wall type which may be built of natural rock, masonry, wood, steel or concrete and the sloping mound type which may be built of rock, concrete or of rock/concrete/asphalt mixtures.

Most vertical walls are impermeable. Exceptions are the rock crib, which consists of a box of scattered pile sheets or boards filled with rock, and the perforated vertical wall breakwater mentioned later.

Vertical Type Breakwater

With a single breakwater, the Phoenicians built their famous open coast port at Tyre 4,000 to 5,000 years ago, using* rectangular blocks tied together with cobber dowels to a vertical wall. Similar vertical designs were common in the nineteenth and in the beginning of the twentieth century.

Many mishaps proved the big weakness in this design. Collapses were caused partly by waves breaking directly onto the structure and partly by bottom scour in front of the jetty, causing it to overturn. Four hundred meters of the breakwater at the port of Algiers failed in 1934, and 700 meters of the breakwater at Catania failed in 1933. Both breakwaters consisted of a vertical wall of superimposed blocks based on a rubble stone foundation.

Although the two breakwaters were of similar design and caliber, the failures were brought about in entirely different ways due to essential differences in construction. Both breakwaters were built of massive concrete blocks of cyclopean proportions-in the case of Catania, 12 by 4 by 3.25 meters, and in the case of Algiers, 11 by about 4 meters square. These blocks, weighing 320 and 400 tons respectively, were set as headers transversely in the breakwaters, their ends forming the inner and outer faces of the wall. However, where the blocks at Catania were simple superimposed without bedding or bonding, those at Algiers were provided with internal hollow shafts or wells which, on completion of the wall to full height*, were filled with concrete reinforced by steel bars so as to form a coherent structure from base to coping. As might be expected under such conditions, the breakwater at Catania failed by the blocks sliding over one another in successive course; the breakwater at Algiers collapsed as a whole-in intact vertical sections before fracturing and disintegrating, the rubble mound being undermined through wave action and the erosion of a deep trench in the soft sea bed of sand and mud at the foot of the wall. The failure at Catania was very similar to the failure at Genova.

In order to avoid such failures, the great force involved in a breaking wave must be absorbed-or better, be avoided-and adequate scour protection should be provided at the foot or toe. The latter calls for careful planning including hydraulic model experiments and experience.

New Words and Expressions

1. breakwater 防波堤
2. jetty 突堤
3. confine 限制
4. terminology 术语
5. asphalt 沥青
6. impermeable 不透水的
7. crib 木笼
8. pile sheet (= sheet pile, sheath pile, sheeting plank) 板桩
9. perforate 穿孔
10. cobber 伙伴
11. dowel 销钉
12. mishap 事故
13. scour 淘刷
14. overturn 倾复
15. superimpose 叠置
16. rubble 乱石,抛石
17. caliber 质量
18. massive 大而重的
19. cyclopean 蛮石,毛石
20. header 丁头石,露头石
21. bedding 垫层
22. bonding 砌合,搭接
23. shaft 竖井

24. well 井
25. coping 顶层
26. course 层
27. intact 完整的
28. fracture 破裂，裂缝
29. disintegrate 崩解
30. rubble mound 抛石基床
31. undermine 淘刷，潜淘
32. trench 沟，地壕

Notes

1. thereby preventing these from exerting their destructive influence upon the area... 句中 prevent from 和 exert upon 都是固定搭配，现在分词 preventing 为结果状语，exerting 为动名词作介词 from 的宾语。
2. using rectangular blocks tied together with..., 句中的现在分词 using 作方式状语。

Lesson 26 Wharves, Quays, and Piers

Wharves, quays and piers are marine structures which are used for the mooring or tying of vessels while they are loading or discharging cargo and/or passengers. Wharves and quays are backed by warehouse areas, marshaling and storing areas. industry areas, roads, rails, etc. -areas often created by extensive fill operations. It is characterisitic for many ports in the United States and many other places in the world where ports are built on the estuary, bay, lagoon or riverside that fill for construction of port areas and areas adjacent to the port come from dredging of port channels and basins. *

A pier is usually a rectangular wharf structure which projects out into the water. In the United Kingdom, it is often referred to as a jetty. It may also be called a mole, and, in combination with a breakwater, it is frequently termed a breakwater pier.

Because of its geometry, it can be used for berthing of vessels on three sides. A pier does not necessarily need to run perpendicular to the shoreline or wharf line but may project under any angle. It may also be connected with the shore or general wharf line by a trestle and may thus become T-or L-shaped.

Wharves, quays and piers are often in the general port language combined in one terminology-docks.

Layout of Quays and Wharves

Quays and Wharves may be placed in an infinite number of ways-no firm rules exist, but it may be done in a more or less practical way. The two main boundary conditions for a layout are the water available and its geometry (bay, river, open sea) and the land areas available (for harbor services and transport and for industry which most practically may be placed in the harbor area).

Basically two principles exist, the parallel quay system and the pier system with piers perpendicular to or at an angle with the shore. T-piers are mixture of the two systems. These principles are demonstrated in the New York and Newark Port area.

*　　*　　*　　*　　*

No general rules exist for length of basins. Quinn only mentions piers with one or two berths on either side of a pier. Fugl Meyer, on the other hand, says that "the length of a basin should not exceed 2,000 meters, elsewise transportation and navigation is impeded". The basins should not be curved as this makes berthing inconvnient. A slight concavity is less inconvenient. Convex quays for larger ships are only practical when floating fenders or other contrivances are used.

The minimum length of a quay should be sufficient for mooring the longest ship expected to arrive. At medium-sized ports with 9 meters of water depth, such a ship may be 160 meters long, and adding 20 meters at both ends for moorings, the total minimum length should be 200 meters.

With respect to basin widths, Fugl Meyer considers the following traffic situations in a basin with quays at both sides in order to arrive at some definite figures:

1. Maximum ships at both quays with two rows of lighters on the outer side of each ship and fairway twice the breadth of a large ship between the moored vessels.

2. Smaller cargo ships at both quays with one row of lighters on the outer side and a fairway four times the breadth of a smaller ship so that two ships are able to pass one another.

3. The necessity of widening the basins at river port so that a row of dolphins can be placed in the middle as moorages for ships discharging directly to the river lighters and other river craft. If such dolphins are placed in the basin, an additional width is required exceeding the width necessary for situation 1. The addition will be one ship of maximum size and a river craft on either side of it. Two fairways are necessary, and in this case they must be twice the width of the ship expected.

The following designation are used for figuring the required width of the basin in the above three situations:

$B=22$meters, width of a large ship

$b=14$meters, width of a local ship

$c=7$meters, width of a lighter

$f=10$meters, width of a river craft

Situation　1: $4\times B+4\times c=116$meters

Situation　2: $6\times B+2\times c=98$meters

Situation　3: $7\times B+6\times f=214$meters

In regard to basin depth, Fugl Meyer rightfully claims that the necessary depth of the basins in a port cannot be determined solely by the maximum draught of the arrivals. It is more practical to have sufficient depth to accommodate the largest conceivable arrival. This raises the important question of what depths are wanted versus what depths are possible.

New Words and Expressions

1. quay 实体顺岸式码头
2. mooring 系泊
3. tie 停泊
4. warehouse 仓库
5. marshal 调度
6. store 堆存
7. mole 堤道码头
8. berth 泊位
9. trestle 栈桥，高架桥
10. open sea 外海
11. convex 凸的
12. fender 护舷
13. contrivance 护舷
14. row 排
15. lighter 驳船
16. fairway 通道
17. breadth 宽度
18. dolphin 靠船墩
19. moorage 系泊处
20. designation 规定
21. rightfully 恰当地
22. claim 声称
23. solely 仅仅
24. draught 吃水深
25. conceivable 可想象的

Notes

It is characteristic for... channels and basins. 为一较长的复合句，其中 where ports... 为定语从句，修饰 United States and many other places in the world. of port areas and areas ajacent to the port 都是修饰 construction 的. come from dredging... 为过去分词作状语，说明 fill(填土)的来源。由于全句较长，故最后部分单列译出。

Lesson 27 Fenders

A fender system is supposed to assure safe berthing without damage to vessel or wall and to absorb forces which might occur while the vessel is moored at the quay wall. * Only part of the forces between vessel and wall is absorbed by the fenders. The forces in the mooring system were supposed to take care of most of the forces working parallel to the wall but they are unable to handle forces perpendicular to and against the wall.

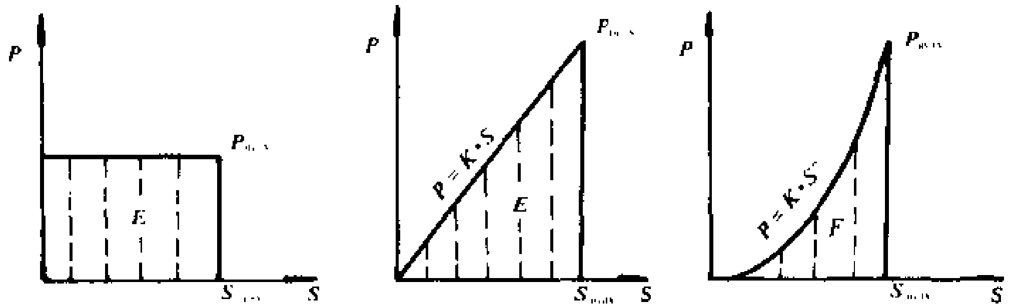
Fenders may be divided into two main groups: (a) protective fenders, which are supposed to function as an energy absorbing protective pad between the vessel and the wall available at all times, and (b) impact fenders, which are supposed to absorb impact particularly during the berthing maneuvers.

The absorption of energy by a particular fender may be compacted from its deformation diagram:

$$\text{Absorption} E = \int_0^s F(s) ds$$

When $F(s)$ = force, and s = travel distance of fender.

Figure 27. 1 shows examples of such diagams for three different system-hydrauhc, steel springs and rubber. The best system in principle is the linear spring system. The hydraulic system may be a little hard to the vessel, and the system indicated as "rubber"(not necessarily just rubber) is often too "ship-friendly" on the cost of the quay wall. However, not all rubber fenders have this characteristic.



Hydraulic Fenders Steel springs Rubber fenders

Fig. 27. 1 Deformation diagrams for fenders

The protective fenders are usually wood or rubber. The wooden fenders may be arranged with horizontal and vertical members. Exposed timber members may be provided with a relatively thin protection of hard wood which may be fastened to the main vertical members by spikes. Creosoted camels (floating timber) or hard wood had been used much earlier.

Various kinds of rubber fenders are used as protection. Hollow round or square rubber fenders can be hung on the wall(Fig. 27. 2). Solid rubber members or tubes may also be used on the front side or behind or between other members (see Fig. 27. 3). Old tires may serve the same purpose. They may be hung up directly on the wall or be put together as "Cordkapp fenders"-horizontally or vertically. The fenders mentioned above all have energy absorption diagrams like rubber fenders in Fig. 27. 1.

Damage to a quay wall usually results from impacts during the berthing maneuver. Heavy protective fenders also function as impact fenders, but typical fenders must have a stronger design.

Energy absorption of impacts may be provided by compressin, bending or shear of rubber materials, compression of steel springs, hydraulic compression system, gravity system, pneumatic systems and hydropneumatic system.

The Japanese V-shaped Seibu-fender absorbs the energy by compression and bending. It is used where very heavy bulk carriers load or discharge; Narvikore-port Norway is a typical example.

The gravity fender system works on the pendulum principle and depends on heavy chains. Limited use has been found in the Brooklyn Naval Yard and in tanker berths where it

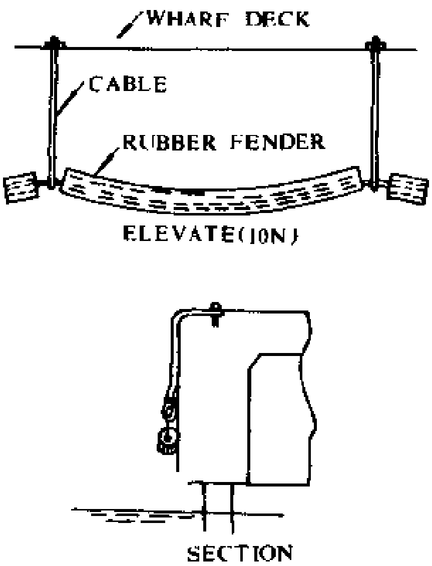


Fig. 27.2 Rubber tube for fendering

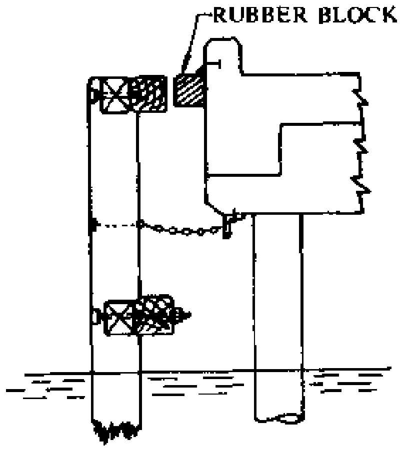


Fig. 27.3 rubber block between fender pile and wall

has proved to be a satisfactory answer to the problem of avoiding heavy jarring from glancing blows.

A new principle in fendering, which may prove to be useful particularly for breasting dolphins, * is mentioned in Reference 28. It utilizes the torque principle and is called "Cambridge fenders," because it is based on research work on plastic deformation of metals at Cambridge University, England. Each fender consists of timber pads or rotating pneumatic fender units carried between the extremities of a pair of torque arms. These torque arms are rigidy attached to a vertical torque tube which rotates in journals fixed to dockside or dolphin. The impact energy of the ship is absorbed by the torsional deflection of a bar concentrically mounted within the torque tube with one end fixed to the dock side.

New Words and Expressions

1. be supposed to 应该
2. assure 保证
3. take care of 消除，处理
4. pad 衬垫
5. berthing maneuver 靠船
6. exposed 裸露的
7. timber 原木
8. fasten 紧固
9. spike 道钉，长钉
10. creosoted 用杂酚油处理过的
11. camel 浮垫
12. pneumatic 气压的，风动的
13. pendulum 钟摆
14. jar 震动
15. glancing 掠射
16. breasting dolphin 靠船墩
17. torque 转矩
18. extremity 末端
19. journal 颈轴
20. torsional deflection 扭转偏移
21. concentrically 同心地
22. deck 甲板

Notes

1. ，A fender system. . . at the quay wall. 句中由 and 连续的 to assure 和 to absorb 两个动词不定式是 suppose 的要求。be supposed to 意为：应该。which might 引出的限制性定语从句，修饰 forces，其中又含一由 while 引出的状语从句。
2. ，which may be fastened to the main vertical members by spikes. 为限制性定语从句，修饰 wood.
3. ，which may prove to be useful particular for breasting dolphins 是个非限制定语从句。

Lesson 28 Mooring

A vessel may be subjected to the following motions as shown in Fig. 28.1 heave，yaw，pitch、sway，roll，and surge. Although all movements may occur for a vessel m oored at a quay wall，it is the surge occasionally the heave，which causes trouble. The surge motion is usually caused by the penetration of long wave in the harbor basin. A very comprehensive literature on the computation of mooring forces in avilable.

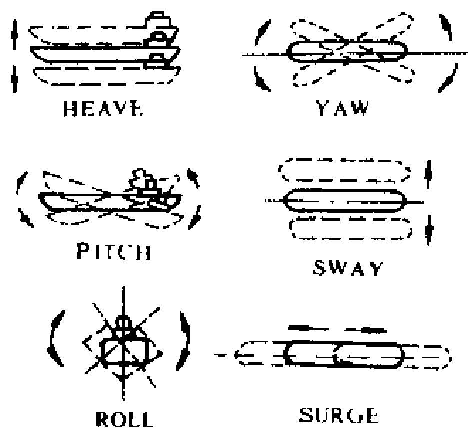


Fig. 28.1 Various movement of vessel

Mooring is provided by wires or ropes attached to pollards，bolards and rings which are usually fastened to concrete blocks or other heavy elements included in the quay wall.

Bow，stern and side lines keep the vessel at the quay. Surge (or spring) lines hinder surge motion parallel to the quay. Forces to be absorbed are exerted on the vessel by winds，currents，waves (short period for larger vessels) and occasionally by other kinds of waves like tsunamis and ship waves. In order to absorb the forces，cables should be in as horizontal a position as possible，which is difficult where the tidal range is high. Moreover，it is an advantage that mooring cables be made of the same material，arranged symmetrically，if forces are mainly of symmetrical character. *

Mooring ropes are available in many types of lay constuction，mainly of steel and natural or synthetic fiber materials. Individual wires or fibers are woven together into strands which are woven into ropes according to specific lay patterns. In "regular lay"，the wiren or fibers of the strands have a directional twist which is opposite to that of the strands themselves. The lay is "right hand" if the twist of the strands appears clockwise when looking along the rope；"left hand" if the twist is counter-clockwise.

The wires in steel ropes may have different grades of strength and may be galvanized for protection against corrosion. A steel wire rope usually consists of six strands, each containing 19, 24 or 37 individual wire filaments built around fiber (or steel) cores. Fiber ropes usually consists of three strands (plain-lay), but may be obtain in four strands(shroud-lay) or nine strands(cable-lay) construction.

Typical fiber materials are manila, sisal, coir, nylon, saran, dacron, rayon and prolene (polypropylene). Manila hemp is grown in the phillippines; sisal fiber in Mexico, East Africa and Java and coir in India. The remaining fibers are synthetic products which provide certain desirable properties not found in natural fibers.

Manufacturers' data on weights of mooring ropes in air and water, when plotted against nominal diameter, show a square power law relation weight to diameter for both steel wire and fiber mooring ropes, wet or dry. In general, the weights of mooring line per unit length, w, in water and, w_a, in air may be expressed in terms of nominal diameter, d, by

$$w = C_w d^2$$

and

$$w_a = C_a d^2$$

in which C_w and C_a the constants of prepertionality in the respective relationships.

Manufacturers' data for the breaking(ultimate) strength, T_u of steel wire and fiber mooring ropes are plotted as function of nominal rope diameters. The distribution of plotted points of like type closely parallel the series of diagonal lines which represent square-power relationships.

$$T_u = C_u d^2$$

Where C_u is the constant of proportionality.

Next to steel, nylon ropes have the greatest strength for their size and would be valuable for certain types of mooring because of low weight. Dacron, prolene and manila ropes may be of value in instances where less elasticity is required than nylon. Manila and coir ropes have been used extensively in harbor mooring; manila being a favorite. Coir ropes, with greater elasticity but less strength that manila, have been widely used for "spring" or "strops" to which steel wires are connected for cushioning the effects of surge in harbors.

With fiber ropes there is generally a difference between the ultimate strengths of the wet and dry rope. For nylon rope, wet strength is commonly rated from 5 to 19% lower than dry strength. Prolene rope has a wet strength which is about 5% greater than its dry strength. Dacron rope has effective equality between wet and dry strengths.

New Words and Expressions

1. yaw (船首)偏摇,偏航
2. sway 横荡
3. roll 横摇
4. surge 纵荡
5. rope 缆绳
6. attach 系缚

7. pollard 树桩

8. bollard 双系(缆)柱

9. ring 环

10. spring 斜缆,倒缆

11. hinder 阻止

12. moreover 此外

13. lay 绞,搓,捻

14. synthetic 合成的

15. fiber 纤维

16. weave(wove,woven) 编织

17. strand 股

18. twist 扭绞

19. galvanize 镀锌

20. filament 细丝

21. core 芯

22. plain-lay 简单绞

23. shroud 箍绞

24. cable-lay 缆绞

25. manila 马尼拉(白)麻

26. sisal 西沙尔麻

27. coir 椰棕,椰壳纤维

28. nylon 尼龙

29. saran 莎纶

30. dacron 涤纶

31. rayon 人造丝

32. prolene(=polypropylene)(商名)聚丙烯

33. hemp 大麻

34. nominal 标称(的),额定(的)

35. diagonal 对角的,斜的

36. instance 场合

37. strop 环索

38. cushioning 缓冲

Notes

Moreover, it is an advantage that..., arranged symmetrically, if forces are...是个复合句.因作主语的 that mooring cables be made of the same material 太长而改用 it is...that...的结构。句中 arranged symmetrically 为过去分词作方式状语,说明 cable 的布置方式。if forces are...是条件从句。

Lesson 29 Artificial Islands

There is a wide variety of reason why harbor authorities * and industry in various locations of the world are contemplating the creation of artificial islands for the reception of large ships and the development of related industrial activities. Although the definition of "large ships" adopted by IAPH and PIANC is generally vessels of 200,000 dwt and greater, for this report some smaller special purpose ships are also considered.

In general, realization of such islands could solve the problems arising from the ever-increasing drafts of ocean-going vessels as well as those related to coastal congestion and pollution.

As boundary conditions of such projects will vary considerably from one location to the other, * it cannot be expected that general recommendations could be conceived applicable for the complete evaluation of the technical and economic feasibility. * Nonetheless, it is obvious that a number of problems encountered * during the study of one project will run fairly parallel to those encountered * in another and that it will be useful to exchange the experience of all institutions concerned in the international forum of PIANC.

So an island terminal will generally be part of a transport system, linking an oversea source or destination with one onshore or inland. The choice of an artificial island is a shift of the normal onshore location within the complete transport system. However, a justified decision can be made only by a cost-benefit analysis of the whole transport system from origin to final destination.

Cost of deepening * and expanding * existing' ports and their seaward approaches becomes prohibitively expensive in many instances. The principal factors are:

1. Exorbitant increase of material to be dredged, or if the bottom consists of rock, its difficult removal. (Quantity or quality of bottom material to be removed).

2. Existing tunnels, locks, cables, pipelines, etc. do not permit further deepening unless they are replaced(artificial fixtures).

Coastal Processes

Shoaling, in particular, makes harbor and channel deepening an increasingly costly maintenance problem, because the greater depths tend to produce stilling basins in which sediments transported by tides and currents sink to the bottom.

Congested coastline utilization is becoming a major concern. In a recent U.S. Conference on "The Seaward Advance of Industrial Societies", statistics were presented on the increasing density of population in coastal areas, tending to stimulate the filling-in of estuaries and the creation of "made" land.

1. "Highest and best use" of land thus become a criterion for coastal zoning both onshore and offshore.

2. Lack of dredge disposal sites makes dredging of rivers and channels even less attractive. as land sites become scarce and environmental concerns over tidelands preclude the filling in of marsh areas.

3. Environmental damage of big ship terminals, caused by their construction, as well as by dredging, makes their presence close to population centers increasingly objectionable. This leads in many cases of expanding port needs to lack of feasible sites.

In addition, the operation of such terminals produces an unwelcome increase in supporting activity, and greater risk of severe damage from collisions or from any single accident that is unacceptable to the residents of some areas.

Pollution

Noise, spills, visual objections, and the strong desire on the part of many people to preserve the "status quo" of waterfronts with respect to industrial use, has focused attention on removing these operations to offshore islands. Or, in some cases, it has produced a desire to move polluting industries offshore where "pollution tolerance" may be greater, in order to make room for other industries on shore. For example, noise and unsightly effects will not be heard or seen by residential users of land if they are offshore far enough. Also other emanations from industry may be so diluted in the open, uninhabited ports of the Continental

Shelf as to have no measurable detriment to its ecology.

Expandability of artificial islands is one of their great attraction. Placed far enough from existing developed land, the expansion is not limited and indeed can be aided by the very debris and soild waste that are choking our big cities.

New Words and Expressions

1. contemplate 注视
2. ocean-going vessel 远洋轮
3. congestion 拥塞
4. conceive 想象
5. nonetheless＝nevertheless 然而
6. forum 论坛
7. terminal 集散站
8. oversea 海外
9. justify 证明…是正当的
10. prohibitive 禁止性的
11. exorbitant 过度的
12. fixture 装置
13. stilling basin 静水池
14. congest 拥挤
15. zoning 划区，分区
16. tideland 潮间地
17. preclude 预防，排除
18. presence 存在
19. objectionable 引起反对的
20. expand 扩大
21. collision 碰撞
22. resident 居民
23. spill 溢出物
24. objection 反对，缺点
25. status quo 〔拉〕现状
26. waterfront 滨水区
27. tolerance 容限
28. unsightly 不雅观的
29. emanation 散发物
30. dilute 稀释
31. uninhabited 无人居住的
32. detriment 损害，对…不利的
33. ecology 生态学
34. debris 瓦砾
35. choke 塞满

Notes

1. ,There is a wide variety of reason why harbor... 以关系副词 why 引起的定语从句，修饰 reason.
2. , As boundary conditions... will vary... other, 是个原因从句，that general recommendations could be conceived... feasibility 是主语从句，紧随其后的 it 是先行词（或称为形式主语）。
3. ,Cost of deepening and expanding existing ports... 这里连续出现三个词 deepening, expanding, existing, 前二个为动名词，作定语修饰 cost，第三个 existing 为现在分词作定语，修饰 ports。

Lesson 30 Container Ships

This most popular of unitized vessels has grown from simple port container ships to large super container liners of 53,000 dwt and 2,800 container capacity. Ships of up to 31~32 knot speed are available now. The rapid expansion of container shipping has resulted in the creation of shipping and terminal over-capacity on dense trade routes(Atlantic and Pacific). Secondary trade routes are now converting to containerization with many first and second generation ships diverted to these routes after being displaced * from the highly competitive dense trade routes.

Future container ships will continue to increase in size though not in speed. We expect future transoceanic container ships to have capacities of 3,000~4,000 container equivalents and speeds of 25~26 knots. The major change will be in the hull form with multi-hulled (catamaran, trimaran) ships increasingly popular. Such vessels will probably not handle individual containers but transfer containers in container block of 8~64 containers by strong-back gantry lift or horizontal warehouse ship type conveyor transfer.

Trailer ships are the most volume and stability limited vessels of all commercial cargo ships. Because they cover a narrow range of size, the use of constant ratios is reasonable for this ship type. Ro/Ros have a low L/D(length to depth ratio) because they need large hull depth due to the addition of the hull carriage.

Other than slightly greater depth and beam, a Ro/Ro has similar dimensions to a container ship of comparable deadweight.

As opposed to container ships, break-bulk ships are slower and therefore have lower L/B(length to beam) ratios. Because they are generally smaller and have less stability problems, they have smaller B/D ratio. Because their hatches are smaller, they need less depth than container ships because' tween deckers are packed tighter than container ships. They are slightly fuller hulled (higher block) than container ships and because they are less volume limited than container ships, their deadweight as a percent of displacement increases with displacement because steel, fuel and machinery weights do not rise linearly with displacement.

Tankers tend to vary considerably in their particulars, but do not vary that much from ore or grain carriers and are quite similar except for having higher L/B and L/D ratios. The higher L/D is possible because of the high cargo density and lack of hatches.

Because tankers are used as grain carriers, and combination ore/oil carriers exist, this similarity is not surprising.

Ore and mineral carriers are much slower than container ships therefore have lower length to beam ratios, and higher block coefficients. Because they are operating at speeds where skin friction is a more important component of hull drag, and since large ships generally do not service shallower ports, the beam/draft ratio is smaller in order to reduce the ratio of deadweight to wetted area. The L/D is smaller than container ships because they are weight limited, and their lack of large hatches allows this because the continuous deck ensures hull strength without large hull depth. Deadweight to displacement ratio increases with displacement because steel, machinery and fuel weight does not increase in proportion to displacement.

Grain carriers tend to be a bit longer than the same capacity mineral bulk carrier, with higher L/B and B/D ratios, approaching those of break-bulk ships. They have greater depth for the same deadweight compared to mineral carriers, but have the same L/D ratios. Their block coefficients are slightly lower because of their slightly higher speeds. The deadweight is not as high a percentage of displacement as mineral carrirers because of the higher steel (depth) weight, more machinery, and fuel weight required for higher speeds.

New Words and Expressions

1. unitized 单元化
2. liner 班船
3. knot 节(=海里/小时)
4. dense 密集
5. containerization 集装箱化
6. transoceanic 横渡大洋的
7. hull 船体
8. multi-hulled 多体的
9. catamaran 双体船
10. trimaran 三体船
11. strongback 强基底
12. conveyor 输送设备
13. trailer ship 滚动式拖运架装卸货船 即 roll on/roll off(ro/ro)滚装船
14. volume-limited 体积限制
15. hull carriage 拖运架
16. break-bulk ship 散货船
17. comparable 类似的
18. hatch 舱盖
19. decker 甲板层
20. displacement 排水量
21. fuel 燃料
22. particular 个别详情
23. ore 矿砂
24. block coefficient 填实系数
25. wetted area 吃水[线]面积

Notes

,after being displaced... 其中 being displaced 是动名词的被动语态,作介词宾语。

Section IV Management and Supervision

Lesson 31 Construction's Future

The most profound recent developments in construction are the increasing size of many of its projects and organizations, the increasing technological complexity of such projects, more complex interdependencies and variations in the relationships among its organizations and institutions, and proliferating regulations and demands from government. At the project level, management has just begun to integrate design, procurement, and construction into one total process. There are now, and will continue to be, shortages of resources, including materials, equipment, skilled workers, and technical and supervisory staff. There will be more and more governmental regulation of the safety of design and of field construction methods, environmental consequences of projects, and personnal policies at all levels. Management must also cope with new ecomomic and cultural realities resulting from inflation, energy shortages, changing world development patterns, and new societal standards. These trends have been accelerating and will probably continue into the future.

Clearly, economic difficulties and increasing shortages of materials and other resources play a major role in the problems now facing today's projects. But this is not to say that engineers and managers must sit hopelessly by while urgently needed projects run out of control or are abandoned altogether. On the contrary, it is all the more critical that the skills of project engineers and managers improve, and that they have better tools with which to work, so they can optimize the planning and control of available resources and better cope with challenging realities imposed by new economic constraints. In spite of continuing economic problems, there is an ongoing need for the construction industry to expand and improve its capabilities and its scope of operations to meet changing and, in the long run, growing demands for its services.

The potential benefits from imporoved methods of accomplishing the management of future projects are worth seeking. For example, knowledgeable sources have estimated that the costs of delay one major two-unit nuclear power plant exceed $ 200,000 per day. Consider this in view of current 10-to 11-year design and construction times for such porjects, and multiply it by the 50-plus power plants in the active concept, design, or construction phases at any one time. The potential savings thus derived are for just one segment of the industry. Similar conclusions may be drawn when looking at urban rapid transit systems, refinery and chemical plants, pipelines, mineral resource developments, and the design and construction of projects to implement the advanced technologies that will be required even to maintain, let alone improve, our standard of living.

Time, money, equipment, technology, people, materials. These are resources. Organize them into activities, perform the activities in a logical sequence, and one has a project. Whether it is to construct a cottage at the beach or to design and construct a billion-dollar rapid transit system, the pattern is the same. Practice has been to assign total responsibility for all these factors to one person: a project manager. Over the years, this has proven to be a good approach. Intelligent, competent, experienced project managers have succeeded in "putting it all together". Can they continue? Why the past decade's failures? Now, more than ever, planning and control of the resources required to successfully accomplish today's increasingly complex projects remain among the most difficult and perplexing management responsibilities. Success will require the fullest understanding of all facets of the construction industry.

New Words and Expressions

1. profound 意义深远的
2. complexity 复杂性
3. interdependency 相互依存
4. proliferte 激增
5. procurement 采购，采办，物资供应
6. supervisory 监督的
7. consequence 后果
8. personnel 人事
9. cope with 对付，应付
10. inflation 通货膨胀
11. sit by 坐视无睹
12. run out of control 失去控制
13. abandon 放弃
14. optimize 乐观地考虑
15. challenge 挑战，要求
16. impose 强加
17. contraint 约束，压制，压力
18. construction industry 建筑业
19. in the long run 归根到底，终究，从长远的观点来看
20. knowledgeable 有知识的
21. sources 提供消息人士
22. two-unit 双机组
23. implement 贯彻，完成
24. let alone 更不必说，姑且不提
25. sequence 顺序
26. competent 有能力的，胜任的
27. perplexing 复杂的
28. facet 方面，面

Lesson 32 The General Agreement on Tariffs and Trade

GATT-the General Agreement on Tariffs and Trade-is a multilateral treaty, subscribed to by 88 governments which together account for more than four-fifths of world trade. Its basic aim is to liberalize world trade, and place it on a secure basis, thereby contributing to economic growth and development and to the welfare of the world's peoples. The General Agreement is the only multilateral instrument that lays down agreed rules for international trade.

For the past 35 years, GATT has also functioned as the principal international body concerned with negotiating the reduction of trade barriers and with international trade relation. GATT is thus both a code of rules and a forum in which countries can discuss and overcome their trade problems and negotiate to enlarge world trading opportunities. The eightfold growth in the volume of international trade since the Second World War has provided continuing evidence of GATT's success in this double role.

GATT entered into force in January 1948. Since that time, its membership has risen from its original 23 countries to the present figures of 88, while a further 31 countries also apply its rules in their trade.

GATT's rules govern the trade of its member countries and the conduct of their relation with one another. The contractual rights and obligations which it embodies have been accepted, voluntarily, in their mutual interest, by the member countries. Overseeing the application of these rules is an important and continuing part of GATT's activities. GATT is also a place where countries negotiate and work together for the reduction of trade barriers, in pursuit of its constant and fundamental aim of the further liberalization of world trade. In successive multilateral negotiations in GATT, obstacles to trade have been progressivly reduced.

Throughout the past two decades, GATT has been increasingly preoccupied with the trading problems and needs of the developing countries, which account for more that two-thirds of its membership. Developing country GATT members have for many years been able to apply certain of its rules with considerable flexibility. In 1965, additional provisions were added to the General Agreement specifically dealing with trade and development. Promotion of the trade interests of developing countries was an important element in the Tokyo Round of trade negotiations.

New Words and Expressions

1. tariff 关税
2. multilateral 多边的
3. treaty 条约
4. subscribe to (在文件上)签名
5. liberalize 使…自由化
6. secure 牢固的
7. instrument 文件,契约(工具,仪器,器械)
8. lay down 制订
9. function 发挥作用
10. trade barrier 贸易壁垒
11. code 准则,守则
12. eightfold growth 增长七倍
13. enter into force 生效
14. apply its rules 采用它的规定
15. contractual 契约的
16. obligation 义务
17. embody 包括,体现
18. voluntarily 自愿地

19. mutual 共同的
20. oversee 监督
21. in pursuit of 寻求,追求
22. preoccupy 关注
23. flexibility 灵活性
24. additional provision 补充条款
25. Tokyo Round 东京回合,东京会谈

Lesson 33 Condition of Civil Engineering Construction (FIDIC)

Part 1-General Conditions

Definitions and Interpretation

1.1 In the Contract (as hereinafter defined) the following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires:

(a)(Ⅰ) "Employer" means the person named as such in Part Ⅱ of these Conditions and the legal successors in title to such person, but not (except with the consent of the Contractor) a ny assignee of such person.

(Ⅱ) "Contractor" means the person whose tender has been accepted by the Employer and the legal successors in title to such person, but not (except with the consent of the Employer) any assignee of such person.

(Ⅲ) "Subcontractor" means any person named in the Contract as a Subcontractor for a part of the Works or any person to whom a part of the Works has been subcontracted with the consent of the Engineer and the legal successors in title to such person, but not any assignee of any such person.

(Ⅳ) "Engineer" means the person appointed by the Employer to act as Engineer for the purposes of the Contract and named as such in Part Ⅱ of these Conditions.

(Ⅴ) "Engineer's Representative" means a person appointed from time to time by the Engineer under Sub-Clause 2.2.

(b) (Ⅰ) "Contract" means these Conditions (Part Ⅰ and Ⅱ), the Specification, the Drawings, the Bill of Quantities, the Tender, the Letter of Acceptance, the Contract Agreement (if completed) and such further documents as may be expressly incorporated in the Letter of Acceptance or Contract Agreement (if completed).

(Ⅱ) "Specification" means the specification of the Works included in the Contract and any modification thereof or addition thereto made under Clause 51 or submitted by the Contractor and approved by the Engineer.

(Ⅲ) "Drawings" means all drawings, calculations and technical information of a like nature provided by the Engineer to the Contractor under the Contract and all drawings, calculations, samples, patterns, models, operation and maintenance manuals and other technical information of a like nature submitted by the Contractor and approved by the Engineer.

(Ⅳ) "Bill of Quantities" means the priced and completed bill of quantities forming part of the Tender.

(Ⅴ) "Tender" means the Contractor's priced offer to the Employer for the execution and completion of the Works and the remedying of any defects therein accordance with the provisions of the Contract, as accepted by the Letter of Acceptance.

(Ⅵ) "Letter of Acceptance" means the formal acceptance by the Employer of the Tender.

(Ⅶ) "Contract Agreement" means the contract agreement(if any) referred to in Sub-Claues. 9. 1.

(Ⅷ) "Appendix to Tender" means the appendix comprised in the form of Tender annexed to these Conditions.

(c) (Ⅰ) "Commencement Date" means the date upon which the Contractor receives the notice to commence issued by the Engineer pursuant to Clause 41.

(Ⅱ) "Time for Completion" means the time for completing the execution of and passing the Tests on Completion of the Works or any Section or part thereof as stated in the Contract (or as extended under Clause 44) calculated from the Commencement Date.

(d) (Ⅰ) "Tests on Completion" means the tests specified in the Contract or otherwise agreed by the Engineer and the Contractor which are to be made by the Contractor before the Works or any Section or part thereof are taken over by the Employer.

(Ⅱ) "Taking-Over Certificate" means a certificate issued pursuant to Clause 48.

(e) (Ⅰ) "Contract price" means the sum stated in the Letter of Acceptance as payable to the Contractor for the execution and completion of the Works and the remedying of any defects therein in accordance with the provisions of the Contract.

(Ⅱ) "Retention Money" means the aggregate of all monies retained by the Employer pursuant to Sub-Clause 60. 2(a).

(f) (Ⅰ) "Works" means the Permanent Works and the Temporary Works or either of them as appropriate.

(Ⅱ) "Permanent Works" means the permanent works to be executed (including Plant) in accordance with the Contract.

(Ⅲ) "Temporary Works" means all temporary works of every kind (other than Contractor's Equipment) required in or about the execution and completion of the Works and the remedying of any defects therein.

(Ⅳ) "Plant" means machinery, apparatus and the like intended to form or forming part of the permanent Works.

(Ⅴ) "Contractor's Equipment" means all appliances and things of whatsoever nature (other than Temporary Works) required for the execution and completion of the Works and the remedying of any defects therein, but does not include Plant, materials or other things intended to form or forming part of the Permanent Works.

(Ⅵ) "Section" means a part of the Works specifically identified in the Contract as a

Section.

(Ⅵ) "Site" means the places provided by the Employer where the Works are to be executed and any other places as may be specifically designated in the Contract as forming part of the site.

(g) (Ⅰ) "Cost" means all expenditure properly incurred or to be incurred, whether on or off the Site, including overhead and other charges properly allocable thereto but does not include any allowance for profit.

(Ⅱ) "day" means calendar day.

(Ⅲ) "foreign currency" means a currency of a country other than that in which the Works are to be located.

(Ⅳ) "Writing" means any hand-written, type-written, or printed communication, including telex, cable and facsimile transmission.

New Words and Expressions

1. general condition 通用条件
2. employer 雇主
3. legal successor 合法继承人
4. consent 同意
5. contractor 承包人,承包工,承包商
6. assignee 受让人,受托人
7. specification (技术)规范
8. drawings 图纸
9. bill of quantities 工程量清单
10. tender 投标,标书
11. letter of acceptance 授标通知书
12. contract agreement 合同协议书
13. incorporate 结合
14. approve 批准
15. execution 实施
16. remedy 补救
17. defect 缺陷
18. comprise 包含
19. commencement date 开工日
20. pursuant to 按照
21. time for completion 竣工时间
22. taking-over certificate 接收证书,验收证书
23. retention money 保留款
24. aggregate 总款
25. as appropriate 视情况而定
26. execute 实施
27. appliance 用具,器具
28. expenditure 费用,花费
29. incur 遭受
30. overhead charge 通常开支,间接费用
31. allocable 可分摊的,可分派的

Notes

1. FIDIC 是法文 Fédération Internationale Des Ingénieurs-Conseils(国际咨询工程师联合会)的缩写,由该会制订的土木工程合同条款简称菲迪克条款。本课文仅摘录其一小部分,作为示范。
2. FIDIC 条款共分二个部分,第一部分是通用条件(General Conditions)第二部分是特定

条件(Specific Conditions)。这两个部分共同构成决定“雇主”,“承包人”和“工程师”三者的权力和义务的条件。

Lesson 34 Tender and Agreement

TENDER

NAME OF CONTRACT:* ______________________________

______________ TO:* ______________________________

____

Gentlemen,

1. Having examined the Conditions of Contract. Specification, Drawings, and Bill of Quantities and Addenda Nos ________ for the execution of above-named Works, we the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract, Specification, Drawings, Bill of Quantities and Addenda for the sum of ______________________________

____

(______________________________)

or such other sums as may be ascertained in accordance with said Conditions.

2. We acknowledge that the Appendix forms part of our Tender.

3. We undertake, if our Tender is accepted, to commence the works as soon as is reasonabiy possible after the receipt of the Engineer's notice to commence, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Tender.

4. We agree to abide by this Tender for the period of* _____ days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

5. Unless and until a formal Agreement is prepared and executed this Tender, together with your written acceptance thereof, shall constitute a binding contract between us.

6. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this ______________ day of ____________ 19 ______________

Signature ______________ in the capacity of ______________________

duly authorised to sign tenders for and on behalf of ______________________

(IN BLOCK CAPITALS)

____

Address ____

Witness ____

Occupation ____

(Note: All details marked* shall be inserted before issue of Tender documents.)

Agreement

This Agreement made the ___ ________ day of __________ 19 ________________

Between ____

____ of ____

__________(hereinafter called the Employer)of the one part and ________________

____ of ___________________________

____ (hereinafter called the "Contractor") of the other part.

Whereas the Employer is desirous that certain Works should be executed by the contractor, viz ____

and has accepted a Tender by Contractor for the execution and completion of such Works and the remedying of any defects therein.

Now this agreement witnesses as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz:

(a) The Letter of Acceptance;

(b) The said Tender;

(c) The Conditions of Contract(Parts I and II);

(d) The Spcification;

(e) The Drawings; and

(f) The Bill of Quantities.

3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein the Contract Price or such other sums as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

In witness whereof the parties hereto have caused this Agreement to be executed the day and year first before written in accordance with their respective laws.

The Common Seal of ____

was hereunto affixed in the presence of: ____________________________________

____ or

Signed Sealed and Delivered by the ____________________________________

said ____

in the presence of: ____

Binding Signature of Employer ______________________________________

Binding Signature of Contractor ____________________________________

New Words and Expressions

1. addendum(复 addenda) 附录,补遗
2. Nos numbers 的缩写形式
3. undersign 在文件末尾签名
4. in conformity with 依照
5. ascertain 查明
6. abide by 遵守
7. bind 具有约束力
8. expiration 满期,截止
9. in the capacity of 以…的资格
10. authorise 委托,授权
11. witness 证人,见证人,证据,成为证据
12. insert 插人,填空,填写
13. in witness 作为证据,作为证人
14. deem 认为
15. construe 解释
16. covenant 缔约
17. prescribe 规定
18. seal 盖章
19. affix 签署

Translation for Reference

参考译文

第一课　土木工程中的各种业务

工程是一种专业，就是说工程师必须受过专门的大学教育。许多政府行政区有颁发执照的规定，要求工科大学毕业生在开展他们的事业前要通过一次考试，就象律师须通过律师考试一样。

在大学工科的整个课程设置中，尤其在头两、三年内，十分重视数学、物理和化学。数学在各工程分科中都非常重要，所以一直被特别强调。现在，数学里包括统计学中的各课程，它们涉及数据和资料的搜集、分类和使用。统计数学中的一个重要部分是概率论，当存在着能影响一个问题结果的多种因素或变量时，它将论及将发生的情况。例如，在建造一座桥梁之前，须对它可能要承受的交通量进行一次统计研究。

因为解决许多问题需要进行大量的计算，所以目前计算机程序编制，已列入几乎所有的工程课程之中。诚然，计算机能比人更快、更精确地解决许多需要计算的问题。但是，除非是给它们以清楚和确切的指令和信息——换言之，给以适当的程序，计算机是无用的。

最后两年的工科教学计划包括学生所学专业范围内的课程。对准备成为土木工程师的大学生来说，这些专业课可涉及到如大地测量、土力学或水力学等科目。

土木工程师可以从事科研、设计、施工管理、维修，以至销售或经营管理。这些领域中的每种工作，都有不同的职责、不同的重点，以及工程知识和经验方面不同的用途。

科学研究是科学和工程实践中最重要的方面之一。科研人员往往与其他科学家和工程师一起作为一个集体的成员来参加工作。他(她)往往在一个由政府或工业企业资助的实验室里工作。与土木工程有关的科研领域包括土力学、土壤稳定技术以及新建筑材料的研制和试验。

即使在设计开始以前，也要对每项工程进行仔细的研究。研究工作包括对预定施工现场的地形特征和基土特征进行勘查，还包括要考虑各种比较方案，例如，究竟选用混凝土重力坝还是填土坝。对每种可能方案的经济因素也须权衡。目前，一项研究工作通常还包括要考虑这个工程项目对环境的影响。进行这些可行性研究时要由许多工程师来完成。他们往往是组成一个组一起工作，其中有测量人员、土力学和设计、施工方面的专家。

几乎对所有的工程项目来说，施工都是一个复杂的过程。它涉及到安排进度、使用设备和材料，使成本尽可能地低。因为施工会是很危险的，所以必须考虑安全因素。因此，有许多土木工程师专门从事于施工。

在建筑物竣工后，还必须防止它损毁于失修；所以许多工程师专长于维修。这通常是那些最终将对这些已成建筑物负责的私营公用事业公司或政府机构的职责。象加里福尼亚州供水工程这样一个大型系统，显然需要一支在合格的工程师们领导下的庞大的维修队伍。

土木工程师的很多工作是在户外进行的，经常是在崎岖或困难地带或是在危险的条件下进行工作。另外，还要在不同的天气条件下工作。一个未来的土木工程师应该意识到要对他(她)提出的体力要求。

第二课　水文循环

“水文学探讨的是地球上水的存在、循环和分布，水的化学性质和物理性质，以及水对（包括与生物之间的关系在内的）环境的反作用。水文学的研究范围包括地球上水的全部生命史”，工程水文学则包括那些为控制和利用水的水利工程的规划、设计和运营有关的水文部分。水文学与其它地球科学，诸如气象学、海洋学和地质学之间的分界是不明确的，也无必要严格地去定义它们。同样地，工程水文学与应用水文学的其它分支之间的界线也是模糊的。说实在的，工程师们应把他们现有的水文知识归功于农业学家、森林学家、气象学家、地质学家以及各种领域中的科学家们。

虽然是纯学术观点，水文循环概念仍然是研究水文学的一个有用的出发点。设想这个循环是从海水蒸发开始。产生的水汽由运动着的气团所输送。在适当的条件下，水汽冷凝为云，从而会导致降水。落到地面上的降水，可由多条途径分散。大部分降水暂时保留在其降落地点附近的土壤内，最终因蒸发和植物散发重又回到大气之中。一部分水在地面上或通过表土流入江河，面另一部分水则更深地渗入地下成为地下水的部分。在重力影响下，地面水和地下水向低处流，并会最终注入海洋。然而，大量的地面水和地下水在到达海洋之前，通过蒸发和散发又返回大气中。

从水文循环的讨论中，千万不要得出这是个连续的过程、而水以不变的速率恒定地运动着的印象。不论在时间上还是在空间上，水通过循环的运动都是不稳定的。有时，大自然下起了骤雨，使河槽承受重担，而别的时候，这个循环机制似乎是完全停止，随之降水和径流也好象都停止了。在邻近地区上，循环中的变化可以完全两样，正是这些洪涝和干旱的极值成为工程水文学家最感兴趣的问题，因为设计兴建水利工程的目的就是来防御这些极值所造成的恶果的。造成这些气候极值的原因可以从气象学中寻得，水文学家对这些原因，至少应有概略的了解。

水文学家对水文循环不仅应有定性的理解，还要测定通过循环的水的数量。他们必须要能对各个影响因素之间的相互关系作出定量的说明，以便能预测人类活动对这些关系的影响。他们还必须关心循环中可能发生的极值出现的频率，因为这是经济分析的基础，是一切水利工程的重要决定因素。

第三课　大　峡　谷

美国西南部的峡谷是地球上一些深而古老的通道。它们看上去好象是因地裂面形成的。然而，峡谷不是裂开的，而是被河流切割开的。河水夹带着泥土和小石块，缓慢地吞噬了周围的岩石。几百万年过去了，河水翻滚着奔腾向前，把大地切割得越来越深，在流经的地方留下了延伸几百公里的巨大岩石裂口。

峡谷的形态和高山几乎正好相反，上宽下窄，好象是把一座山倒过来，推进地里后再挪开，只留下了形状。在所有的峡谷中，美国亚利桑那州的大峡谷是最大、最美丽的峡谷之一，长达450公里。

当你来到大峡谷，陡峭的岩壁在你脚下一落千丈，有的地方深达1公里以上。峡谷的最下面是一条深色、盘绕似带的科罗拉多河。

峡谷的另一边，阳光把裸露的岩壁映照成红色、橙色和金色。峡谷壁上这些鲜艳的颜色来

自岩石中的矿物质，它们在不同的光线、季节和天气条件下变化无穷。日落时，当太阳从天空中划过，峡谷岩壁就不再是红色和金色，而呈现出较素净的蓝色、紫色和绿色。

几百根石笋从峡谷底部崛起，有的非常高，但都高不过在峡谷边缘俯瞰景色的人。

观赏大峡谷就象在回顾历史。科罗拉多河在四千万年前开始切割流经这一地区，与此同时，周围的土地在地球内部力量推动下而隆起。雨、雪、冰、风和植物的生长磨掉了刚刚形成的峡谷的顶端；峡谷下面奔流的河水不断剥离着古老的岩层。在这里，你可以看到一层又一层的花岗岩、片岩、灰岩和砂岩。

大峡谷有多种不同的天气环境，顶端与底部常常截然两样。例如在冬季的某些日子里，你可能在峡谷顶部遇到寒风和大雪，但是在底部，你会发现暖风和鲜花。

印第安人没有留下任何关于大峡谷的记录，我们今天所知道的情况大部分是由约翰·韦斯利·鲍威尔记录下来的。1869 年，他作为第一位探险的美国白人考察了峡谷的大部分地区。鲍威尔和他的探险队分乘四只船航行，他们对如何渡过汹涌澎湃的科罗拉多河毫无把握。在许多水流湍急的河段，和房屋一般高的浪能把船打翻。鲍威尔和他的队员在河上度过了三个多月。出发不久，一部分食品和行装丢了。在一个非常危险的急流处，三名队员离队了，他们往峡谷上方走去并出了峡谷，那时，他们遇到了印第安人而被杀害了。鲍威尔探险队的其他人幸免于难，他们忍着饥饿和疲劳，终于到达了峡谷的尽头。

鲍威尔这次探险的报告和地图使他出了名，并引起了人们对大峡谷的浓厚兴趣。然而，直到 1901 年铁路修至这一地区以前，前往参观的人并不很多。

今天，大峡谷已被称为世界七大自然奇观之一，1989 年，有将近四百万人参观了大峡谷，许多人来自别的国家。多数旅游者沿着陡峻的小路往下走，走到谷底要花数个小时。而从谷底爬回谷顶则需要两倍的时间，有些人就骑骡往返。

每年约有三万人乘飞机观看大峡谷。他们花钱乘直升飞机让飞机在峡谷上方盘旋观赏。每年还有约一万七千人从科罗拉多河上观赏大峡谷，他们乘坐橡皮筏或其他船只在激流翻滚的河上航行一至三星期。

美国国家公园管理局负责保护大峡谷以免遭众多旅游者带来的不利后果。所有的垃圾必须运出峡谷，所有的岩石、历史文物、植物都不得损坏，野生动物不许伤害。正象国家公园管理局告诫人们的那样："只许带走照片，只能留下脚印"。

许多作家试图描写大峡谷的奇观，然而他们认识到，要找到恰当的语汇去形容这样的地方是不可能的。作家兼科学家拉里·史蒂文斯说：大峡谷近乎降服一切的寂静和深沉震憾着人们，至少短期地使人们不再妄自尊大。他说：大峡谷使我们记住自己在自然界的位置。

第四课　河　　流

河流是一种天然的大淡水流，它常年地或非常年地在固定的渠槽中流过陆地。河流自然地理特征的变化范围很大，从峡谷中咆哮而出的山洪到宽阔宁静的流水。毫无疑问，河流是人类文明发展中的一个组成部分。

河流历来是运输通道，既在水面上又沿着两岸。河流是水和能量的供应者，也是人类和自然废料的携带者。洪水的淤积造成了肥沃的平原。这些土地常借助于滞留的洪水进行灌溉，而为世人提供大量的食粮。因此，尽管屡次发生灾难性的洪水，但河谷历来是文明的发源地和探险的路线。

供水也许是河流最重要的经济作用。作为可更新资源，水是除了空气以外，人们所使用的最廉价和最基本的商品。如通常费用不是主要考虑的因素，水常常被漫不经心地使用。例如，美国俄亥俄州克利夫兰的凯霍加河，因倾入了大量的碳氢化合物废料而真着过火。这种看得见的污染，还比不上另外的工业废水，在当下游的净水处理厂加氯处理以后会变得更毒那样可怕。

一些发达国家在生活污水和工业废水排入河道以前，就力求使其净化，以便水到下游可再利用。耕作和采矿的方法正在更改，使之产生较少的沉积和污染物。其结果使得许多河流已变为自1930年以来最清洁的状况。

在埃及、巴基斯坦、中国、印度、墨西哥和美国西南部等处的滩地、阶地和江河的冲积扇上，肥沃的灌溉农田供养了世界上大部分的人口。作为河流使土壤肥沃有重大价值的一个明证是：现在埃及对化肥的需求量愈来愈大。就因为尼罗河不再泛滥而施肥于埃及的土地了。一个民族要随着河流的情况来调整自己的生活的极端例子也许要算孟加拉国，每年在恒河-布拉马普特拉河的洪水期间，数以万计的人上船生活。当洪水消退时，新生沙洲变成了岛，新土地种上了庄稼。据说，洪水尚未退完以前，沙洲顶上的庄稼已一片碧绿了。

第五课　流体的特性

1. 密度、重度和相对密度

流体的密度 ρ 是单位体积内流体的质量。在国际单位制(SI制)中，密度的单位是 kg/m^3，也可表示为 $N\cdot s^2/m^4$。

重度 γ 表示单位体积内流体受到的重力，因而具有单位体积中力的单位，例如：N/m^3。

流体的密度与重度之间的关系如下：

$$\rho=\frac{\gamma}{g}\text{ 或 }\gamma=\rho g$$

因为一切物理方程在量纲上都是一致的，密度的单位是：

$$\frac{\text{重度的单位}}{\text{重力加速度的单位}}=\frac{N/m^3}{m/s^2}=\frac{N\cdot s^2}{m^4}=\frac{\text{质量的单位}}{\text{体积的单位}}=\frac{kg}{m^3}$$

必须指出：因为密度与质量有关而质量与地点无关，所以密度 ρ 是绝对的。另外，重度与重力加速度 g 有关而 g 随地点(主要是纬度和平均海平面以上的高程)而变，所以重度 γ 不是绝对的。

相对密度 s 是液体密度与标准温度时纯水密度的比值。在米制中，4℃时水的密度是 $1.0g/cm^3$，相当于 $1000kg/m^3$，因而，在米制中，液体相对密度(系无量纲数)的值与以 g/cm^3 或 Mg/m^3 表示的密度的值相同。

2. 粘滞性

流体的粘滞性是它抵抗剪切和角变形的一种量度。运动流体中的摩擦力是分子间的内聚力和动量交换引起的。随着温度的增加，所有液体的粘滞性都是减小的，而一切气体的粘滞性都是增加的。这是因为随着温度增加而减小的内聚力在液体中居支配地位；而对于气体起主导作用的因素是不同速度的各流层之间的分子交换。于是，快速运动的分子移入运动较慢的流层，将使后者加速。慢速运动的分子移入运动较快的流层，将使其变慢。这种分子交换产生剪切，或者说在相邻流层之间产生了摩擦力。在较高温度情况下，增强了的分子活动度，使气体的

粘滞性随着温度增高而增大。

设有充分大的两块平行板(图 5.1),因平板大,边界条件可不考虑。两板间有一小间距 Y,其间充满流体。设下板固定不动,上板以速度 U 平行于下板运动,速度 U 系为 F 作用于面积为 A 的运动平板所产生的。

接触于各平板的流体质点将粘附在平板上,如果间距 Y 不是太大或速度 U 不是太高,速度分布将呈一直线,而且速度梯度为一常数,即

$$F \sim \frac{AU}{Y}$$

从图 5.1 的相似三角形可见,U/Y 能以速度梯度 du/dy 替代。现引用一比例常数 μ,两薄层流体间的剪应力可表达为

$$\tau = \frac{F}{A} = \mu \frac{U}{Y} = \mu \frac{du}{dy} \tag{5-1}$$

式(5-1)称为牛顿粘滞性方程,可用变换形式来定义该比例常数

$$\mu = \frac{\tau}{du/dy}$$

μ 称为粘滞系数,绝对粘度,动力粘滞系数(因其包括力),或简称为粘度。

理想流体系指无摩擦的流体,即其粘度为零。于是,任一截面上的内力总是垂直于该截面,即使在运动时亦是如此。故而,力纯粹是压力。实际上这种流体是不存在的。

绝对粘度的量纲为单位面积上的力除以速度梯度。在 SI 制中,绝对粘度的单位如下:

$$\mu\text{的单位} = \frac{\mathrm{N/m^2}}{\mathrm{s^{-1}}} = \frac{\mathrm{N \cdot s}}{\mathrm{m^2}}$$

在包括粘度的许多问题中,常常出现粘度被密度除的值。这称为运动粘滞系数。所以这样称它是因为它和运动学一样只包括长度和时间的量纲。于是

$$\upsilon = \frac{\mu}{\rho}$$

在米制中,υ 的单位为 $\mathrm{cm^2/s}$。

第六课 预应力混凝土

自 1945 年以来,预应力混凝土的迅速发展,反映了对这种高质量的建筑材料的实际需要。质量一定要高,因为构件承受荷载最不利的情况发生在它使用的初期,即在钢筋应力传递给混凝土之时。破坏很可能在这时发生,而不是尔后由于钢筋和混凝土发生徐变,混凝土收缩变硬使得钢筋应力有所降低之时。所以,在构件成为建筑物的组成部分以前,或至少在更换它们已很不方便以前,及早查出不合格的构件予以报废。

与钢筋混凝土相比,预应力混凝土的主要优点是:

(a)整个混凝土截面承受荷载,而在钢筋混凝土中约有一半的截面,即中性轴以下的开裂区不起作用。工作挠度比较小(图 6.1)。

(b)可以承受很高的工作应力,而在钢筋混凝土中,这通常是不可能的,因为那会导致构件的严重开裂,不仅有碍观瞻,面且如造成钢筋生锈,还会发生危险。

(c)在预应力混凝土中,几乎可完全避免开裂。

预应力混凝土的主要缺点是,制造时需要比钢筋混凝土更仔细地操作,因而成本较高,但

因其性能好，用量较少。因此会有这样的情况：一个建筑物使用预应力混凝土会比用钢筋混凝土来得便宜；也会有这样的情况：只有采用预应力混凝土才能解决问题，否则就无法解决。

对混凝土施加预应力，指的是在混凝土承受任何荷载以前，就使它处于受压缩的情况之下。这意味着混凝土截面可以设计得使它在全部设计荷载的作用下不受什么拉力。所以从理论上说，预应力混凝土构件没有裂缝，实际上也确实很少有裂缝。预应力通常是在埋置了钢筋的混凝土硬化以前，通过张拉钢筋而施加的。在混凝土已经硬结到足以承受由钢筋传来的应力以后，此应力的一部分就从钢筋传给了混凝土。

对于一根预制的预应力混凝土梁，其最重要的部分就是钢筋束和混凝土。钢筋束顾名思义就是混凝土中承受拉力的钢缆、钢筋或钢丝。在混凝土硬化前(即应力传递以前)，钢筋束或是未被张拉(后张法预应力)，或是已被张拉并被固定在混凝土外面的支座上(先张法预应力)。随着混凝土的硬化，它通过沿着全长的粘结力，将每一根钢筋握裹得愈来愈紧。由锚板或锚块组成的端部锚固设备设置在后张预应力构件内钢筋束的两端，面当混凝土已充分硬化，在应力传递时会使钢筋张拉。另一种方法是预先张拉钢筋，待钢筋从外部支座上放松时，通过粘结力或锚固力或两者兼而有之将应力传递给混凝土，使混凝土受压缩变短，同时，钢筋也缩短，从面失去一些张力。

随着时间的增长，混凝土还会更加缩短(同时钢筋也在缩短)。这就称为混凝土的徐变。徐变意味着在荷载的作用下，混凝土会不断地缩短，应力在截面上分布得更加均匀，因而亦更加安全。钢筋也产生徐变，但为量很少。两者作用的结果是：预应力混凝土梁中永远不会有高于传递时的应力。

第七课 测 量 学

测量学可以定义为对地面上的自然地物和人工地物的相对位置进行量测，并将这些量测成果按某种适当的比例尺制成地图、平面图或断面图的技术。

但在实践中，“测量”一词往往以特殊含义表示与测绘平面图有关的那些操作，也就是说，在构成水平面的二维平面上工作；而“水准测量”一词的含义，则是指在垂直于水平方向的第三维上工作。这样就有：

平面测量：有关在平面图上表示地物的操作。

水准测量：有关表示地面上各点之间相对高差的操作。

测量人员的工作可分为四部分：

外业：在野外进行量测和记录。

计算：进行必要的计算，以确定位置、面积和体积。

制图：将量测成果绘成地图。

放样：设桩以定出边界或指导施工。

测量工作有多种，每一种都很专门化，以致对某一种很熟练的人，可能对另外一种接触很少。简要地说，较重要的分类是：

平面测量：在这种测量中，地球曲率略而不计。它适用于小面积地区。

大地测量：在这种测量中，要考虑地球曲率。它适用于大面积和长距离地区，并用来精确地定出适合于控制其它种测量的基本控制点。

地形测量：为了绘制表示自然和人工地物的位置以及地面高程的地图而进行的测量工作。

路线测量：为兴修公路、铁路、管道、输电线、运河和其它工程而进行的不闭合于起点的测量工作。

水道测量：湖泊、河流、水库和其它水体的测量工作。

施工测量：提供建筑物的位置和高程的测量工作。

摄影测量：应用地面摄影相片和航空摄影相片的测量工作。

可以有把握地说：(a)没有一种量测是绝对精确的；(b)每种量测都含有误差；(c)量测的真值永远是个未知数；因此，(d)量测所具有的真误差永远是未知的。这些事实可用下列两句话加以说明：一个人不论举出多大的一个数，永远还有一个更大的数；不论举出多小的一个数，还有更小的数存在。用分划为十分之一英寸的尺子量测某段距离时，该距离只能读到百分之一英寸(用内插法)。如果用的是分划为百分之一英寸的较好的尺子，那么，这同一距离就可估读到千分之一英寸。由于较好的设备日益发展，量测成果会更接近它们的真值。

错误是由于对问题的误解、粗心大意或判断力差而造成的。大的错误称为大错，它们须通过对全部工作的系统性检查来发现，并须通过部分或全部返工来消除，它不属于误差的范围。小错误很难察觉，因为它们与误差混在一起。在未被察觉时，这些小错误只得作为误差来考虑，并使各种误差混淆不清。

第八课　土 壤 颗 粒

对土壤的各种描述和分类都是以粒径为依据的。这是描述土壤最简单的标准。根据土壤粒径通常把各种土壤命名为砂砾、砂土、粉砂和粘土。这些种类之间的分界线是任意的，这在人为的定义中是常见的。

显然，天然土壤通常由不止一种粒径的土粒组成。在这种情况下，土壤按其主要成分来命名。例如，某种土壤中主要是粘土，但也含有一些粉砂，就称为粉砂粘土。图 8.1 所示是简便命名混合土壤的美国公路管理局分类体系。三角形图的三个坐标轴分别表示组成土壤的粘土、粉砂和砂土含量百分率。对三种成分的不同组成，给以特定的名称，在三角图内分区标明。如某种土壤由 40％砂土、35％粉砂，25％粘土组成，就称它为粘壤土，如图 8.1 中 A 点所示。

粒径分布　若要对粒径特性作适当的描述，要求确定落入不同粒径范围内，土壤含量的百分率。

过筛分析　如土粒足够大，可用过筛分析来确定粒径分布。将试样置于孔径逐级减小的一套筛里摇撼。表 8-1 给出一次筛分结果的例子。留在某号筛上的土量代表大于该号筛孔而小于上一号筛孔直径的土粒的部分。其成果可用图 8.2(a)的频率直方图表示。垂直轴表示落入某一粒径组段内土壤含量的百分率。在工程实践中，更常用的是图 8.2(b)所示的累积百分率。该图的纵坐标表示小于某一指定粒径的百分率。把频率直方图上的值累加起来，就得到累积曲线上的值。为了得到小于某一指定粒径如 0.149mm(100＃筛)的百分率，可从最小级分开始，把小于 0.149mm 所有组段中的含量百分率累加起来(见表 8-1 的末列)。实用中，通常把累积曲线画成一条平滑曲线。

比重计分析　最细的筛孔约为 0.04mm，因而小于 0.04mm 的土粒，就需要用比重计分析。进行分析时，把土样分散在水中，使其成为稀薄的悬浮液。任其静置不动，土粒会依其颗粒大小，按斯托克斯定律下沉至容器底部。较大的土粒先沉淀。经过时段 t，仅有比某一粒径更小的土粒仍悬浮在水中。按斯托克斯定律，球形土粒在时段 t 内，通过距离 y 的沉降速度为

$$V = \frac{y}{t} = \frac{\gamma_s - \gamma_w}{18\mu}D^2$$

式中，μ 为水的粘滞系数，D 是土壤粒径，γ_s 和 γ_w 分别代表土粒和水的重度。由此得

$$D = \sqrt{\frac{18\mu}{\gamma_s - \gamma_w}}\sqrt{\frac{y}{t}} \qquad (8\text{-}1)$$

因此，在深度 y 以上的范围内，经过时间 t 后，所有土粒的直径都比按式(8-1)得的 D 要小。

悬浮在深度 y 处的土粒的总量，可用比重计测定悬浮液的重度的办法加以确定。经过校准，可在比重计上直接读出悬浮土壤的克数。

从粒径分布曲线上可以取得两个习用常数。一个是小于某粒径的百分率为10%的粒径，称为有效粒径 D_{10}，另一个是均匀系数，它是小于某粒径的百分率为60%的粒径 D_{60} 与 D_{10} 的比值。有效粒径有相当的实际意义，用它可估计土壤的渗透率。顾名思义，均匀系数是土粒大小中均匀性的指标。若土壤粒径大小比较一致，则 D_{60} 与 D_{10} 相接近，而均匀系数接近于1。对于粒径分布广泛的土壤，D_{60} 远大于 D_{10}，其均匀系数就大。

第九课　概率论与数理统计

本书的目的是介绍现代应用数学的两个重要分支：概率理论和数理统计。这两门相当新的学科主要是在上世纪发展起来的，在理论和应用方面发展都非常快。事实上，如果人们要确切地理解报章杂志的内容，必须具有这两门学科中的某些知识。

最初，因赌博者的需要而促进了对概率论的研究，至今各种碰运气的游戏仍然对概率方法提供引人入胜和有启发性的例子。目前，概率论在广阔而日益扩大的各个领域中得到了应用。它构成了孟德尔遗传理论的基础，从而在遗传科学的发展中起了主要作用。与原子微粒有关的现代物理理论运用了概率模型。对于传染病通过人群散布情况的研究，用的是概率论的一个分支——流行病理论。排队论用概率模型以调查在各种服务水平和服务项目(例如，结账柜台，电话接线人员及计算机终端等的数目多少)情况下的顾客等待时间。虽然在一本导论性的书中不可能详尽地论述如此多样和复杂的应用，但是打一些基础并提出某些简单应用还是可能的。本书的第一部分阐述建立概率模型及其数学处理的方法。这将为后面几章所叙述的统计方法以及对概率论的进一步研究提供基础。

统计学原先用于有关国家或民族的人口、贸易水平和失业人数资料的收集。许多统计学家至今仍在从事为政府提供精确统计资料的重要工作，从而可以判断出他们工作的必要性和有效性。然而，在二十世纪内，统计方法的应用领域业已急剧增加，现在实际上已包括需要收集和分析数据资料的人类活动的一切领域。这些资料可来自于人口普查结果、调查表、现场调查或指定试验。可以取得大量资料(例如从人口普查中)，这样要求有各种精确地综合和简化方法对其进行处理。另一个极端是，在科学试验中，也许需要进行多年的工作和大量的费用才能取得少数量测结果。于是人们想要确定这些数据与某个通用理论是否相符，或者要用这些数据来估计一些物理常数。由于数据的取得确实不易，重要的是应该从中取得尽可能多的信息量。

本书主要论述后一种问题，从有限的数据中得出具有普遍意义的结论。因为这是从有限的数据资料得来的，结论难免具有误差。用概率论和一些有关的方法来试图对误差定量的一门统计学分支称为统计推断。本书的后半部论述统计推断中的两个不同的问题：模型检验和估计。在拟定了随机模型以后，我们首先想要知道它与实测数据是否一致，如果不符，模型构成中的

哪些假定需要修改。这些问题可用显著性检验加以研究。随后，如设模型是满意的，人们就希望对模型中出现的那些未知数-参数-进行估计。确定估计的可能误差值是估计问题中必不可少的部分。

统计学家也关心于适当的数据收集方法的设计，以便从这些资料的分析上，得到尽可能多的、需要的信息。必须十分小心从事，才能使数据资料避免带有预料不到的各种偏差，这些偏差会使分析失效或使含义混淆。在许多情况下，要求统计学家们去分析那些用不适当的方法收集的数据资料就好象是在病人死后再去请医生，你能知道的至多是病人的死因。

统计决策理论是统计学的又一分支，它自二次大战以来得到了高度的重视。它要处理的是面对着真实自然情况的各种误差，从几个可能的行动步骤中选择一个的问题。在得出一个代价最小的行动步骤中，错误决策的费用和从实测数据及其它来源取得有用资料的费用都要加以考虑。

许多统计问题包括推断和决策。首先我们决定收集什么资料。有了数据资料以后，我们试图尽可能从中多知道一些东西(统计推断)。于是，获得的信息就能在下一个行动步骤中加以考虑。然而，重要的是要仔细区分推断和决策的各理论部分。在决策问题中，人们感兴趣的仅仅是从数据中得到的资料足以减少某个设想行动的预期费用而已。在统计推断中，人们感兴趣的是统计推断自身的原因，而不管任何一个特定的决策问题，从该决策中获得的信息也许在将来会有用。

第十课　试验技术概述

10.1　试验的类型

虽然一般都认为实验工作是任一水力学课程的重要部分，但常常有学生们在做试验的规定步骤和处理试验结果时并未掌握有关理论的基本原则的情况。

不言而喻，只要有可能，在进行试验研究前，课堂教学中应包括基本理论。这点对水力学尤其重要，因为要能得到理论解，要求在许多情况下，作出有关流体特性和边界的一些假设。

在这种情况下，要提出理论性能与实际性能之间的相关关系，必须借助于试验。

在流体静力学的领域和少数场流情况中，能得出精确的数学解，它并不需要从试验得到任何校正。管道层流分析就是这方面的一个例子。

某些流体结构使得任何数学分析统统失效，这时，工程师必须完全依赖于试验方法。

现在可以把任一试验研究归入下列某一类目之中：

(a)进一步证实业已从正确的数学分析中完全导出的相关关系；

(b)给各种系数定值，使得一部分完成的理论分析(或基于可疑假定上的分析)能够最终全部完成；

在许多情况中，理论方法假设流体为无粘性并且不计一切能量损失。在实验室中，用测定真实性能的办法，得出相关关系的形式是：

真实性能＝系数×理论性能

(c)当结构和流型使得任何形式的理论解成为不可能时，研究各变量之间的关系。这里，象量纲分析这种技术能够将各变量汇编成组，使试验步骤取得合理的说明。

虽然本书不能详细地包括这方面的内容，为了预测原型即足尺建筑物的性能，仍应提及进行水工建筑物缩尺模型试验的技术。这种实验室内的模型容许直觉观察流型，并且对模型的直

接量测结果能使工程师最终敲定他的设计方案，或对已成建筑物规定一些改进。

10.2 实验室工作的目标

任一试验研究的主要目标如下：

(a)安装能精确代表指定条件的设备；

(b)提供为量测各种变量(流量，水位，压强等)必需的全部测试仪器；

(c)为得到富有意义的成果，使实验按照能有足够多的精确量测值的办法进行；

(注意：三、四个点据定不出可靠的图解相关关系)

(d)以简明的方式提出试验成果；

(e)讨论并解释试验成果，并作出结论。

10.3 实验报告

在试验工作计划开始时，必须在实验报告的形式和内容上有所指导。各个学校的要求不同，我们也无意使其标准化。然而，希望下列的讨论会突出一些基本原则和暗示如何避免出现与编写报告有关的某些问题。

段落标题为任一报告提供了框架，下列目录将满足大多数的要求：

试验题目

试验目标

仪器设备

理　论

试验步骤

观测项目

分　析

结　论

第十一课　扬　子　江

我们谈论十亿人口的中国，在那儿有许多怪事，其中主要的一个是：那里没有扬子江。大多数中国人不知道这个名字，他们称它为大江或长江。在重庆以上，人们称那条湍急挟砂水流为金沙江。现在，这仅是个使用不当的名称了。距今五十年以前，在冬季、水位下降时，中国人蹲在江边淘金，他们淘洗泥浆并收集金砂。欧洲旅游者曾报导过，他们看到洗衣妇女戴着从这条发源于青藏高原的长江中采来砂金制成的粗大手镯。

但比名称更多的是这条江的情态。1887 年 Archibald Little 在《经过长江三峡》一书中写道："我必须仔细地为每天的笔记注上日期，在不同季节里，河流变化多端，致使任何描述必须小心地理解为仅适用于描述的当天。"Little 船长为之倾倒，他将长江与密西西比河和亚马逊河相比后说，长江真是难以描述的。在许多河段都有强烈的壮观景象。长江常发生猛烈洪水，其冬季水位情况下的汹涌急流使得船长在驾船经过浪花和急流水舌朝下行驶时，祈祷着航线上千万别有舢板，因为要他停船或倒退是办不到的。当然，长江也并非总是这么戏剧性的。它的四大河段好象是四条独立的河流；重庆以上河段是神秘的而且仍然与黄金和滑坡联系着；上游段(重庆一宜昌)河水最不驯服，具有三峡和中国古典名著《三国演义》中的景色；中游段(宜昌一武汉)是平静的，宽约一英里；下游段(武汉一上海)有缓流而粘稠发黄的江水，两岸人口众多。

从重庆到上海，我顺水航行了 1500 英里，看到每英里的情况都不同，可是还有 2000 英里

的河道没看见。长江穿越12个省和区，700条内河汇入其中——长江的全部统计数字为量庞大得难以理解，不但不能澄清真相，反而会把情况搞混。并且，因为用文字描述也许比数字更确切，有一天我问一位中国船长是否认为这条江有其独特的个性？他说："这条江的情况随着季节而变。每天都有变化。它是不平静的。在这条江上驾船总是在与大自然作斗争。只有一个办法能驾驶好船只。"他跟着解释说："这就是必须把这条江当作敌人来看！"

长江是中国的主动脉，它的主水道，许多神话的出处，大部分历史的现场。在它的两岸有一些大城市。

我们登上了东方红39号轮，很快就启程了。由于在宜昌兴建了船闸和水坝，我们分乘两艘船下行，昆仑号内燃机船在宜昌以下等候。东方红39号与昆仑号一样大小，可乘载900人。按我说只有我们33人和102名船员。我们一点也不辛苦，看起来虽然我们在中国的心脏部分旅行，却往往好象中国是在另外一处似的。

船上的扬声器里播放着蓝色多瑙河圆舞曲，东方红39号在舢板、渔船和重载的渡轮间摇摆着前进。船长在休息室里向我们问候并告知："水流流速为每秒2米，"又说："作为你们的船长，我对你们的安全负责，所以请不必担心。"

刘船长六十岁。他有个狭窄的头、平直的后脑勺，短而硬的头发，牙齿间有大的隙缝。他一直在这条江上工作。他的父亲十五岁就开始当乘务员，在一条中国船上供应食品。"我如人们用英语说的那样，是个'boy'，但我走自己的路，直到成为船长。我从未上过学。你不能在学校里学会这条江的学问。你只能在驾驶台上学。"

第十二课　水利工程——坝

人类最古老的工程有灌溉和供水系统；的确，中东河谷最早期的文化就是以灌溉农田为基础的。港口设备和通航运河也是早期的工程成就。这些系统通常总称为水利工程。水力学是涉及水和其它流体的流动与控制的科学。

在水利工程中最令人惊叹的现代工程就是象埃及尼罗河上阿斯旺高坝和美国西南部科罗拉多河上胡佛水坝那样的大坝。与大部分现代水坝一样，这些坝有多种不同的用途，其中有防洪、蓄水、灌溉、航运和水力发电。此外，大多数水坝具有跨越坝顶的行车道，与公路系统连接。坝后的湖，象被胡佛水坝壅挡形成的米德湖，也用作游览区。

在设计和兴建大坝以前，必须对坝址进行广泛的勘测和研究。这种勘测不仅检验该区的地形特征，还要检验土样和岩样，以确定可能影响它的地质因素。也应确定筑坝河流的水力特征，如不同季节的流量和被坝拦截的水量等。工程师们用这些资料去计算潜在的水压力。还必须研究坝址，看看能否采用围堰施工，或是必须使河水改道。围堰是一些不漏水的土堆筑成的围栏，其中的水可用泵抽出。当需要将河水改道时，一种办法为河道挖掘隧洞；另一种则是环绕着坝址为河流开挖临时渠道。

即使对坝址已作充分的调查，设计也已做好，准备工作仍不算全部完成。往往还要制作水坝缩尺模型，以便在模拟条件下，对其进行测试。也广泛地运用计算机计算这些巨大建筑物所能承受的各种应力（包括由地震引起的应力）。

坝的构造基本上有两种类型，圬土坝和填筑坝。在发明波特兰水泥之前，通常使用大琢石筑坝，而现在的圬土坝是用钢筋混凝土建造。圬土坝多用于控制峡谷中的激流，这种峡谷有良好的岩石地基。胡佛水坝就是一个极好的例子。填筑坝实质上是横跨河道的大土堆。除使用

夯实土壤外，填筑坝还可用碎石或砂子建造。这种水坝通常是横跨河面较宽、水流相当缓慢的河道而建造的。阿斯旺高坝就是一个很好的实例。

在坝的设计中，被拦截水流的速度和压力是重要的因素。另一个因素是基础下可能发生渗流，常需要在设计中采取特殊防护措施。渗流是水通过如土壤或石灰岩、砂岩等岩石之类多孔介质的渗漏。

根据筑坝原因，许多水坝都有其它一些附属建筑物，其一即是溢洪道，它可使洪水或多余的水从坝后水库泄入下游。对于填筑坝，溢洪道通常建在坝的一端。对于混凝土重力坝，向下游倾斜的坝面往往即用作为溢洪道。在这种情况下，必须有某种基脚或特殊装置设在坝底以使水流射入下游河道时不致冲刷坝基。

当坝用于灌溉或发电时，还要另外开一些孔口。坝中建筑闸门以泄放水流。闸门上都装有滤网格栅，以拦截漂浮物。将水从这些闸门引至发电站中涡轮机的导管称为压力管道。有些坝还建有鱼梯，可使河中的鱼通过水坝往返于它们的繁殖区。

第十三课　水利工程——运河与船闸

现代最著名的水利工程成就中有三条大的国际运河。德国的基尔运河连接着波罗的海和北海，长 95 公里。还有埃及的苏伊士运河，沟通地中海和红海，为欧洲和亚洲之间提供了一条通道，避免了绕道非洲的航程。它长 169 公里，而且没有船闸。船闸是运河的一部分，用闸门关闭；船闸内的水位可以调节，从而使船舶能上升或下降至不同的高度。苏伊士运河最初于 1869 年通航，由于该地区的战事而于 1967 年关闭，并于 1975 年重新通航。近来，工程师们计划拓宽与加深苏伊士运河以接纳来自波斯湾油田装载石油的超级油轮。运河是经过疏浚、裁弯取直、筑堤岸或其它方法控制，从而使它们适于航行的河流。古代罗马和中国都开凿了运河，在中国，使北京与长江连接的大运河在任何年代都可算是一项最伟大的工程，直到今天仍在使用。在欧洲，远在铁路最初在大地上铺设以前，开凿运河的新时代已于 17 世纪开始。这个时代开凿的一条重要运河是朗格多克运河，它穿越法国南部，将大西洋与地中海连接起来。

货物经由水路运输远比陆运经济，因此，尽管十九世纪注重铁路，二十世纪注重公路，现在仍在继续不断的开凿运河。欧洲的许多河流和港口都与运河网相连，这些运河承担着这个高度工业化地区的大部分商业贸易。在美国，运河不如欧洲和中国那么重要。一项值得注意的十九世纪的工程伊利运河它横贯纽约州的北部，连接哈得孙河的奥尔巴尼与五大湖。纽约市的卓越商业成就应该大部分归功于伊利运河。

近来，最重要的运河工程之一是由美国与加拿大联合兴建的圣劳伦斯通海水道。这个由河流、运河、湖泊构成的大水系使得从大西洋到苏必利尔湖上明尼苏达州德卢斯的整个水程都能通行远洋轮船。借助于芝加哥的环境卫生及通航运河，圣劳伦斯通海水道与密西西比河-密苏里-俄亥俄河系相连；的确，它开辟了北美大陆整个中心地区的航运事业。

第十四课　侵　　蚀

侵蚀过程

土壤能受到侵蚀，即在风、水、重力（滑坡）和人类活动的作用下，从其现时的位置移开。水的侵蚀作用可看作是从土壤颗粒受雨滴冲击而分离开始。雨滴的动能能把土壤颗粒溅到空中

去。在平地上，土粒沿各方向的重新分布比较均匀，但在斜坡上就会出现下坡的净输送(图14.1)。如果坡面漫流发生，一些下降的土粒会被带入水流，并在它定落于土壤表面以前向坡下更远处迁移。坡面漫流主要是层流，不能从土体中析离土粒，但能搬移已在土壤表面的松散土粒。溅击和坡面漫流的作用造成片蚀，即土壤表面比较均匀的减削。片蚀是很难察觉的，除非土壤表面降至篱笆柱子上的老土痕以下、树根裸露或石头盖顶的小土柱仍然存留着。

雨滴的直径 d 变化从 0.5～6mm(0.02～0.25in)，沉降速度 v 随直径变化从 2 到 9m/s(7～30in/s)。因为动能与 d^3v^2 成正比，最大雨滴的侵蚀能力可达较小雨滴侵蚀能力的 10,000 倍。这与观测到的侵蚀是大多由少数强烈暴雨所引起的这种情况相符。这个结果又因暴雨期间很可能发生坡面漫流这一事实而加剧。

在坡面上的某点处，大量的坡面漫流会聚集而形成小溪流。如水流的紊动强到足以冲走河床和河岸的土粒，就会发生沟蚀。当冲沟加深，其纵剖面图上在源头处最陡(图 14.2)。在这个地区侵蚀最快，冲沟朝源头伸展。

在陡峻且边坡不稳定的峡谷中，土壤的块体的运动(例如：土块向下游缓慢蠕动或是边坡迅速崩塌-滑坡)是土壤输入河流的重要途径。由地震或暴雨期间土坡饱和而引起的滑坡会形成一些临时性的土坝，此后土坝漫顶和侵蚀会在下游产生危险的洪水波。

控制侵蚀的因素

控制侵蚀的重要因素是降雨情势，植被，土壤类型和地面坡度。因为雨滴冲击的重要作用，植被以其能吸收下降雨滴的能量和减小到达地面雨滴的大小，显著地保护着土壤免遭侵蚀。植被也使土壤免遭沟蚀，起着机械保护作用。此外，良好的植被一般通过增加有机质使土壤的下渗能力增强。下渗能力较强意味着坡面漫流(从而侵蚀)较少。

粘性土壤比疏松土壤更容易抗御溅击侵蚀。一般说来，随着土壤含砂成份增多，因内聚力丧失，溅击侵蚀就增强。它随着土壤中水稳性团粒百分数增加而减少。颗粒不形成团的土壤较之团粒丰富的土壤易被侵蚀。

陡坡上侵蚀的速度较之坦坡上更高。坡度愈陡，在将土粒向下坡输送的过程中，溅击侵蚀就愈强烈。在陡坡上，地面漫流速度也大，块体运动很可能在陡峻地带上出现。坡地的长度也是重要的。坡面愈短，侵蚀下来的土壤到达河流就愈快，但这将与坡面漫流的流量和流速随坡面长度而增加这一实际情况相抵消。

土地利用在决定侵蚀速度中也是个重要因素。低劣的耕作制度或粗糙的道路修筑会使侵蚀大大加速。烧荒或伐木也会增加侵蚀危害。适当的土壤保护措施会减少侵蚀流失。通用的土壤流失方程试图把所有这些因素都综合起来，但很难用单一指数来表示降雨情势，土壤可侵蚀性的野外测定一般还不可行，因而，这个方程和类似的其它方程至多也是粗略的。

第十五课　河流类型和滩地

河流类型

从平面图上看，河流可描述为蜿蜒型、分汊型或直线型。蜿蜒型河流在巨大的、大致对称的环线或弯道中流动。蜿蜒型河流的中位线长度约为河谷长度的 1.5 倍，即蜿蜒度平均约为 1.5。曲流的波长为河宽的 7～11 倍，而弯道的曲率半径通常在河宽的 2～3 倍之间。曲流的振幅或曲流带的宽度变化很大，在众多的影响因素中它似乎较多地受河岸物质特性的控制。振幅通常是河宽的 10～20 倍。

分汊型河流是由许多被岛屿隔开的交织河流(重汇支流)所组成。它具有粗粒河床质,往往很宽和较浅。关于分汊型河流的几何形态无法作出正规的说明。自然界中不存在长的直线型河流,但许多河流因其曲率不够也不宜称为蜿蜒性河流。蜿蜒度小于 1.25 的河流,通常就定义为直线型河流。

重要的问题是要解释为什么某条河流会是上述类型中的某一型。通常在岸滩是易被侵蚀的砂质土壤且很少植被的河段上可以找到分汊型河流。河床质较粗且颗粒不均匀。分汊河段的底坡比邻近非分汊河段的底坡要大。从水力学的角度看,分汊河段不如非分汊河段有效。分汊河段中,各支流的总宽度可以是不分汊河道宽度的 1.5 至 2 倍,水深则相应地较小。因此,分汊是当河道变陡时的一种消能方式,于是,本来由于流速增加将导致侵蚀的情况得以避免了。

不论在试验水槽中或在野外,如果河岸质易被侵蚀,则水流流过时常会形成曲流。蜿蜒性河道的长度可达非蜿蜒性河道的 1.5 至 2 倍。它的底坡相应地减小,但因河道变长和弯段损失,水头损失增大了。如无这些损失,速度就会较高,势必下切河槽。但许多蜿蜒性河流,因泄入具有固定高程的水体,并不能下切河槽。若下切不能出现,就需要另外的一些办法来消除有效能量。

于是,分汊和蜿蜒都可以看作是消能的工具。分汊多发生在河床质粗大而不均匀和河岸易被侵蚀之处。蜿蜒则可能发生在底坡较平坦,土粒较细并且河岸质较有凝聚力之处。

在任一情况下,河流处于一种平衡状态之中——意指河流将保持均夷,但显然不是指河槽没有变化。在分汊型河流中,在各重汇支流之间有不断的位移和变化,曲流则不断地经受着凹弯道处冲刷和后成边滩处淤积的演变,使曲流看起来经常往下游移动。人们任何企图改变河流的自然类型要有慎重的规划,而且往往需要兴建昂贵的护岸工程以防止河岸冲刷并回到原来的类型。

滩地

河流的滩地是与主槽相邻的谷底平原,在高水时会被淹没。河流会横跨谷底来回摆动,改造滩地上的沉积物,先冲刷河谷的一边再冲另一边。滩地主要由河槽泥沙淤积和漫滩时细粒泥沙在滩地上沉积造成的。另外,有机质会聚集在截弯取直的曲流环(牛轭湖)中。当河水侵入滩地时,由于粗粒泥沙的沉积,沿主槽的两岸常常会形成天然堤岸。主槽中的泥沙沉积加之岸上的天然堤岸,能使河水处于比滩地还高的情况下流动。当水流流过冲积锥时就常出现这种情况。

如前所提到的,滩地被洪水淹没的重现期相当短。利奥波尔德等人报导了漫滩所需水量的许多估计值。重现期一般为 1 至 2 年,通常认为美国东部和中部的滩地,在 3 年中被洪水淹没二次是相当合理的。然而,这些数据的普遍性是有问题的。尼克松对英国河流作过类似的分析,他发现平均每年洪泛两次。准确地定义滩地和漫滩水位尚有困难。这就无法明确尼克松的资料所指情况是否与美国的相去很远。无论如何,有一点是清楚的:滩地经常会遭水淹,因而如果利用滩地建造房屋或为了其它目的都必须慎重从事。滩地的横向坡度往往很小,用肉眼常难观察出自然堤来。因此,在研究对滩地特征具有重要影响的那些问题时,必须要有充分详细的地形图或专门的野外勘测以便取得合用的必需资料。

第十六课　流域产沙与泥沙利用

从五十年代初期起,各土壤保持试验站设立了许多试验小区,开展了受调节的和未受调节

的小流域之间的对比试验，以便估计在不同的坡度、坡长、土壤、植被、耕作方式和降雨条件下的产沙量。从这样收集来的资料中，我们对流域不同部位的产沙强度及各种水土保持措施在控制侵蚀方面的效果取得了一些认识。在广大的黄土丘陵沟壑地区，在旱谷与支流或支流与干流汇合处，很少有易使泥沙堆积的平缓地带。岔巴沟的不同小流域（面积自 0.18 至 1.87 平方公里）的泥沙侵蚀模数在 16,800 至 25,600 吨/平方公里/年的范围内变化，与流域面积无甚关系，这表明坡面和沟谷的土壤侵蚀量与支流的输沙量非常接近，泥沙递送比接近于 1。这一点与外国的发现相当不同。

河流的特性与河流所在流域的特性息息相关。黄土高原的西北部与鄂尔多斯高原的沙漠毗邻。由于风砂的入侵，黄土中混有相当数量的砂，形成比较粗的级配。有些河流下切至砂岩地层，而后者是极易遭风化的。风化的产物也是粗颗粒的。有充分的证据表明：黄河下游的快速填积，主要是由来自这个粗砂补给区。黄河流域中有 43 万平方公里地区的泥沙侵蚀十分严重，但是 80%的粗粒泥沙只来自 10 万平方公里。如能在抑制这个地区的产沙方面作一些集中的努力，则由于下游河段河槽不断淤填而造成的危险将会大大地减轻。

在中国，虽然泥沙带来很多麻烦，但它也是可以利用的自然资源。黄土中含有多种肥料，若将它引入农田，产量会大大提高。广大劳动人民通过长期的初中，在引洪淤灌以改良土壤的方法方面得到了许多经验。在赵老裕，用淤泥水灌溉和开垦方面已有一千多年的历史。近年来，在陕西省、山西省、内蒙古自治区，在如何用洪用沙的技术方面，又有较大的发展。充分利用水沙资源，以发展沿岸的工农业是治理黄河的重要方针之一。

第十七课　泥沙输送力学

将随机处理和力学原理相结合，是河流动力学和泥沙输送的现代发展的重要趋势。中国的科学家们，通过对明渠紊流的随机分析，导出了时均流速和紊动强度的垂直分布公式，这些公式不仅适用于主流带也适用于边界层。曾对单粒泥沙运动随机理论的某些方面作了研究，包括泥沙的休止时间、单步行进距离、运动高度、脱离床面时间和从一种运动方式向另一种的转变。也提出了推移质输沙及泥沙扩散的随机模型和统计理论。

曾经量测到卵石在床面上不同位置时的受力情况。获得的资料强调了对于泥沙的起动，举力和拖力具有同等的重要性。在中国的实践中，习用平均速度来表示泥沙的起动条件。对于细粒泥沙，颗粒间的凝聚力必须加以考虑。由各研究者提出的粗、细粒泥沙起动的普遍规律，与实测资料符合较好。

由于现有的推移质公式的精度往往不能满足生产上的要求，在确定西南山区砾石河流的推移质输沙时，间或采用下列步骤：首先对所研究的河流建造一个正态或变态很小的模型；不同流量情况下由模型估算的推移质输沙率按适当的尺度比换算到原型。所得到的水-沙关系曲线与野外资料尚称符合。在缺乏实测资料的地区，可以用岩性分析法，估算不同支流的砾石来量。这一方法曾用来估算长江三峡地区的砾石来量，据称结果尚属满意。

对于悬移质泥沙，建立在扩散理论上的悬移质垂直分布要求水面含沙量为零，与实际情况不符。这是因为在公式推导中，取水面混合长度为零所致。这是个有异议的假定，倘使对该理论在这方面能作出适当的修正，单就该水面浓度而言，会得到比较好的结果。每当近河底处存在较大的含沙量梯度时，对数流速分布中的卡曼常数与理查森数有很大的关系。在推导悬移质垂直分布的积分过程中，必须考虑含沙量对沉降速度的影响。

中国西北地区河流的含沙量往往很高。某些支流的年平均含沙量远超过 500kg/m^3，曾经测得体积含沙量高达 60%。这样高含沙量水流的性质与一般挟沙水流有很大的不同。近年来，对超高含沙量水流机理的研究取得了一些进展。

第十八课　河床演变

对于河槽类型，大多数外国同行们常把它分为三种，即：蜿蜒型、分汊型和直线型。从我们在中国河流观察到的情况看，长江中、上游具有一个或数个江心洲，汊道比较稳定，表现出与黄河下游的分汊型河流的性能完全不同，在那里的中心岛却是分散和不稳定的，河道处于经常游荡之中。对于人们所关心的河床演变来说，这两种河流应分属于不同的河型。在中国，我们保留对如长江中、下游河段用“分汊型河流”的名称；用“游荡型河流”一词专指象黄河下游那样的河型。

蜿蜒型河流的形成在很大程度上与河岸物质(更确切地说，与形成滩地的物质)的相对易蚀性有关。在六十年代初期，我们在实验室中，采用以植被稳定岸滩和以多粘土洪水进行泛灌的办法，成功的模制出典型的蜿蜒型河道。从下荆江河弯观测中大体上认识了环流在决定河床演变中的重要作用。水文部门在下荆江和渭河下游对蜿蜒型河流的河流形态作了详细的观测，取得有用的资料。在下荆江和南运河上，为了航运和防洪的需要进行人工裁弯，并对导河的演变，老河道的恶化以及裁弯对上、下游的影响等作了详细的观察。

黄河下游以其泥沙丰富、冲淤幅度区大、河槽移动频繁而著称。正为此，它是研究游荡型河流河床演变的理想场所。在六十年代，我们总结了到那时为止积累的经验，在这个基础上对其下游可能的变化作了预测，并在文献中正式地加以报导。对于高含沙量的游荡性河流，在作洪水演算时必须考虑滩地槽蓄对水流和泥沙的滞留作用以及主槽的冲淤影响。在这方面，业已有一些半经验方法。黄河下游的凌汛经常使山东省大堤遭受危险，已对过去的经验作了全面总结。除了黄河下游以外，北京附近的永定河也是一条典型的游荡性河流。在横跨上游河道的官厅水库建成以后，河流的粗化十分明显。大片滩地冲毁，导致河槽展宽，并危及堤防系统。

长江中下游分汊型河道的形成，除了位于进出口处控制点的调节作用外，洪水流量变化不大可能也是一个因素。一些地理部门在实验室内进行了分汊河流造床过程的试验。由此获得的知识一定会加深人们对自然演变过程的理解。

考虑到河流的河相关系，已知条件是：水流的连续性方程，运动方程和输沙方程；未知数是：河宽、水深、比降和流速。要完全求解这个问题，还需要一个另外的方程。在这个方面已有若干设想和假设，其中之一就是“最小活动性假设。”有了这个附加的假定，冲积河槽和感潮河段的河相关系能满意地得出。冲积河流的河槽形式在很大程度上取决于河床和岸滩的相对易侵蚀性。对于长江中、下游河段，在建立河槽几何形态的相关关系中，曾采用河床质与河岸质的起动流速之比值作为参数。

在工程项目的规划设计中，需要对河床演变作定量估算。如列出非均匀、非恒定水流的微分方程，同步求解水、沙的连续性方程，就可获得可用于确定流速、水深以及冲淤速率的三组特征线。现有一套计算方法可用以确定河床的粗化影响，水力参数以及在人工裁弯后，导河与老河道的河床演变。在建立黄河下游的数学模型时，发现水流的河床质挟沙能力随着来沙量而变化；由于河床的冲淤量很大，致使河槽形状及河床的有效级配随着挟沙量急剧地改变。整个问题是相当复杂的，目前只能用上游水文站输未的河床质输沙量作为第三个参数，提出一个流量

与河床质输沙率之间的经验关系。这一关系反映了众所周知的事实：在黄河下游，“来沙愈多，河槽的淤积愈多，排入海中的泥沙也愈多。”

第十九课　挖　泥　船

疏浚是利用称为挖泥船的设备，将处于水下的泥沙移到别处水中或陆上。当今，挖泥船可分为两类：机械的和水力的。在参考文献 15 中，A. L. McKnight 做了很好的评论，下面予以简介，并用其它资料作为补充。

挖泥船的类型

机械类挖泥船有一种蛤壳式或称抓斗式的。这种类型的较大挖泥船已不再受欢迎。另外一种环链多斗式（或多斗-桥架式）挖泥船，以前在欧洲广泛使用，但在美国并不多用，不过在少数工程中，如巴拿马运河也曾用过。

机械类铲斗挖泥船具有一个重型铲斗，由一个很坚固的臂与吊杆移动，可用来挖掘比较松的（通常是不坚实的）岩石。这种铲斗可以安装特殊齿。挪威的“Big Boy”号挖泥船装备有 2.6 立方码的铲斗。

水力挖泥船是疏浚设备中最重要的组成部分。简单的吸扬式挖泥船不用绞刀，它从水底抽吸泥沙，通过连接于船尾部的排泥管线输送到抛泥场。

绞吸式挖泥船在桥架的末端有一个旋转的绞刀，它从水底就地挖掘泥沙，经过船尾-趸船-岸边管线排泥。挖泥船由安装在船尾部的定位桩控制，并借助于摆动装置从挖槽的一侧转到另一侧。

自航装舱耙吸式挖泥船，有装载挖起泥沙的大舱，供随后通过其底部的排泥门将泥沙抛卸。这种挖泥船通常用于水深太大以致不适于绞吸式挖泥船作业或抛泥区对绞吸式挖泥船来说不在经济输送范围以内的地方。

水力挖泥船是通过反复随机试验而发展的，并非有计划地。疏浚工作的先驱者，首先关心的是如何赚钱。只有那些与挖泥船直接打交道的人对它的作业和性能具有较多的知识。疏浚是“一种复杂的、依然是经验性的，从业人员的一生，几乎全部要从经验中学习”。1966 年由于世界疏浚承包人组织（WODCON）的成立，为疏浚工作带来巨大的进步。1967 年间这个组织在纽约举行了首届国际性会议，目前出版定期刊物，并每两年举行一次国际会议。另一个组织 WODA（国际疏浚协会，圣佩德罗）出版月刊，还发行了“1970 年世界挖泥船和其所有人指南”。

毫无疑问，水力挖泥船已成为所有港口工程中最重要的疏浚设备。如果没有这种挖泥船，水道、内河的贸易运输就要停顿，水运企业就要崩溃，海运显然也就不存在了。

水力挖泥船可以挖掘运河、港口和港湾，在内河、运河及水道中进行维护性疏浚，还可以为建造突码头、顺岸码头、船坞、堤坝以及水下基础工程进行挖掘。它也可以吹填沼泽洼地，建造堤坝及导流堤，并可开采砂、砾石、贝壳以及煤、金、金刚石等许多矿物。这种挖泥船的使用范围是广阔的。

小型水力挖泥船可在仅有几英尺深的水中操作。较大的挖泥船则需要较大的吃水深，但可挖到更大的深度。借助于接力泵，泥沙的排送距离是不受限制的。

虽然这种挖泥船挖软泥时的排出量比挖硬土时的排出量大得多，它几乎能挖掘任何物质。它可挖掘淤泥，粉土，壤土，粘土，砂，硬磐，砾石，珊瑚以至岩石。它曾经挖掘并输送过千磅以上的巨砾。

第二十课　河口湾泥沙问题

中国有很长的海岸线，许多河流注入海中，随着径流总量、潮汐作用和泥沙来源及含沙量之不同可形成各种河口湾。河口湾可分为四类，即：(1)强潮海相河口湾；(2)弱潮陆相河口湾；(3)湖源海相河口湾；(4)海陆双相河口湾。

钱塘江河口湾是一个典型的强潮海相河口湾。河口呈漏斗形，年平均潮差在阚浦为 5.3 米。钱塘江因其涌潮闻名，在海宁最大浪高为 3.7 米，推进速度为 8～9 米/秒。强劲的海潮作用，把泥沙从海中带入河口湾，形成了一个长 130 公里和高 10 米的沙坎。在河口湾内有这样一个沙坝存在自然会在许多方面影响河床演变。从国内外 22 个河口湾收集到的资料显示：如果径流和潮流的比值小于 0.02，将形成口内沙坎；如果比值超过 0.1 将形成拦门沙。

黄河河口湾是一个典型的弱潮陆相河口湾。在神仙沟出口处，平均潮差仅有 0.5 米。每年黄河将 12 亿吨泥沙带入渤海，其中有三分之二在三角洲地区和近岸带沉积，使三角洲迅速向前推进。从 1855～1954 年，岸线平均每年向外延伸 0.15 公里，造陆 23 平方公里。近年来，由于游荡范围受到限制以及河槽改道，岸线外推速度加快达每年 0.42 公里。

长江和珠江是陆海双向型河口湾。出于排泄洪水的需要，在珠江三角洲上，河道到处分汊，形成了一个复杂的河网。长江口的比降十分平缓，在低水强潮季节，潮汐作用的影响可上溯到江口以上 650 公里处。在河口附近形成大量的沙坎，水下三角洲，基本上有南移的趋向。

入海泥沙大多来自长江和黄河。两条河流所携带的泥沙在组成上都相当细，这就在许多沿海地区造成大片淤泥质海滩。浮泥的运动对海港和河口湾的淤积影响很大。曾在实验室进行水槽试验，提出了河口湾流及沿岸水流输泥能力的估算公式。

为防止盐水入侵和便于排泄内涝，解放后沿着中国海岸建造了许多挡潮闸。挡潮闸的建立改变了河口湾地区的动力条件，为闸下游带来严重的淤积。如果河水径流供给充足，通过有规律地操纵闸门，淤积应能得到控制。人们应该充分利用河水来调整涨、落潮流速间的比值，改变涨、落潮进出沙量的相对比例。如果挡潮闸距河口不远，而闸门下的沉积物较细，则通过机动船搅动疏浚使落潮流含沙量增加，就会有效地减少淤积量。

第二十一课　波浪的某些基本定义

为了顺利地讨论波浪现象，必须先以一些简短的定义介绍某些概念。

在平底的水体中，以固定形式推进的，周期性的表面重力波，能用波高 H，波长 L 和平均水深 h(水底至平均水平面间的距离，来描绘)，如草图 21.1 所示。平均水平面的定义是波顶以下的面积与波底以上的面积相等。波顶高是平均水面对波浪顶的距离，也称为正振幅。类似地，谷底深为负振幅。对于微幅波(线性理论)，两振幅相等，于是波幅 $a=\frac{H}{2}$。

在一固定测站上，相继通过两个波顶的时间间隔为波期 T。在该固定站上，当波顶出现，相角如为 0°；在一个波周期内，相角增加 360°。波底处的相角为 180°。

如果考虑波浪是两维水平运动，相等相角的一条曲线称为波前。虽非通用但易于想象的是把在水平面上，通过相邻波顶的曲线认为是波前。波浪推进方向，由波向线来描述，它是与波前正交，如图 21.4 所示。

推进波是一个没有(或仅少量)反射的、即单向的波列。波前以相速度 C 沿正交方向传播。微幅波的能量 E(势能加动能)以波群速度 C_g 沿同一方向传播。E 和 C_g 的乘积是平均波能流。在深水($h/L>1/2$)中,波群速度是相速度的一半,而在浅水($h/L<1/20$)中,两者几乎相等。如有水流出现,情况将较复杂。

波浪表面纵剖面上的运动,确切地说是给出了一张真实流体运动的粗浅图画。推进波传递能量和动量,但未必传递质量。波前单位长度上的体积流量 q 是质点时均水平速度在整个深度上的积分值。如 $q=0$,就是纯波运动。对于微幅波,质点轨迹为闭合的椭圆曲线。(注意:这是质点的迹线,不是流线。)在平均水平面上,垂直半轴等于 $H/2$,而在水底,椭圆退化成直线。在深水中,质点作圆周运动,而在浅水中,椭圆在水平方向上极度伸展。如图 21.5 所示。

在波顶,顶点速度与波浪推进方向相同,在波底则相反。在波顶点速度最大。质点速度通常远小于相速度,即 $u \ll c$。(当波浪近于破碎时是个例外,那里波顶处质点的最大速度等于相速度。)

波陡 S 的定义是波高与波长之比,即 $S=\dfrac{H}{L}$。

第二十二课　风成波和有效波高

人们每天在海洋上见到的又是海岸侵蚀的主要原因的波浪,是由风吹过水面而生成的。当然,有一些波,如海啸,并非由风引起的;即使它们有极大的破坏性,但因其非常罕见,不成为海岸侵蚀的重要因素,故在此不作考虑。

风成波是传递能量的重要媒介;首先从风那里获得能量,通过浩瀚的海洋传递,然后传送到海岸带,在那里,它是引起侵蚀的主要原因,或者产生各种近岸流和泥沙输送类型。波浪的生成主要取决于下列三个风暴要素:风速、风暴历时,发生风暴的受风水域。历时的重要性在于风吹的时间愈长,可传送于发展中的波浪的能量就愈多。受风水域有类似的作用,一旦波浪传出风暴区,它们再也不能获得另外的能量,所以受风水域愈大,波浪能得到更多的能量。

最简单的波型是用波高 H、波长 L 和波周期 T 来描述的。不过,风暴区内的波浪并不符合这种理想化的图形,而是由不同波峰和波谷构成的复杂类型的波;看起来,没有两个波具有相同的波高或波长的。如追踪一个单独的波顶,常可观察到的是:波高逐渐减小,最终消失。产生这种复杂波型是因为:一个风暴并不只产生某种固定波高和周期的波,而是产生一整个系列的波或曰波谱。当风开始吹过本来静止的水体时,仅生成波周期小于 1 秒和波高只有几厘米的小涟漪。随着时间过去,会形成周期愈来愈长的波,但是小涟漪还要不断地出现,而具有各种波周期的波浪也就产生了。周期长的波有较长的波长,也使没有因破碎而丧失能量的波的波高变大。伴随着波周期的逐渐增大,在生波区内呈现出波高有所增加。要描述生波区内的波浪特征,显然比仅用一个波高和周期就能加以确定的正弦波困难得多。一旦采用某种技术(包括水压传感器,测波杆,水面闪烁装置和其它遥感法)取得一组水面高程记录,往往就可采用两种可能途径之一来进行分析(图 22.1)。可以进行波高的统计分析,标出记录中的最大波高、平均波高或均方根波高。通常用的统计波高则是有效波高 H_s,它是波浪中最大的三分之一的波高的平均值。所以选用它是基于这样的考虑,即在许多应用中,较大的波比小波重要,从而 H_s 提供了一个比其它波高,例如平均波高,更有代表性的波浪量度。也曾经表明 H_s 与代表性波高的目测值大致相应,在目测中,观测者自然将其观察偏重于大波。理论和实测均表明,在充分发展的风

暴波中，这些统计波高有明确的比率。例如，H_s与平均波高之比接近于1.56，与均方根波高之比为1.42。在一组波浪记录中，最大实测波高与记录的长短有关，所以最大波高与其它波浪统计值之间没有固定比值。还可定义一个有效波周期或平均波周期，但是与相应的波高相比，物理意义上就要差些，而且我们还会看出，它们的应用会导致一些错误的结果。

第二十三课　港址选择中的场地要求

建港位置的选择取决于许多因素，其中包括陆地要求、水深和空间的要求以及尽可能地保护港口免遭波浪、海流和淤积等影响的要求。

场地要求取决于港口的性质以及为运输、贮存(室内室外)和工业对面积的相应要求。难以给出对陆地面积要求的一般规则，但现代化集装箱泊位通常要求有8公顷的陆地面积。最近的发展已将这个数字增加到10～12公顷。港口如何用来为工业生产服务，常是规划中的一个主要因素。许多港口有相当一部分的收入来自工业占地的出租，而港口经营本身却可能是亏损的。所以，许多因素要在陆上设施的规划中加以考虑。

当预计的吞吐量和中转量已按基本准则规定后，可对运输面积、贮存面积和港口设施作出具有合理精度的规划。目前，在所有港口的综合规划中，这种分析常是要做的。

港址选择和港口建筑物布置包括的一些基本问题，已由PIANC(国际海运会议常设理事会)所属的LCORELS(大船接纳委员会)作了相当详细的论述。成果已在各种报告中刊布。

PIANC ICORELS I组中1979报导了"分析风、浪和涌的资料来估计年内出现天数的方法和港口、船泊在这些要素作用下运营受阻的最长历时。"

IV组制订了有关航道尺寸；回转圆水域和安全要求水域；助航设备；和船舶操纵问题(包括船舶模型试验)等的通用准则。此外，为了施工和维护而进行的疏浚问题也由IV组给予了论述，疏浚和浚得弃土处理的环境效果由PIANC委员会在其出版的公告No.27(第二卷，1977)的附录内"疏浚及疏浚物质处理的环境效果研究"一文中进行了报导。

港址选择与波浪的方位，水流以及泥沙输送有关。海洋建筑物必须尽可能地置于掩蔽处，例如：

1. 岛或浅滩的背后。
2. 深水海湾或海边峡湾中。
3. 掩蔽的环礁湖、潮汐入口或河湾中。

关于沿岸流问题，必须留出在海边造了建筑物后，海底和岸线逐渐改变的余地。

由于大型海工建筑物耗资巨大，在进行规划时务必考虑到将来的发展，包括船舶大小的概估增长，特别是散装货船与集装箱船两者吃水深的增大。

正如PIANC的ICORELS委员会No.1文件中详述的那样，港址选择与许多环境参数密切相关。所谓的"实施极限条件"取决于下列就地条件：

1. 天文潮
2. 风
3. 由于气象条件引起的水位变化，尤其是风暴潮(涌波)和所谓的"负涌波"。
4. 波浪(振幅，周期，方向)。
5. 海流。
6. 能见度。

7. 冰。

8. 泥沙输送。

在考虑到投资费用:维修费用和为航行安全所必须的开支等的各种可能性进行比较经济调查后,再对每个项目制定其实施极限条件。

为了确定这些要求,需要对上列的现场条件进行统计调查。得出的实施极限条件一般要受到环境条件的影响。也要受到经济考虑以及某些实用方面(例如拖轮辅助设备和其它必须的服务设施等)的影响。

第二十四课 港湾的口门与航道

港湾的口门、航道和回转水域的设计,取决于预期进入本港最大船只的尺寸。在港口设计中,虽然气象和海洋因素是重要的,但首要的在于确定实际的设计船只的尺寸。记住在船舶建造中的最近趋势是向大型和快速船只发展。

图 24.1 为美国商业部海运局估计的,到 2040 年最大的油轮、散装货船和杂货船的规划尺寸。图 24.2 上的数字是根据目前和潜在的工艺水平估计出的船舶的任意选取的实际限度。图 24.1 中船舶尺寸表明到 1982 年,油轮载重量可达 100 万吨,到 1995 年散装货船可达 40 万吨,杂货船可达 5 万吨。上述载重吨位的平均值假定为实际上限。

因为有些人会认为上述判断过于保守,克雷曾将曲线外延至超出了所谓的实际上限,而不考虑其可靠性和实用性。

口门水深和航道水深

将口门水深与航道水深区分开,表明这两个水深未必一致。港湾入口常受到比发生在港湾内要大的波浪。因此,船舶的抬升或纵摇在航道入口处比航道内要大。在决定所要求的水深时应包括预期抬升这一因素。

国际海运会议常设理事会(PIANC)建议最小设计水深应当就设计船只的夏季静止海水吃水深再加上 1.5 至 2.5 米。不过,尽管这个标准能用以估计必需的航道水深,具体的计算还要在综合下列因素的基础上来确定:

1. 船舶的满载吃水
2. 潮汐
3. 海水密度
4. 船体尾部下坐
5. 纵摇和横摇
6. 纵倾
7. 经验因素(变浅速率)

航道宽度

航道宽度通常在边坡坡脚处或就设计水深量取。航道宽度取决于下列因素:(a)设计船舶的宽度,速度和操纵灵敏性,(b)是否容许错船、(c)航道水深,(d)航道定线和航道是在窄的还是宽阔的水道中,(e)航道边坡的稳定性,(f)航道中的风、波浪、水流和横流。没有显含所有这些因素的公式,但已建立以设计船宽为基础的一些标准,其中隐含了这些因素。PIANC 建议,若无错船,航道宽应是设计船宽的 3~4 倍;若有错船,航道宽应是设计船宽的 6~7 倍。他们建议这些标准是用于理想条件的,横风和横流还须另加考虑。

决定必需的航道宽度的另一种方法是建立在对巴拿马运河作模型船和原型船运动试验研究海平面的调查中得的。引航员和驾驶员的意见已采纳在提出的标准中。这个方法将航道总宽度分为：(a)操纵带的宽度，(b)船舶的净空宽，(c)岸边净空宽。

第二十五课　防波堤和突堤

防波堤和突堤并非同义词。在美国和英国，突堤的定义有所不同。在美、英两国，防波堤是保护港口、锚地或港池的建筑物，以防止波浪对围起来以接纳船舶的地区产生破坏性的影响。在美国，突堤是那种伸入水域的建筑物，用来引导或限制水流或潮流使其进入指定的河槽，或防止其淤浅。突堤建在河口或海湾进口处，以便河槽加深及稳定，从而有利于航行。在英国，突堤是顺码头和突码头的同义词。

为了避免这两个术语引起混淆，将只用防波堤这个名词。

防波堤

防波堤基本有两类：直(或几乎垂直)墙型，可用天然岩石，圬工，木料，钢或混凝土建成；斜墙型，可用岩石，混凝土或石料、混凝土和沥青混合建成。

多数直墙是不透水的。但是由分散的板桩或木板组成并充以石块的笼箱-填石木笼和下文提到的多孔直墙防波堤为例外。

直墙型防波堤

用单道防波堤，腓尼基人在4000至5000年以前在泰尔建成了他们著名的开敞海岸港，用特种销钉将矩形块体连成直墙。十九世纪和二十世纪初，类似的直墙设计普遍采用。

许多事故证明了这种设计有重大的缺点。一部分是波浪直接在建筑物上破碎，另一部分是堤前的底部淘刷引起防波堤崩塌，从而导致了它倾复。1934年间，400m长的阿尔及尔港防波堤，以及1933年卡塔尼亚700m防波堤均遭破坏。这两座防波都是抛石基床上叠置块体的直墙建筑。

虽然这两座防波堤具有相似的设计和质量，由于施工有基本的差异，破坏方式完全不同。两座防波堤均由掺杂一定蛮石成分的混凝土巨块砌成，卡塔尼亚是12×4×3.25m，阿尔及尔是11×4×4m。这些巨块各重320t和400t，在防波堤上丁头横放，两端成为墙的内外面。然而，卡塔尼亚的块体是简单的砌置，既无垫层，也无搭接；阿尔及尔的巨块具有内部的竖井，当整个墙建成后，填以钢筋混凝土，于是从基底至顶部形成一个整体的建筑物。如预计的一样，在这种条件下，卡塔尼亚防波堤因块体逐层滑动而破坏；阿尔及尔防波堤在开裂和崩解前是沿垂直截面整体塌落的，在波浪的作用下，抛石基床被淘挖，墙脚处沙泥质软海底上冲出一条深沟。卡塔尼亚的破坏情况与热那亚的破坏非常相似。

为了避免这类破坏，破波所含有的高压力必须加以吸收，或最好是设法避开，在堤脚处必须有防止淘刷的适当措施。后者要求有包括水工模型试验经验的精心设计。

第二十六课　透空式顺岸码头、实体式顺岸码头和栈桥式突码头

透空式顺岸码头，实体式顺岸码头和栈桥式突码头都是海上建筑物，用以系泊或停靠船舶、装卸货物和或上下旅客。这两种顺岸码头的后面有仓库区，调度和堆存区，工业区，道路，铁路等，这些场地通常是由大规模填方形成的。美国和世上许多地方的港区及其邻近地区都是象

这样建造在河口湾、环礁湖或河岸的填土上。该填土来源于港口航道和港池的疏浚弃土。

突码头通常是矩形的、伸向水域的透空式码头。在英国，常称它为突堤，也称之为堤道码头。与防波堤结合时，则常称为防波堤式突码头。

由于其几何形状，它可以有三侧靠船。突码头不一定必须与岸线或码头线垂直，可以任意角度伸出去。也可用栈桥与岸线或码头线连成T形或L形。在一般的港口术语中，透空式顺岸码头，实体式顺岸码头和突码头常通称为码头。

透空式码头和实体式码头的布置：

透空式码头和实体式码头有多种布置形式，不存在固定的规则，只要实用即可。有两个主要的布置的边界条件，一是可用的水域及其几何形状(海湾、内河、外海)，二是可用的陆地面积(为建造港口服务设施和转运以及实用上最好设在港区内的企业使用)。

基本上有两种布置原则：顺岸式和突堤式。突堤式包括与岸线垂直或成一定角度的突码头。T形突码头是两者的混合物。这些原则在纽约和纽瓦克港区中都有所示范。

*　　*　　*　　*　　*

对于港池长度问题，无通用的规则。Quinn 仅提到突码头每侧布置一、两个泊位。Fugl Meyer 则认为“港池长度不应超过 2000m，否则将有碍于运输和航行”。港池不应是曲线形的，因为这将使靠船不便。微凹形妨碍不大。凸形的码头在停泊大船时必须有浮式护舷或其它装置才行。

码头的最小长度必须能够停靠预期到港的最长船只。对于 9m 水深的中型港口，会停靠最长可达 160m 的船只，两头还要各加 20m 供带缆用，总长度至少应有 200m。

至于港池的宽度，在两侧都有码头的港池中，Fugl Meyer 考虑下列交通情况以便得出某些明确的数字：

1. 两侧码头均靠泊最大的船，每条船的外舷又各停靠两排驳船，这些系泊的船只之间还要有一条两倍于大船宽的通道。

2. 两侧码头均靠泊较小的货船，外舷又各停靠一排驳船，四倍于较小船船宽的通道，以供两条船能通过。

3. 加宽河港港池，使其中间置一排靠船墩作为系泊处，让大船直接卸货于河驳及其它河船上。如果在港池中设置这样的靠船墩，要求附加宽度应超过情况 1 所需的宽度。附加量为最大船船宽和船两侧各一条河船的宽度。需要两条通道，在这情况下它们必须是预期船宽的两倍。

下列规定可用以得出上述三种情况中，港池宽的需用数值：

$B=22$m，大船宽

$b=14$m，沿海船(地方船)船宽

$c=7$m，驳船宽

$f=10$m，河船宽

情况 1：$4\times B+4\times c=116$m

情况 2：$6\times 6+2\times c=98$m

情况 3：$7\times B+6\times f=214$m

关于港池的深度，Fugl Meyer 恰当地主张，港口港池的必要深度不宜仅仅取决于到港船舶的最大吃水深，更实际的是要有充足水深以容纳预计的最大到港船只。这就提出了什么水深是必要的与什么水深是可能的这一重要问题。

第二十七课　护　舷

护舷设施应该是在船只靠码头时保证靠船安全，不损伤船只或岸壁，并吸收靠船力。护舷只能吸收船只与岸壁间的一部分力。系泊设施能消除平行于岸壁的大部分力，但不能对付垂直作用于岸壁的力。

护舷可分为两大类，(a)保护性护舷，它在船只与岸壁之间，始终起着吸收能量和护垫的作用，(b)撞击性护舷，它能吸收撞击力，尤其是在靠船作业期间。由某一护舷吸收的能量可由其变形图得出：

$$吸收量\ E=\int_0^s F(s)ds$$

其中 $F(s)$＝力，s＝护舷移动的距离。

图 27-1 所示为三种不同的护舷系统——液压的、弹簧的和橡胶的——的变形图例。原则上，最好的是线性弹簧系统。液压系统对船体似乎稍硬了些，而“橡胶”系统(不一定仅是橡胶)通常是对船体有利，但对码头岸壁费用偏高。然而，并非所有的橡胶护舷都有此特性。

保护性护舷通常是木质的或橡胶的。木质护舷可以是纵横构件排列而成。裸露的原木构件上可用一层较薄的硬木加以保护。并用长钉固紧在主要的垂直构件上。用杂酚油处理过的浮木或硬木早有采用。

有各种橡胶护舷用作保护设施。中空圆形或方形的护舷可以挂在码头岸壁上(图 27.2)。实心的橡胶构件或橡胶管也可在其它构件的正面，后面或中间使用(图 27.3)。旧轮胎也可使用。可以直接挂在岸壁上，或是水平地或垂直地捆扎在一起的“cordkapp 护舷”。上述所有护舷都具有如图 27.1 中橡胶护舷一样的能量吸收图。

码头壁的损坏通常是靠船时的撞击引起的。重型保护性护舷也能起抗撞击的作用，但典型的护舷必须有较牢固的设计。

橡胶材料的弯曲，压缩或剪切，钢弹簧的压缩，液压系统，重力系统，气压系统，液压气压系统都能吸收撞击能量。

日本的 V 形 Seibu 护舷，通过压缩和弯曲吸收能量，用于有大量散装货物装卸的码头上；挪威纳尔维克矿石港是个典型的例子。

重力式护舷悬挂在重链上，按钟摆原理工作。在布鲁克林海军船厂和一些油码头上偶有采用，经证明对避免突然撞击时的大震动很有效。

在护舷方法中有一新的原理，特别是对于直撞靠船墩时很有用，在已参考文献 28 中提及。它利用转矩原理，因其建立在英国剑桥大学的金属塑性变形研究工作上，故称为“剑桥护舷”。每一个护舷是由木垫或转动的气压护舷构件夹在一对转矩臂的端部间构成的，转矩臂牢固地连接在垂直的转矩管内，转矩管在固定于码头边或靠船墩上的颈轴中转动。船的撞击能量被一端固定于岸壁边并同心地插入转矩管的杆的扭转偏移所吸收。

第二十八课　系　泊

如图 28.1 所示，船舶会受到下列各种运动：升沉，偏摇，纵摇，横荡，横摇，纵荡。虽然，船舶系靠码头岸壁时，各种运动都会发生，但纵荡，有时是升沉引起麻烦。纵荡运动通常是由于长波

侵入港湾水域引起的。系缆力计算有非常全面的文献可用。

系泊是将钢丝缆或缆绳系缚在系缆桩柱和环上，而这些桩、柱和环通常是紧固在预置于码头岸壁内的混凝土块体或其它重型构件上。

船首缆、船尾缆和边缆使船系靠在码头边，斜缆(或倒缆)阻止与码头平行的纵荡。作用在船上而必须吸收掉的力是由风，水流，波浪(对小船是短周期波)，偶而也由海啸和船行波引起。为了吸收这些力，缆绳应尽可能地水平布置，这在潮差大的地方难以做到。此外，如果受力主要是对称的，缆绳最好由同样的材料制做，并对称地布置。

系船缆绳主要是钢和天然或合成纤维材料，有许多种搓绞结构，单根钢丝或纤维先编织成股，再按特定的绞法编成绳。“传统绞法”是把成股的钢丝或纤维朝股的相反方向绞。“右绞”是沿着缆绳的方向看去股呈现顺时针的绞纹；“左绞”是逆时针的绞纹。

钢缆绳中的钢丝可以具有不同的强度，并可镀锌防锈。钢丝缆一般由6股绞成，每股包括19，24或37根单根细钢丝，绞绕在纤维(或钢)蕊上。纤维缆绳一般有3股(简单绞)，也有4股(辘绞)和9股(缆绞)的构造。

典型的纤维材料是马尼拉白麻，西沙尔麻，椰壳纤维，尼龙，莎纶，涤纶，人造丝和聚丙烯。马尼拉大麻产于菲律宾；西沙尔麻纤维产自墨西哥，东非和爪哇，椰壳纤维产于印度。其余的纤维都是合成产品，它们具有天然纤维所缺少的某些合用的特性。

根据制造厂的数据，缆绳在空中和水中的重量与标称直径绘成图表明：无论是钢丝缆还是纤维缆，无论是湿的还是干的，重量与直径的关系呈平方规律。一般每单位长度缆绳在水中的重量 w 和在空气中的重量 w_a，可用标称直径 d 表示为：

$$w=C_w d^2$$

$$w_a=C_a d^2$$

其中 C_w 和 C_a 分别为各式中的比例常数。

根据制造厂的数据，把钢丝绳和纤维绳的破坏(极限)强度 T_u 作为标称直径的函数作图。同类点据的分布都近乎平行和表示了平方关系的斜线：

$$T_u=C_u d^2$$

其中 C_u 是比例常数。

对于同样尺寸的缆绳，仅次于钢丝缆，尼龙绳具有最大的强度，因其重量轻，在某些系泊类型中，有其价值。涤轮，聚丙烯和马尼拉麻绳在要求弹性比尼龙为低的场合有使用价值。马尼拉麻绳和椰壳纤维绳广泛地应用在海港的系泊方面；马尼拉麻绳最受欢迎。椰壳纤维绳比之马尼拉麻绳弹性大但强度差，多用作“倒缆”或“环索”，与钢丝缆连结使用，对港口的纵荡起缓冲的效果。纤维缆绳的干湿极限强度通常不同。尼龙绳的湿度通常低于其干强度5%～19%聚丙烯缆绳的湿强度则高于干强度约5%。涤纶缆绳干湿强度几乎一样。

第二十九课　人　工　岛

有很多理由说明为何港口当局以及世界各地的企业正在注视着人工岛的创建，以接纳大船和适应有关企业活动的发展。虽然IAPH(国际港湾码头协会 International Association of Ports and Harbours)和PIANC对“大船”的定义通常是20万吨以上的船，在本报告中，还要考虑一些较小的特种船只。

一般说来，这类岛的实现能解决因远洋轮的吃水深日益增长以及海岸带的拥塞和污染等

引起的各种问题。

由于此类工程的边界条件因地点的不同而变化很大，不可能期望构想出一些普遍适用的建议，对技术和经济的可行性作出完整的评价。然而，在研究一个工程时遭遇到的各种问题会与另一个工程遇到的问题相似，所以，在PIANC的国际论坛上，有关机构的经验交流将是有益的。

岛屿集散地通常是海外源地或目的港与岸上或内陆相连系的运输系统中的一部分。人工岛是整个运输系统中，正常岸上位置的一个替换选择。不过，合理的决定只能在对整个运输系统(从源地至终点港)作了成本-效益分析后做出。加深和扩展现有港口以及朝海洋方面拓进的费用，在许多情况下因耗资过大而不宜采取。基本的因素是：

1. 疏浚量过大，或底部是岩石，很难清除。

2. 现有隧洞、船闸、电缆和海底管线等不允许港口加深，除非可加替换(人工装置)。

海岸演变

由于较大的水深会产生静水池，使潮汐和海流输送来的泥沙沉入水底，淤浅特别会使港湾和航道的加深带来日益增长的昂贵维护问题。

已拥挤不堪的海岸线的利用正成为人们主要关心的问题。近来在美国召开的"工业社会向海发展"会议上，统计数字表明，沿海地区的人口密度日益增长，河口湾区趋于饱和及促进人工造陆。

1. 土地的"最高和最好的利用"已成了海岸带(陆上和近海)区划的一个准则。

2. 缺乏疏浚弃土场地使得对河流及航道的疏浚不再有吸引力，由于陆上场地缺乏而且对潮间地环境的担心，又会排斥沼泽地的填充。

3. 因疏浚和建造大船的集散港会对环境造成损害，港址接近居民中心，将遭到日益增强的反对。这使得许多需扩建的港口必然缺乏可选场所。

此外，这类集散港的运营，增加了一些不受欢迎的辅助活动，从碰撞或任何单项事故到造成严重破坏的较大风险，是某些地区居民们所不能接受的。

污染

噪音、废弃物、看得见的缺点和许多人强烈愿望在滨水区的工业利用上保持现状，使得人们专心注意于这些业务转移到近海的岛屿上去。或者，在一些场合，希望将产生污染的工业迁移到近海区去，以腾出岸上场地给其它工业，因为近海区的"污染容限"可以较高。例如，噪音和不雅观的影响将因其远在近海处而不再被当地居住的土地使用者听到或见到。大陆架上开阔而无人居住的港口中，工业的其它发散废料可能稀释到无害于生态。

人工岛的可扩大性是它们具有吸引力的众多原因之一。若充分远离现有的发展地区，则人工岛的扩大是无限的，而且还确实可以尽量利用充斥我们大城市的瓦砾和垃圾。

第三十课　集装箱船

最流行的单元化船只已从简单的港口集装箱船发展为具有5.3万吨载重量、2800个集装箱装载能力的大型超级集装箱班船。现在，船速已高达31～32kn(nmile/h)。集装箱装运的快速扩展，已导致大西洋和太平洋密集贸易航线上货运和集散港的超载。中级贸易航线上目前也正转向集装箱化，其中有从高度竞争的密集贸易航线上撤换下来的第一代和第二代船只。

将来的集装箱船，虽然速度不会增长，但规模将继续增加。希望将来横渡大洋的集装箱船，

具有相当于3000～4000个集装箱的能力，速度达25～26节。主要的变化将是在船体上，多体（双体，三体）船将日益流行，这样的船可能不是处理单个的集装箱，而是将8～64个集装箱装入一个集装体中，由强基底的龙门吊吊装，或由仓库船型的输送设备水平转运。滚动式拖运架装卸货船是所有商业货船中容积和稳定性受最大限制的船舶。因为船只大小变化不大，这种船的各种比率可取为常数。由于增加了船体拖运架，要求船体加深，滚装船的长深比（L/D）不大。

除了船深、船宽稍大以外，滚装船和与其载重量相近的集装箱船相比，尺寸接近。

与集装箱船相反，散装船较慢，因而长宽比（L/B）较小。因散装货船通常较小而稳定性问题也较少，其宽深比（B/D）较低。又因舱盖小，各甲板层较紧凑，故船深比集装箱船小。与集装箱船比，散装货船较少体积限制，总装得较满（较高），作为排水量的百分数的载重量随排水量而增加，因为钢材，燃料和机械的重量并不随排水量而提高。

油船的情况似乎逐个有相当大的变化，但与矿砂船及谷物船尚属接近，除了具有较大的L/B和L/D比之外，其它方面颇为相似。由于载货密度大，又无舱盖，L/D较大是可能的。

因为油船常用来作粮食船，也有矿砂/油混装船，所以这点相似是不足为奇的。

矿砂矿石船比集装箱船慢得多，因而长宽比较小而填实系数较大。由于矿砂船运行速度相当于表面摩擦力成为船体阻力中比较重要的组成部分，又因大船一般不进入较浅港口，所以为了降低载重量与吃水面积之比，船宽/吃水比较小。矿砂船的L/D较集装箱船小。这是因为矿砂船的重量受到限制，没有大舱盖，所以连续的甲板保证了船体的强度，但不要求船体多深所致。载重量对排水量之比随排水量而加大，因为钢材，机械和燃料等的重量并不与排水量成比例增加。

粮食船比等载运能力的矿砂船稍长，L/B和B/D也较大，接近于散装货船。与矿砂船比，在载重量相等的情况下，船深较大，但L/D相同。由于速度稍快，所以填实系数略低。载重量占排水量的百分数不如矿砂船高，因为船体钢材较重，机械较多以及为高速航行的需要又加大了燃料重量。

第三十一课　未来的施工

在施工方面，意义最深远的新近发展表现为施工项目和施工组织的规模日益加大，工程项目的复杂性日益增长，施工组织与工程机构之间的相互依存和关系的变化日趋复杂，来自政府的规定和要求与日俱增。在规划阶段，管理工作不过是刚刚开始组合着设计、采购和施工使其成为一个整体过程。到这时就会出现、并且还会不断出现包括材料、设备、熟练工人以及技术人员和监工人员在内的资源短缺。有关设计安全、野外施工方法、工程的环境影响和不同施工阶段的人事方针等方面的政府规定也将愈来愈多。管理工作还必须应付由于通货膨胀、能源短缺、变动的世界发展型式和新的社会标准所产生的新经济现实和新文化现实。这些趋势业已加速并将会持续下去。

显然，经济困难以及材料和其它资源的日益短缺，在当今工程项目所面临的各种问题中起主要作用。但并不是说，当急需的工程项目失控或被迫全部予以放弃时，工程师和经理们可以坐视而无动于衷。相反地，更加关键的是项目工程师和经理们的技能有所改进，他们会有较好的工作办法，使他们能尽善尽美地调度和控制可用资源，并更好地应付因新经济压制而带来的这种挑畔性现实。尽管经济问题继续出现，仍然会不断地要求建筑业扩充和改进其能力与经营范围，以适应于变动中和长远看来增长着的业务需求。

值得人们去探求因未来工程管理方法得到改进而获得的潜在受益。例如，有识人士估计大型双机组核电厂延误一天要损失不止20万美元。试想，考虑到当前对这种的工程设计施工时间长达10～11年之久，若在主动构思、设计和施工阶段中的任何时候(因管理方法的改进)而增加了50多个电厂，将是多大的受益！照这样可能节约下来的只不过是企业的一部分。另外，考虑到城市高速运输系统、精炼厂和化工厂、管道、矿物资源开发，以及在工程设计施工中贯彻先进技术，同样能得出类似的结论。这些先进技术足以维持(姑且不说提高)人们的生活水平。

时间、金钱、设备、技术、人力、材料等因素，一切都是资源。将它们组织起来进入活动之中，使这些活动按合理的顺序进行，人们就会得到一个工程项目。无论是兴建海滨小屋还是设计建造亿万元的高速运输系统，型式总是一样的，实际上是把所有这些因素委派于工程项目经理一人来负责。多年来的实践证明这是个好办法。聪慧、能干而经验丰富的工程负责人业已成功地把这些因素“装配起来”了。这些负责人是否还能这样继续下去？为什么过去十年中又出现过事故？比过去尤甚，现在为了胜利地完成目前日益繁复的工程所需资源的规划和控制，仍然在于最困难和最复杂的管理职责方面。欲取得成功，要求对建筑业各个方面有最充分的理解。

第三十二课　关税及贸易总协定

关税及贸易总协定(简称关贸总协定GATT)——是一项多边条约，有88个政府签署，它们的贸易总和占世界贸易五分之四强。关贸总协定的基本宗旨是使世界贸易自由化，并使其建立在牢固的基础上，从而为经济增长和发展、为世界各民族的福利作出贡献。关贸总协定是为国际贸易制订协议法规的唯一多边文件。

过去35年间，关贸总协定还犹如一个最重要的国际机构，在减少贸易壁垒谈判和促进国际贸易关系方面发挥作用。因此，关贸总协定既是一个行动法规，又是一个论坛，在这个论坛上各国可以讨论解决它们的贸易问题，并且通过谈判来增加世界贸易的机会。第二次世界大战以来，国际贸易总额增长了七倍，这证明关贸总协定在上述双重作用中不断取得成功。

关贸总协定于1948年1月生效。从那时起，它的成员国从原有23国增加到目前的88国；同时，另有31国在贸易中也采用它的各项规定。

关贸总协定的各项规定对其成员国的贸易起支配作用，并指导它们处理相互间的贸易关系。为了共同的利益，各成员国自愿接受协定所体现的契约权利和义务。监督这些规定的实施是关贸总协定各项活动中一个重要和持续的部分。关贸总协定也是各国消除贸易壁垒，寻求世界贸易进一步自由化这个一贯的基本目标而进行协作和谈判的场所。关贸总协定范围内陆续进行的多边谈判，已经使贸易障碍逐步减少。

在整个过去的20年中，关贸总协定越来越关注着占成员国总数三分之二以上的发展中国家的贸易问题和需要。多年以来，关贸总协定的发展中国家成员国能够相当灵活地运用它的某些规定。1965年间，在总协定中追加了一些专门处理贸易和发展问题的补充条款。增加发展中国家的贸易利益是贸易谈判东京回合中的重要内容之一。

第三十三课　土木工程施工合同条件(FIDIC条款)*

第一部分　通用条件

定义和解释

1.1. 在合同(如下文所定义的)中,除了在上下文中有其它含义者外,下列单词和词组具有专指的含义:

(a) (Ⅰ)雇主——指本合同条件的第二部分中所规定的本人和其法定继承人,但(除非得到承包人同意)不指雇主的任何受让人。

(Ⅱ)承包人——指其投标已被雇主和雇主的法定继承人接受的人,但(除非得到雇主同意)不指承包人的任何受让人。

(Ⅲ)分包人——指合同中命名为工程中某部分的分包人,或经工程师和其法定继承人同意工程的某部分由其分包的人,但不是任何分包人的受让人。

(Ⅳ)工程师——指雇主指定为合同工作、起工程师作用的并且是合同条件第二部分中命名的人。

(Ⅴ)工程师代表——指在子条款 2.2 规定下,由工程师随时指定的人。

(b) (Ⅰ)本合同——指合同条件(第一、第二部分),规范,图纸,工程量清单,投标书,授标通知,合同协议书(如已签订)以及能确切结合授标通知书及合同协议书(如已签订)的后续文件。

(Ⅱ)技术规范——指合同中所包括的工程规范和在第 51 条规定下或由承包人提出并经工程师批准的,对规范所作的任何修改和增订。

(Ⅲ)图纸——指按照合同规定,工程师向承包人提供的所有图纸、计算和同类性质的技术资料,以及承包人提交并经工程师批准的所有图纸、计算,样品,类型,模型,运营及维修手册和类似的其它技术资料。

(Ⅳ)工程量清单——指投标书中标明价格的完整工程数量清单。

(Ⅴ)投标——指承包人向雇主提出的关于实施和完成工程的报价以及按照授标通知书同意的合同中的规定,对任何工程缺陷进行补救的报价。

(Ⅵ)授标通知书——指雇主对投标的正式接受文件。

(Ⅶ)合同协议书——指在子条款 9.1 中所涉及的任何合同协议书。

(Ⅷ)投标书附录——指包含在附加于合同条件中的标书的附录。

(c) (Ⅰ)开工日——指承包人收到由工程师按第 41 条发出的开工通知上的开工日期。

(Ⅱ)竣工时间——指合同规定(或按第 44 条延长)的,从开工日算起的完成全部工程或规定部分工程的实施并通过竣工试验的时间。

(d) (Ⅰ)竣工试验——指合同中规定的或由工程师与承包人协商同意的一些试验,承包人必须在全部或部分工程由雇主接收以前予以完成。

(Ⅱ)接收证书——指按第 48 条发放的一张证书。

(e) (Ⅰ)合同价——指根据合同规定,在授标通知书中载明的,作为实施和完成全部工程并对其任何缺陷进行了适当补救措施所应付予承包人的款项。

(Ⅱ)保留款——指按子条款 60.2(a),由雇主保留的总金额。

(f) (Ⅰ)本工程——指永久性工程和临时性工程或二者之一,视情况而定。

(Ⅱ)永久性工程——指根据合同而实施的永久性工程(包括机械设备)。

(Ⅲ)临时工程——指为实施和完成工程以及为任何缺陷进行补救所要求的和有关的各种临时性工程(不包括承包人设备)。

(Ⅳ)机械设备——指预期形成永久性工程或其一部分的机械仪表装置或其它物品。

(Ⅴ)承包人设备——指为了实施和完成工程并补救其任何缺陷所要求的任何性质的各种

器具和物品，(临时工程不在内)，但不包括机械设备、材料或预期形成永久性工程或其一部分的其它物品。

(Ⅵ)部分工程——指合同中专门指定的工程的某一部分作为部分工程。

(Ⅶ)现场——指由雇主提供作为实施工程的场所，以及在合同中专门指明作为现场的一部分的任何其它场所。

(g)(Ⅰ)成本——指在现场内外遇到的或将遇到的全部费用，包括正当摊派的通常开支和其它开支，但不包括任何利润补贴。

(Ⅱ)工作日——指日历日数。

(Ⅲ)外币——指工程场所所在国家以外的其它国家的货币。

(Ⅳ)文件——指任何手写、打字或印刷的信息，包括用户电报、海底电报、传真发送等。

第三十四课　标书与合同协议书

标　　书

合同名称：* ____________________

致：* ____________________

先生们：

1. 考虑到实施上述工程的合同条件、技术规范、图纸、工程量清单以及投标书附录第______号，在本文件末尾签名的我们，愿按照合同条件、技术规范、图纸、工程量清单和全部附录以款额为____________________

(____________________)的投标总价，或根据上述合同条件能肯定的其它标价，提供工程的兴建完成并修补其任何缺陷。

2. 我们承认附录是本标书的一部分。

3. 如果本标书被接受，我们将在收到工程师的开工通知后，合理地尽快着手开工，并在标书附录声明的时间以内，完成合同中所包括的全部工程。

4. 我们同意在收到通知的当天起* ______天的期限内遵守本标书，该标书对我们具有法律的约束力，保证在该期限截止以前的任何时候予以认同。

5. 除非等到正式的协议书业已签订并开始付诸实施，本标书与你们书写的有关授标文件一起，将是我们之间具有法律约束力的合同。

6. 我们理解你们并非在接受最低标价或接受你们收到的任一份标书方面受到法律约束。

日期19______年______月______日

签名______以______的资格正式委托并代表____________签字。

(印刷体大写)

地址____________________

证人____________________

职务____________________

(注：在标书文件发出以前，所有带*号部分的细节都应填写齐全)。

合同协议书

本协议书于19________年________月________日

由____(以下称为"雇主")作为甲方

与____(以下称为"承包人")作为乙方签订。

鉴于雇主期望承包人实施某项工程,即________________________并业已接受承包人提出的为实施和建成该工程并对其任何缺陷进行补救的标书。

兹对下列事项达成协议:

1. 本协议书中的词汇和词组应与下文提及的合同条件分别赋于它们的具有相同的含义。

2. 下列文件应被认为是组成协议书的一部分,并应作为其一部分进行阅读和理解:

a)授标通知书

b)上述的标书

c)合同条件(第一和第二部分)

d)技术规范

e)图纸

f)工程量清单

3. 考虑到雇主准备向下文所提及的承包人付款,承包人特此与雇主缔约在各方面均依照合同规定实施和完成本项工程并补救其任何缺陷。

4. 雇主特此立约在合同规定的时限内按合同规定的方式向承包人支付因实施和完成本项工程并修补其任何缺陷所应得的合同价款或其它应付款项。

根据各自的法律,双方按本协议书一经签订立即开始执行协议,此证。

在____________在场的情况下,盖____________________的正式印章

或在______________在场的情况下,由上述________________代表甲方签字盖章并负责递交甲方。

受约束雇主签字________________________

受约束承包人签字________________________

［Ｇｅｎｅｒａｌ　Ｉｎｆｏｒｍａｔｉｏｎ］
书名＝港口及航道工程专业英语
作者＝
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