T/CECS 1629－2024

中国工程建设标准化协会标准

Standard of China Association for Engineering Construction Standardization

热熔式可回收锚杆技术规程

Technical Specification for Application of Hot-Melt Removable Anchors

中国建筑工业出版社
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Technical Specification for Application of Hot-Melt Removable Anchors

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前 言

Preface

本规程根据中国工程建设标准化协会《2018 年第二批协会标准制订、修订计划》（建协标字[2018]030 号）的要求，由浙江大学和苏州市能工基础工程有限责任公司会同国内多所大学、科研单位、岩土工程专业设计单位、岩土工程施工单位、检测与监测单位等，经过广泛调查研究，参考有关国家、行业、地方及团体标准，编制了本技术标准。

This specification has been developed in accordance with the Second Batch of Association Standards Development and Revision Plan for 2018 (Jianxie Biaozi [2018] No. 030) issued by the China Association for Engineering Construction Standardization. The document was jointly prepared by Zhejiang University and Suzhou Nenggong Foundation Engineering Co., Ltd., with contributions from several universities, research institutions, geotechnical design organizations, construction units, and testing and monitoring agencies. The preparation involved extensive investigations and reference to relevant national, industry, local, and association standards.

本标准共分 9 章和 8 个附录，主要内容包括：总则、术语符号、基本规定、材料及构件、设计、施工、试验、检验与监测等。

This standard contains nine chapters and eight appendices, covering:

(i) General Provisions,

(ii) Terms and Symbols,

(iii) Basic Requirements,

(iv) Materials and Components,

(v) Design,

(vi) Construction,

(vii) Testing, and

(viii) Inspection and Monitoring.

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本标准由中国工程建设标准化协会地基基础专业委员会归口管理，由浙江大学和苏州市能工基础工程有限责任公司负责具体内容的解释。本标准在执行过程中如有意见或建议，请寄送至苏州市能工基础工程有限责任公司（江苏省苏州市新区滨河路 711 号 3 楼，邮政编码：215011，邮箱：nenggong@126.com）。

This standard is administered by the Geotechnical and Foundation Engineering Committee of the China Association for Engineering Construction Standardization. Technical interpretation is the responsibility of Zhejiang University and Suzhou Nenggong Foundation Engineering Co., Ltd.

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目录

1 总则

1 General Provisions

1.0.1 为规范热熔式可回收锚杆技术的工程应用，做到安全适用、技术先进、保护环境、节约资源，制定本规程。

1.0.1 This specification is established to standardize the engineering application of hot-melt removable anchors, ensuring safety, technical advancement, environmental protection, and resource efficiency.

1.0.2 本规程适用于热熔式可回收锚杆的设计、施工及质量检验、监测等。

1.0.2 This specification applies to the design, construction, quality control, and monitoring of hot-melt removable anchors.

1.0.3 热熔式可回收锚杆的使用应综合工程地质和水文地质条件、周边环境条件、基坑功能要求和使用期限、回收要求及条件等因素,结合地区经验,因地制宜、合理选型,精心设计,精细施工,加强质量控制。

1.0.3 The use of hot-melt removable anchors shall consider engineering geology, hydrogeology, surrounding environments, functional and service-life requirements, recovery conditions, and regional experience. Designs shall be adapted to local conditions with appropriate selection, careful detailing, precise construction, and strengthened quality control.

1.0.4 热熔式可回收锚杆的工程应用除应符合本规程的规定外，尚应符合国家现行有关标准及现行中国工程建设标准化协会有关标准的规定。

1.0.4 In addition to this specification, hot-melt removable anchor works shall comply with current national standards and standards issued by the China Association for Engineering Construction Standardization.

2 术语和符号

2 Terms and Symbols

2.1 术语

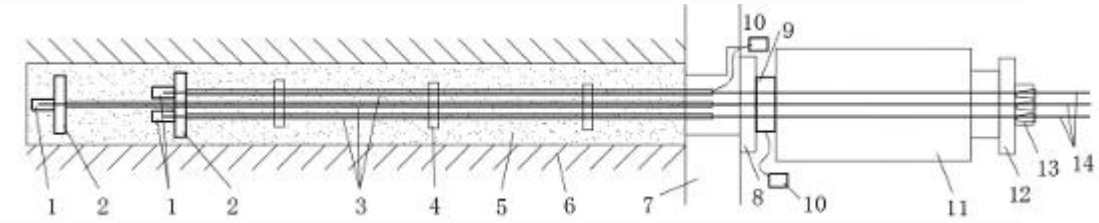
2.1 Terms

2.1.1 热熔式可回收锚杆 hot-melt removable anchor

内锚具为热熔式可回收锚具、锚筋材料为无粘结钢绞线的压力型预应力锚杆，简称热熔锚(图 2.1.1)。

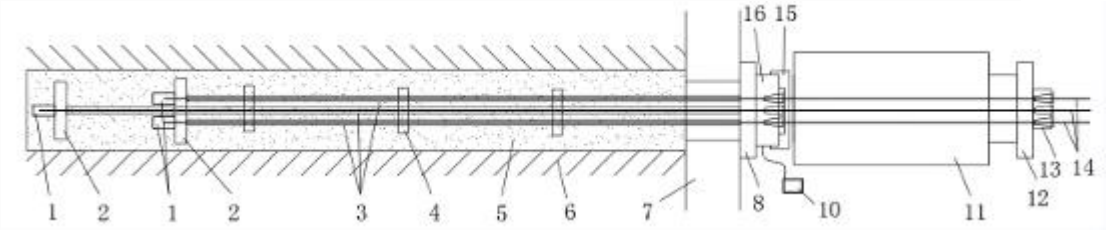
2.1.1 Hot-melt removable anchor

A pressure-type prestressed anchor that uses a hot-melt removable inner anchorage and unbonded steel strands. Referred to as a *hot-melt anchor*. (Figure 2.1.1).



(a)荷载试验工况

(a) Load test condition



(b)张拉锁定工况

(b) Tensioning and locking condition

图 2.1.1 热熔锚结构示意图

Figure 2.1.1 Schematic diagram of hot-melt anchor structure

1-内锚具/数字内锚具;2-承载板;3-护套及润滑油脂;4-对中架/隔离架;5-浆体/锚固体;6--地层;7--锚座;8--锚垫板;9-数字环;10-数据采集仪;11-千斤顶;12-钢垫板;13-工具锚;14有粘结钢绞线;15-限位板;16-外锚具(工作锚)/数字外锚具;

1-Inner anchorage/digital inner anchorage; 2-Bearing plate; 3-Sheath and lubricant; 4-Centering/spacer frame; 5-Grout/anchorage body; 6-Strata; 7-Anchor seat; 8-Anchor plate; 9-Digital ring; 10-Data logger; 11-Jack; 12-Steel plate; 13-Tool anchorage; 14-Bonded steel strand; 15-Limiter plate; 16-Outer anchorage (working anchorage)/digital outer anchorage.

2.1.2 内锚具

位于压力型锚杆的杆体底端，固定锚筋并将锚筋拉力传递到承载体的锚固装置。

2.1.2 Inner anchorage

A device at the lower end of a pressure-type anchor that secures the tendons and transfers load to the anchorage body.

2.1.3 热熔式可回收内锚具

采用热熔材料固定夹片及锚筋，通电后热熔材料熔解而具有解锁回收锚筋功能的内锚具，简称热熔内锚具。

2.1.3 Hot-melt removable inner anchorage

An inner anchorage that uses fusible material to fix the wedges and tendons. When electrified, the material melts, releasing the tendons to enable recovery.

2.1.4 承载体

位于压力型锚杆底端，将内锚具或锚筋的力传递到锚固体的板状或柱状部件，其中形状为板状时也称为承载板。

2.1.4 Bearing element

A plate- or column-shaped component at the bottom of the anchor that transfers load from the inner anchorage or tendons to the anchorage body.

2.1.5 热熔式可回收数字锚杆

配置了数字内锚具的热熔锚，简称数字锚。

2.1.5 Digital hot-melt removable anchor

A hot-melt anchor equipped with a digital inner anchorage.

2.1.6 数字内锚具

内置数字测力装置可用于测试锚杆持有荷载的热熔式内锚具。

2.1.6 Digital inner anchorage

A hot-melt inner anchorage embedded with a digital load-measuring device for monitoring anchor load.

2.1.7 数字外锚具

内置数字测力装置可用于测试外外锚头压力的外锚具。

2.1.7 Digital outer anchorage

An outer anchorage equipped with a digital device to measure head pressure.

2.1.8 数字测力环

在外锚头端测试锚杆压力的输出数字信号的测力装置。

2.1.8 Digital load ring

A digital load-measurement device installed at the external anchor head.

2.1.9 预制杆体

预先在工厂把无粘结钢绞线、承载体及内锚具等零部件制造装配成一体的锚杆杆体，简称预制杆。

2.1.9 Prefabricated anchor tendon

A factory-assembled tendon composed of unbonded strands, bearing elements, and inner anchorages.

2.1.10 单筋杆

由一个承载体、一条钢绞线及一个内锚具组成的预制杆体。

2.1.10 Single-strand tendon

A prefabricated tendon made of one bearing element, one steel strand, and one inner anchorage.

2.1.11 双筋杆

由一个承载体、两条钢绞线及两个内锚具组成的预制杆体。

2.1.11 Double-strand tendon

A prefabricated tendon composed of one bearing element, two strands, and two inner anchorages.

2.1.12 解锁锚具抗拆力

可回收锚杆在拉力作用下，锚筋能正常解锁回收所对应的最大轴向拉力。

2.1.12 Unlocking tensile resistance

The maximum axial force under which tendon unlocking and recovery can be reliably achieved.

2.1.13 锚具效率系数

锚筋--锚具组件实测极限抗拉力与锚筋公称极限抗拉力之比。

2.1.13 Anchorage efficiency factor

The ratio of the measured ultimate strength of the tendon–anchorage assembly to the nominal tensile strength of the tendon.

2.1.14 锚具解锁

解除锚具与锚筋力学关联的动作。

2.1.14 Anchorage unlocking

The action of releasing the mechanical connection between the anchorage and the tendons.

2.2 符号

2.2 Symbols

2.2.1 作用和作用效应

2.2.1 Actions and Effects

f_{ck} 浆体边长为 70.7mm 的立方体抗压强度标准值;

f_{ck} : Characteristic compressive strength of a 70.7 mm cube-shaped grout specimen.

R_{uk} 锚杆受拉极限承载力标准值;

R_{uk} : Characteristic value of the ultimate tensile resistance of the anchor.

N_k 锚杆轴向拉力标准值。

N_k : Characteristic axial tensile force applied to the anchor.

2.2.2 几何参数

2.2.2 Geometric Parameters

A_{ln} 锚固体受压净面积;

A_{ln} : Net area of the anchorage body subjected to compression.

D、D_k 原孔锚固段及扩体锚固段直径;

D, D_k : Diameters of the standard and enlarged anchorage sections, respectively.

L_{as} 、L_{ak} 原孔锚固段及扩体锚固段长度;

L_{as} , L_{ak} : Lengths of the standard and enlarged anchorage sections, respectively.

$L_{a,i}$ 锚固段在第 i 层岩土层中的长度。

$L_{a,i}$: Length of the anchorage embedded in the i-th stratum of rock or soil.

2.2.3 设计参数和计算系数

2.2.3 Design Parameters and Coefficients

f_{mk} 锚固体与第 i 层岩土层之间粘结强度标准值;

f_{mk} : Characteristic value of bond strength between the anchorage body and the i-th layer of rock or soil.

f_{ak} 扩体锚固段面端岩土层端阻强度标准值;

f_{ak} : Characteristic end-bearing strength at the base of the enlarged anchorage section within rock or soil.

$F_{p0.2}$ 钢绞线 0.2%屈服力;

$F_{p0.2}$: Yield force corresponding to 0.2% strain in the steel strand.

K_a 锚杆受拉承载力安全系数。

K_a : Safety factor of the tensile capacity of the anchor.

3 基本规定

3 Basic Requirements

3.0.1 热熔锚设计与施工前应具备拟建场地岩土工程勘察资料,并应查明场地地下障碍物、周边既有建(构)筑物、市政设施等施工与周边环境情况。

3.0.1 Prior to design and construction, complete geotechnical investigation data shall be obtained, including subsurface obstructions, nearby structures, municipal utilities, and environmental conditions.

3.0.2 热熔锚设计工作年限不应少于 1 年且不应大于 5 年。

3.0.2 The design service life of hot-melt anchors shall be between 1 and 5 years.

3.0.3 热熔锚设计时应对抗拔承载力、锚筋抗拉承载力及锚固体底端抗压承载力等进行验算,并应提出施工及质量检验、工程监测要求。

3.0.3 Design shall verify pullout resistance, tendon capacity, and base compressive capacity. Requirements for construction, quality control, and monitoring shall also be defined.

3.0.4 锚杆选型时应选择适宜的部件,对持有荷载要求严格及变形要求严格的工程宜选用数字内锚具。

3.0.4 Anchor components shall be selected according to project needs. Digital inner anchorages are recommended where strict load-holding or deformation control is required.

3.0.5 热熔锚工程应进行基本试验、回收试验及验收试验，可进行持有荷载试验。

3.0.5 Basic, recovery, and acceptance tests shall be performed. Load-holding tests may be conducted when required.

3.0.6 热熔锚工程施工前应编制专项施工方案。

3.0.6 A dedicated construction plan shall be prepared before anchor installation.

3.0.7 热熔锚施工和回收工况应符合设计要求。

3.0.7 Construction and recovery conditions shall meet design requirements.

3.0.8 相关责任方需提供符合收热熔锚的拆除工作面等回收条件。

3.0.8 Responsible parties shall provide adequate working space and conditions for anchor recovery.

3.0.9 热熔锚工程应对锚杆施工及锚杆回收进行质量检验和记录。

3.0.9 Quality inspection and documentation shall be maintained for both installation and recovery.

4 材料和部件

4 Materials and Components

4.0.1 热熔锚的材料及部件应根据锚杆设计承载力、套管孔径及场地岩土工程条件等进行选用。

4.0.1 Materials and components used in hot-melt anchors shall be selected according to the anchor's design capacity, casing diameter, and geotechnical conditions at the site.

4.0.2 热熔锚预制杆宜由热熔锚具、承载体、钢绞线、导线等材料与部件组成，数字锚预制杆宜由热熔锚具、承载板、钢绞线、导线、测力装置、数据线等材料与部件组成。

4.0.2 Prefabricated tendons for hot-melt anchors shall comprise hot-melt anchorages, bearing elements, steel strands, and electrical wiring. Digital anchor tendons should additionally include load sensors and data transmission cables.

4.0.3 热熔锚预制杆的构造及规格应符合本规程附录 A 的规定。

4.0.3 The configuration and technical specifications of prefabricated tendons shall conform to the provisions set out in Appendix A of this specification.

4.0.4 热熔锚预制杆应符合下列规定:

4.0.4 Prefabricated tendons shall meet the following requirements:

1.锚筋回收后，单件热熔锚具残留物的长度不应大于 0.5m，残留物中的金属体积不应大于 $1.0\times10^{-3}m^3$;

1. After tendon recovery, the remaining residue from a single hot-melt anchorage shall not exceed 0.5 meters in length or 1.0×10^{-3} m^3 in metal volume.

2.钢绞线应采用预应力混凝土用钢绞线且不应采用回收钢绞线，钢绞线公称直径宜为 15.2mm，公称抗拉强度不宜低于 1860MPa，性能指标应符合现行国家标准《预应力混凝土用钢绞线》GB/T5224 有关规定;

2. Steel strands shall comply with the National Standard GB/T 5224. A nominal diameter of 15.2 mm and a minimum tensile strength of 1860 MPa are recommended. The use of recycled strands is prohibited.

3.承载板应采用热轧钢板制作，钢材牌号不应低于 Q355B;

3. Bearing plates shall be fabricated from hot-rolled steel with a grade not less than Q355B.

4.热熔锚具及承载板的防腐层材料宜采用工程塑料，钢绞线宜采用防腐润滑脂及高密度聚乙烯树脂护套防腐，导线及数据线宜外敷高密度聚乙烯树脂防腐;

4. Anchorages and bearing plates shall be coated with engineering plastic for corrosion protection. Steel strands shall be protected using anti-corrosion grease and high-density polyethylene (HDPE) sheathing. Wires and data cables shall also be externally coated with HDPE.

5.防腐润滑涂层及护套性能应符合现行行业标准《无粘结预应力钢绞线》JG/T 161 的有关规定;

5. The corrosion protection grease and sheathing shall comply with the relevant provisions of the current industry standard JG/T 161: *Unbonded Prestressed Steel Strands*.

6.热熔锚的数据线及导线应连续附着在钢绞线护套两侧;

6. The data cables and wires shall be continuously affixed to both sides of the strand’s HDPE sheathing.

7.预制杆应带有产品标识，标识应符合附录 A 规定。

7. Each prefabricated tendon shall bear product identification markings, in accordance with the requirements of Appendix A.

4.0.5 数字锚具、数字环可单独使用也可组合使用，性能应符合下列规定:

4.0.5 Digital inner anchorages and digital load rings may be used independently or in combination. Their performance shall meet the following requirements:

1.精确度等级不应低于 0.5%FS;

1. Accuracy shall be no less than 0.5% FS.

2.数字内锚具量程不应低于 200kN，数字环量程不应低于 500kN;

2. The measurement range of digital inner anchorages shall be at least 200 kN, and for digital rings, at least 500 kN.

3.分度值不应大于 1kN;

3. The resolution shall not exceed 1kN.

4.工作温度宜为-40℃-80℃;

4. The operating temperature range shall be from -40°C to 80°C.

5.传感器及导线应在 0.5MPa 水压下不渗漏。

5. Sensors and connecting wires shall remain leak-free under a water pressure of 0.5 MPa.

4.0.6 注浆管宜采用高密度聚乙烯、聚氯乙烯或聚炳烯材料，且注浆管承受的一次压力不应小于 1.0MPa; 注浆管承受的二次注浆压力不应小于最大注浆压力的 1.2 倍，且不应小于 5.0MPa。

4.0.6 Grouting pipes should be made of high-density polyethylene (HDPE), polyvinyl chloride (PVC), or polypropylene. They shall withstand a primary grouting pressure of at least 1.0 MPa and a secondary pressure of no less than 1.2 times the maximum grouting pressure with minimum pressure of 5.0 MPa.

4.0.7 定位架、束线环及绑扎线宜采用非金属材料。

4.0.7 Centering frames, bundling rings, and binding wires should be made of non-metallic materials.

4.0.8 定位架宜具备隔离与对中功能,且其形状及结构应能满足锚筋保护层要求;定位架的开孔率应能满足浆液在钻孔内的流动性要求。

4.0.8 Centering frames shall be capable of both isolating and aligning the tendon. Their shape and structure must ensure the required concrete cover for the tendons, and their perforation rate shall allow for adequate grout flow within the borehole.

4.0.9 注浆体宜采用水泥净浆并应符合下列规定:

4.0.9 Grouting material shall be cement slurry and shall meet the following requirements:

1.水泥宜采用强度等级为 P.O 42.5R 及 P.O 52.5R 的普通硅酸盐水泥,扩孔水泥可采用普通硅酸盐水泥或复合硅酸盐水泥;

1. Cement should be ordinary Portland cement of grade P.O 42.5R or P.O 52.5R. For enlarged anchorage sections, either ordinary or composite Portland cement may be used..

2.注浆体拌和用水应符合现行行业标准《混凝土用水标准》JGJ63 的规定;

2. Water used for mixing shall comply with the current industry standard JGJ 63: *Standards for Mixing Water in Concrete*.

3.可使用控制浆液泌水、改善流动性、减少用水量、调整凝结时间或提高早期强度的外加剂,外加剂不应劣化浆体的粘结性能。

3. Admixtures may be used to control bleeding, improve workability, reduce water demand, adjust setting time, or enhance early strength, provided they do not impair the bonding performance of the grout.

4.0.10 外锚具应采用夹片式锚具。

4.0.10 Outer anchorages shall be of the wedge-type anchorage design.

4.0.11 锚垫板宜采用热轧钢板制作，牌号不宜低于 Q355B。

4.0.11 Anchor bearing plates shall be made from hot-rolled steel, with a grade not less than Q355B.

5.设计

5 Design

5.1 一般规定

5.1 General Requirements

5.1.1 热熔锚工程设计宜包括下列内容:

5.1.1 The design of hot-melt anchors shall include the following items:

1 锚杆设计工作年限的确定;

1. Determination of the design service life of the anchors;

2 锚杆类型及预制杆产品的选型;

2. Selection of anchor types and prefabricated tendon products;

3 锚杆拉力标准值、极限抗拔承载力、抗拆力、锁定荷载的确定;

3. Determination of the characteristic tensile load, ultimate pullout capacity, unlocking resistance, and locking load;

4 锚杆尺寸、立面布置、单元锚杆数量及纵向间距的要求;

4. Requirements for anchor dimensions, layout, number of unit anchors, and longitudinal spacing;

5 数字锚的比例、布置及测试要求;

5. Proportion, arrangement, and testing requirements for digital anchors;

6 构造要求;

6. Structural detailing requirements;

7 外锚头防腐技术要求;

7. Anti-corrosion requirements for outer anchor heads;

8 杆体安装前后的保护要求;

8. Protection measures before and after tendon installation;

9 成孔、注浆、张拉、锁定、回收等施工工艺要求;

9. Construction requirements for drilling, grouting, tensioning, locking, and recovery;

10 回收条件要求;

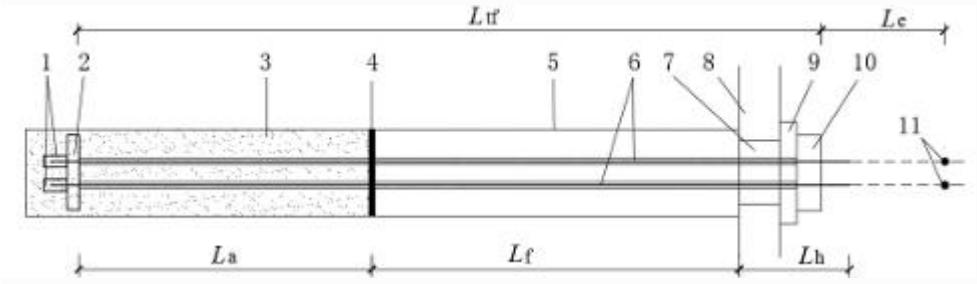
10. Requirements for anchor recovery conditions;

11 锚杆试验、质量检验和监测要求等。

11. Requirements for testing, quality inspection, and monitoring.

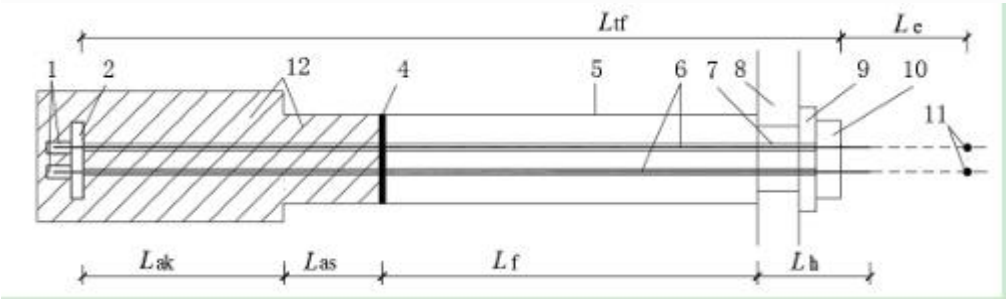
5.1.2 热熔锚类型可按锚固体外形及内外锚头布设形式分为压力型热熔锚、扩体型热熔锚及压力分散型热熔锚（图 5.1.2）。

5.1.2 Hot-melt anchors may be classified as pressure-type, enlarged-type, or pressure-dispersed-type based on anchorage geometry and inner/outer anchorage configurations (Figure 5.1.2).



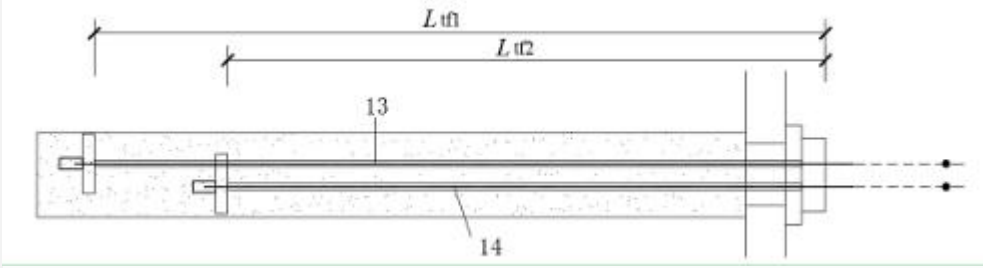
(a)压力型热熔锚

(a) Pressure-type hot-melt anchor



(b) 扩体型热熔锚

(b) Enlarged-type hot-melt anchor



（c）压力分散型热熔锚

(c) Pressure-dispersed hot-melt removable anchor

图 5.1.2 热熔锚结构分类示意图

Figure 5.1.2 Classification of hot-melt anchor structures

1-内锚具; 2-承载板; 3-浆体/锚固体; 4-止浆塞; 5-孔壁; 6-无粘结钢绞线; 7-穿筋孔; 8-锚座; 9-锚垫板; 10-外锚具; 11-千斤顶夹持点; 12-水泥土/锚固体; 13-1 单元锚杆; 14-2 单元锚杆;

1-Inner anchorage; 2-Bearing plate; 3-Grout/anchorage body; 4-Grout stopper; 5-Borehole wall; 6-Unbonded steel strand; 7-Tendon passage hole; 8-Anchor seat; 9-Anchor plate; 10-Outer anchorage; 11-Jack gripping point; 12-Cement-soil/anchorage body; 13-Unit anchor 1; 14-Unit anchor 2;

5.1.3 热熔锚在孔内沿轴向布置（图 5.1.3）时，宜符合下列规定:

5.1.3 For anchors arranged axially within the borehole (Figure 5.1.3), the following provisions shall be satisfied:

1 宜分组设置单元锚杆;

1. Unit anchors should be arranged in groups.

2 单元锚杆数量不宜超过 3 组,且每组不宜超过 3 个;

2. No more than three groups of unit anchors shall be adopted, and each group shall contain no more than three units.

3 承载板宜沿轴向错槎布置，其组内间距 Lb 宜为 0.5m-1.5m;

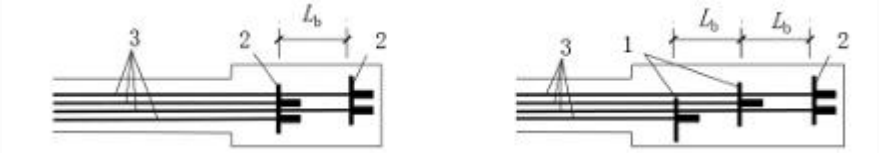
3. Bearing plates should be staggered along the axis, with intra-group spacing *Lb* between 0.5 m and 1.5 m.

4 扩体型锚杆的承载板宜布置在扩体段内。

4. For enlarged-type anchors, bearing plates shall be located within the enlarged section.

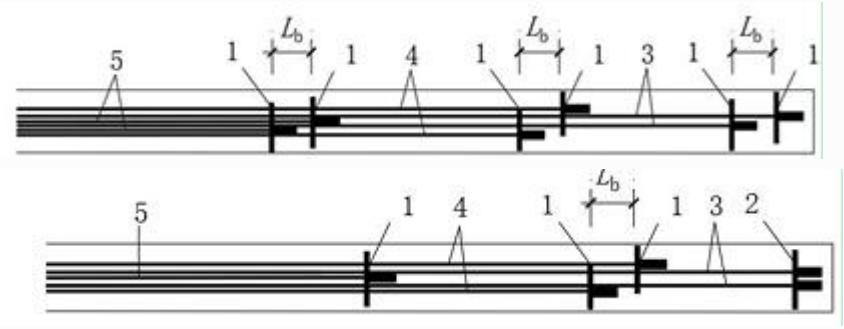
(a)压力型

(a)Pressure-type



(b)扩体型

(b)Enlarged-type



(c)压力分散型

(c) Pressure-dispersed

图 5.1.3 热熔锚沿轴向布置形式

Figure 5.1.3 Axial arrangement of hot-melt anchors

1-单筋杆; 2-双筋杆; 3-第 1 组单元锚杆; 4-第 2 组单元锚杆; 5-第 3 组单元锚杆; Lb -承载板组内间距

1-Single tendon; 2-Double tendon; 3-Unit anchor group 1; 4-Unit anchor group 2; 5-Unit anchor group 3; Lb -Intra-group spacing of bearing plates

5.1.4 热熔锚杆体选型应符合下列规定:

5.1.4 Tendon selection shall comply with the following:

1 等直径锚杆应根据钻孔直径选择套管尺寸及预制杆体规格;

1. For equal-diameter anchors, the casing and prefabricated tendon sizes shall match the borehole diameter.

2 等直径锚杆中单元锚应根据其抗拔承载力的要求选择单筋杆、双筋杆或其组合形式;

2. Unit anchors shall adopt single tendons, double tendons, or their combinations according to pullout capacity requirements.

3 旋喷扩体锚杆的单元锚应选择双筋杆。

3. For enlarged anchors produced by jet grouting, double tendons shall be used.

5.1.5 热熔锚的换撑设计应符合下列规定:

5.1.5 The bracing-replacement design shall comply with the following:

1.锚杆的竖向布置宜与地下建筑结构楼层相匹配;

1. Anchors shall be vertically aligned with the basement floor levels.

2.应遵循“先换撑、后回收”的原则，设计工况应包含从下到上逐层换撑及拆锚过程中的最不利工况;

2. The principle “replace bracing before anchor recovery” shall be followed. The design shall consider the most unfavorable conditions during sequential upward bracing replacement and anchor extraction.

3.换撑结构及构件的强度与刚度应满足地下建筑工程实际要求;

3. The strength and stiffness of replacement bracing elements shall satisfy the project’s structural requirements.

4.基坑的肥槽宜采用预拌流态固化土进行回填。

4. Pre-mixed flowable stabilized soil shall be used for backfilling of the pit enlargement area.

5.1.6 锚固体采用注浆体时抗压强度不应低于 25MPa,采用水泥土时抗压强度不应低于 0.5MPa。

5.1.6 The compressive strength of grouted anchorage bodies shall not be less than 25 MPa. For cement-soil anchorage bodies, it shall not be less than 0.5 MPa.

5.1.7 锚杆荷载设计锁定值宜为轴向拉力标准值的(0.8-1.0)倍。

5.1.7 The design locking load shall be 0.8 to 1.0 times the characteristic axial tensile load of the anchor.

5.2 承载力计算

5.2 Capacity Calculations

5.2.1 锚杆受拉承载力应满足下式要求:

5.2.1 The tensile capacity of anchors shall satisfy:

$$R_{uk} \geq K_a N_k \quad (5.2.1)$$

式中:

Where:

R_{uk} ——锚杆受拉极限承载力标准值(kN),取锚固体抗拔承载力、锚筋抗拉承载力及锚固体底端抗压承载力极限标准值中的最小值，应由锚杆荷载试验确定，初步设计时也可按5.2.3-5.2.7 条估算;

R_{uk} : characteristic ultimate tensile capacity (kN), taken as the minimum of anchorage pullout resistance, tendon tensile resistance, and anchorage base compressive resistance; determined by load testing or preliminarily estimated using Sections 5.2.3–5.2.7.

N_k ——作用标准组合时的锚杆轴向拉力标准值(kN),由锚固结构设计计算得到;

N_k : characteristic axial tensile load under standard load combinations (kN), obtained from structural design analysis.

K_a ——锚杆受拉承载力安全系数,不应小于 1.5。

K_a : safety factor for tensile capacity, not less than 1.5.

5.2.2 热熔锚具抗拆力不应小于 1.3Nk 。

5.2.2 The anti-unlocking resistance of the hot-melt anchorage shall not be less than 1.3 Nk.

5.2.3 锚固体抗拔承载力可按下式估算:

5.2.3 The pullout resistance of the anchorage body may be estimated as:

$$R_{uk,f}=\pi D\sum f_{mk,i}L_{a,i} \qquad (5.2.3)$$

式中:

Where:

$R_{uk,f}$——锚固体抗拔极限承载力标准值(kN);

$R_{uk,f}$: characteristic ultimate pullout resistance (kN);

D——锚固体直径(m);

D: anchorage body diameter (m);

$f_{mk,i}$——锚固体与第 i 层岩土层之间粘结强度标准值(kPa),应由试验确定,初步设计时可按附录 B 建议的经验值初定;

$f_{mk,i}$: characteristic bond strength between anchorage body and the *i*th soil/rock layer (kPa); determined via testing or initially estimated using Appendix B.

$L_{a,i}$——锚固段在第 i 层岩土层中的长度(m),每组可取最长预制杆对应的锚固段长度。

$L_{a,i}$: anchorage length within the *i*th layer (m); for grouped anchors, use the maximum tendon length.

5.2.4 锚筋抗拉极限承载力可按下式估算:

5.2.4 The ultimate tensile resistance of tendons may be estimated as:

$$R_{uk,l}=nF_{p0.2} \qquad (5.2.4)$$

式中:

Where:

$R_{uk,l}$——锚筋抗拉极限承载力标准值(kN);

$R_{uk,l}$: characteristic ultimate tensile capacity (kN);

$F_{p0.2}$——钢绞线 0.2%屈服力(kN),应按现行国家标准《预应力混凝土用钢绞线》GB/T 5224 的规定取值;

$F_{p0.2}$: 0.2% yield force of steel strands (kN), per GB/T 5224;

n——钢绞线数量。

n: Number of steel strands.

5.2.5 锚固体为浆体时底端抗压极限承载力可按下式估算,为扩体形状的水泥土时可按本规程附录 C 进行选取:

5.2.5 The compressive resistance at the base of a grouted anchor may be estimated as:

$$R_{uk,p}=\eta A_{ln} f_{ck} \qquad (5.2.5)$$

式中:

Where:

$R_{uk,p}$——锚固体底端抗压极限承载力标准值(kN);

$R_{uk,p}$: Characteristic ultimate compressive resistance at the base (kN).

η——承载力修正系数,可取 2.0-4.0 或按本地经验初步确定;

η: Capacity correction factor (2.0-4.0), based on local experience.

A_{ln}——锚固体受压净面积(m^2),取锚固体横截面积扣除锚筋孔洞横截面积之后的净面积;

A_{ln}: net compressive area after deducting tendon-hole area (m^2);

f_{ck}——浆体边长为 70.7mm 的立方体抗压强度标准值(kPa)。

f_{ck}: Characteristic compressive strength of 70.7mm grout specimens (kPa).

5.2.6 扩体型锚杆抗拔极限承载力可按下式估算:

5.2.6 For enlarged-type anchors:

$$R_{uk,c}=\lambda\pi f_{mk}DL_{as}+\pi f_{mk}D_kL_{ak}+4\pi(D_{k2}-D_2)f_{ak} \quad (5.2.6)$$

式中:

Where:

$R_{uk,c}$——扩体锚杆抗拔极限承载力标准值(kN);

$R_{uk,c}$: Characteristic ultimate pullout capacity (kN).

D,D_k——分别为原孔锚固段及扩体锚固段的锚固体直径(m);

D,D_k: Diameters of original and enlarged anchorage sections (m).

L_{as},L_{ak}——分别为原孔锚固段长度及扩体锚固段长度(m);

L_{as},L_{ak}: Lengths of original and enlarged anchorage sections (m).

λ——粘结强度折减系数,可取 0.8-1.0 或按本地经验初步确定;

λ: Bond strength reduction factor (0.8-1.0) based on local experience.

f_{ak}——扩体锚固段面端岩土层端阻强度标准值(kPa),可按附录B或本地经验初步确定。

f_{ak}: Characteristic end-bearing strength of the enlarged section (kPa), per Appendix B or local experience.

5.2.7 压力分散锚杆锚固体抗拔承载力初步设计时可取各组单元锚杆锚固体抗拔承载力之和。

5.2.7 For pressure-dispersed anchors, the total pullout capacity shall be taken as the sum of the capacities of all unit anchors.

5.2.8 热熔锚具抗拆力应由锚杆试验确定，初步设计时可按 0.85$R_{uk,l}$进行估算。

5.2.8 Unlocking resistance shall be verified by testing.

For preliminary design, it may be taken as **0.85 Ruk,l**.

5.3 构造

5.3 Structural Details

5.3.1 肥槽宽度不宜小于 1.2m。

5.3.1 The width of the backfill zone shall not be less than 1.2 m.

5.3.2 锚杆布置应符合下列规定:

5.3.2 Anchor layout shall comply with the following:

1 外锚头竖向位置宜设置在换撑结构上方 0.5m～1.2m;

1. Outer anchor heads shall be positioned 0.5–1.2 m above the corresponding bracing member.

2 竖向排距不宜小于 2.5m;水平间距不宜小于 1.2m 且不宜小于锚固体直径的 3.0 倍，距离更小时可角度交错或长短交错布置。

2. Vertical spacing between rows shall be ≥2.5 m; horizontal spacing shall be ≥1.2 m or ≥3 times the anchorage diameter. For smaller spacing, alternate angles or stagger lengths.

5.3.3 锚固段的设置应符合下列规定:

5.3.3 The anchorage section shall comply with the following:

1 锚固段宜设置于岩层、稍密-密实的碎石土层及砂土层、可塑-坚硬状的黏性土层及相应性状的粉土层中;

1. Place anchorage in rock, medium-dense to dense gravel/sand, or plastic to stiff cohesive soil/silt.

2 锚固段不应设置在未经处理的软弱土层、不稳定土层和不良地质作用地层中;

2. Do not place anchorage in untreated weak soils, unstable layers, or unfavorable geological formations.

3 锚固体与相邻基础、地下结构、地下管线等设施的距离及锚杆的间距不宜小于锚固体直径的 3 倍且不宜小于 1.2m，其中扩体型锚杆应取扩体段锚固体直径;

3. Distance to adjacent foundations and utilities ≥3×anchorage diameter and ≥1.2 m; for enlarged types, use enlarged diameter.

4 锚固段上覆土层厚度不宜小于 4.0m，上覆岩层厚度不宜小于 2.0m;

4. Minimum overburden: 4.0 m (soil), 2.0 m (rock).

5 基坑的阳角区域锚固段宜错落布置且不应在同一平面上相交;

5. At pit corners, stagger anchorage so they do not intersect on the same plane.

6 压力型锚杆在岩石中的锚固段长度可为 3.0m-8.0m，在土层中的锚固段长度可为 6.0m-16.0m;压力分散型锚杆在岩石中的单元锚杆锚固段长度可为 2.0m-4.0m，在土层中的锚固段长度可为 3.0m-8.0m;扩体锚固段长度可为 2.0m-4.0m。

6. Recommended anchorage lengths:

- Pressure-type: 3.0–8.0 m (rock), 6.0–16.0 m (soil);
- Pressure-dispersed unit: 2.0–4.0 m (rock), 3.0–8.0 m (soil);
- Enlarged section: 2.0–4.0 m.

5.3.4 锚杆自由段的设置应符合下列规定:

5.3.4 Free tendon sections shall satisfy the following:

1 自由段长度不宜小于 6.0m 且其超过潜在滑裂面外不宜小于 2.0m，位于软弱土层中的锚杆及扩体型锚杆的自由段长度宜加长;

1. Free length ≥6.0 m and ≥2.0 m beyond the slip surface; increase length for weak soils and enlarged anchors.

2 扩体型锚杆扩体锚固段前端至软弱土层的距离不宜小于 4.0m，潜在滑裂面

位置的确定应符合现行行业标准《建筑基坑支护技术规程》JGJ120 的有关规定;

2. Distance from the enlarged section to weak soils ≥4.0 m; slip surface determined per JGJ 120.

3 扩体锚杆的原孔段长度不应小于 7m，与扩体段直径之比不应小于 11。

3. Original borehole length for enlarged anchors ≥7.0 m, with length-to-diameter ratio ≥11.

5.3.5 等直径锚杆钻孔宜符合下列规定:

5.3.5 Borehole drilling for equal-diameter anchors shall meet the following:

1 岩层中钻孔直径不宜小于 90mm，土层中钻孔直径不宜小于 130mm，扩孔直径不宜小于 300mm;

1. Diameter ≥90 mm in rock, ≥130 mm in soil, and ≥300 mm for enlarged sections.

2 钻孔直径宜大于承载板最大直径 10mm 以上;

2. Borehole diameter ≥10 mm larger than the largest bearing-plate diameter.

3 钻孔倾角宜为 10°～45°。

3. Drilling angle 10°–45° from the horizontal.

5.3.6 锚垫板设置宜符合下列规定:

5.3.6 Anchor bearing plates shall conform to the following:

1.宜采用正方形;

1. Square plates are preferred.

2 边长不宜小于 200mm，厚度不宜小于 20mm;

2. Side length ≥200 mm; thickness ≥20 mm.

3.锚垫板穿筋孔的孔径宜大于锚杆杆体外径 10mm～30mm 且不宜大于钻孔直径;

3. Tendon-passage hole diameter shall be 10–30 mm larger than tendon width and not exceed borehole diameter.

4.锚垫板下宜设置找平层，找平层可采用砂浆、细石混凝土或钢楔，其中砂浆及细石混凝土强度等级不宜低于锚座混凝土强度等级。

4. A leveling layer of mortar, fine-aggregate concrete, or steel wedges shall be provided; strength not lower than the anchor-seat concrete.

5.3.7 锚座穿筋孔应预埋穿筋管，穿筋管的孔位及角度应与杆体同轴，孔径宜大于锚杆杆体外径 10mm-30mm 且不宜大于钻孔直径。

5.3.7 Tendon ducts in anchor blocks shall be pre-embedded, coaxial with the tendon, and 10–30 mm larger than the tendon diameter, without exceeding the borehole diameter.

6 施工

6 Construction

6.1 一般规定

6.1 General requirements

6.1.1 热熔锚专项施工方案应包括且不限于以下内容:

6.1.1 The specialized construction plan for hot-melt anchors shall include, but not be limited to, the following items:

1.岩土工程勘察资料与设计要求;

1. Geotechnical investigation data and design requirements;

2.工程场地及周边环境条件;

2. Site conditions and surrounding environmental constraints;

3 热熔锚的场地布置、施工工艺及施工技术参数;

3. Site layout, construction procedures, and technical parameters for hot-melt anchors;;

4.预应力张拉及锁定要求;

4. Prestressing tensioning and locking requirements;

5.锚筋回收要求;

5. Tendon recovery requirements;

6.施工质量检验要求;

6. Construction quality inspection requirements;

7.工程监测要求等。

7. Engineering monitoring requirements.

6.1.2 热熔锚施工所用材料的品种、规格、性能和施工设备的技术性能，应符合设计要求及国家现行有关标准的规定。

6.1.2 The types, specifications, performance of materials, and technical performance of construction equipment used for hot-melt anchors shall comply with the design requirements and applicable national standards.

6.1.3 热熔锚施工前应对机械设备进行检查与试运行。

6.1.3 All mechanical equipment shall be inspected and trial-operated prior to construction.

6.1.4 等直径锚杆宜采用套管成孔后注浆工艺，扩体型锚杆宜采用旋喷扩体自进工艺。

6.1.4 Equal-diameter anchors shall use casing drilling followed by grouting, while enlarged-body anchors shall use self-advancing jet-grouting enlargement techniques.

6.1.5 热熔锚施工及使用过程中应对锚杆杆体、锚头和导线、数据线等采取有效保护措施。

6.1.5 During construction and service, effective protective measures shall be taken to prevent damage to anchor tendons, anchor heads, wires, and data cables.

6.1.6 热熔锚施工记录内容宜包括锚杆型号及编号、锚杆部位、不同阶段的通电测试情况、故障情况及位置、测试日期、测试仪型号及编号等要素(附录 D)。

6.1.6 Construction records shall include anchor type and number, anchor location, electrical testing results at different stages, fault information and locations, test dates, and details of testing equipment (Appendix D).

6.1.7 热熔锚施工过程中，应采取施工安全防护与控制振动、噪声、扬尘、废水、废弃物及有毒有害物质对工程场地、周边环境和人身健康的危害的措施。

6.1.7 Construction safety measures shall be implemented to minimize vibration,

noise, dust, wastewater, waste materials, and hazardous substances affecting the site, surrounding environment, or personnel health.

6.1.8 热熔锚施工宜利用数字锚和数字环进行全过程监测。

6.1.8 Digital anchors and digital rings should be used for full-process monitoring during construction.

6.2 等直径锚杆钻孔与注浆

6.2 Drilling and grouting of equal-diameter anchors

6.2.1 施工前应根据设计要求、场地岩土工程条件、现场及周边环境、场地施工条件及效率等选择施工机械设备、成孔及扩孔工艺、施工技术参数等。

6.2.1 Before construction, select appropriate equipment, drilling and enlargement techniques, and technical parameters based on design requirements, geotechnical conditions, surrounding environment, site conditions, and construction efficiency.

6.2.2 热熔锚成孔钻具的规格应能满足终孔直径不小于设计孔径的要求。

6.2.2 Drilling tools shall ensure the final borehole diameter meets or exceeds the design diameter.

6.2.3 锚杆施工采用套管护壁,应满足下列要求:

6.2.3 When casing is used for borehole support, the following shall be satisfied:

1.套管内壁与承载板周边的空隙不宜小于 3mm;

1. Clearance between casing inner wall and bearing plate ≥3 mm;

2.套管接头宜采用平口连接方式;

2. Casing joints should adopt flat-end connections;

3.套管内壁、钻头刀齿应平滑圆润，不得出现尖锐、快口;

3. Casing inner wall and drill bit teeth shall be smooth and free of sharp edges;

4 安放杆体前应清除孔内岩粉、土屑及泥浆;

4. Remove rock powder, soil debris, and slurry before tendon installation;

5.安放杆体时宜在最上节套管管口设置软垫片。

5. A soft gasket should be placed at the top casing opening during tendon installation.

6.2.4 岩层中钻孔深度超过锚杆设计长度不应少于 0.2m，土层中超过锚杆设计长度不应少于 0.5m。

6.2.4 In rock, borehole depth shall exceed the design anchor length by at least 0.2 m; in soil, by at least 0.5 m.

6.2.5 钻孔孔口为支护桩或地连墙等地下结构时，宜采用开孔器在地下结构上开孔。

6.2.5 When drilling through underground structures such as piles or diaphragm walls, use core drills for opening.

6.2.6 混凝土梁处的锚索施工时，宜先进行混凝土梁施工，在梁中预安装过渡管再施打锚杆。

6.2.6 For anchors in concrete beams, install transition pipes during beam construction before anchor installation.

6.2.7 锚杆钻孔的允许偏差，应符合下列规定:

6.2.7 Allowable drilling deviations:

1.孔位允许偏差为 100mm;

1. Position tolerance: ±100mm;

2.孔径允许负偏差为 3mm;

2. Negative diameter tolerance: 3mm;

3.孔长允许负偏差为孔长的 2%且不大于 500mm;

3. Negative length tolerance: 2% of borehole length, not exceeding 500 mm;

4.锚杆角度允许偏差为 3°。

4. Angular tolerance: ±3°.

6.2.8 浆液拌制及储备应采用专用机械设备随用随制备。

6.2.8 Grout shall be mixed and prepared using specialized equipment and produced on demand.

6.2.9 注浆应符合下列规定:

6.2.9 Grouting shall meet the following requirements:

1.应根据注浆工艺、浆体种类、输送距离、设计注浆压力、连续注浆量等选择注浆机械设备及装置;

1. Select grouting equipment based on technique, grout type, transport distance, design pressure, and continuous volume;

2.宜采用二次注浆工艺;

2. Secondary grouting is preferred;

3 一次注浆应在套管内进行,注浆管宜插入至距离钻孔底端 200-500mm 处自下而上连续注浆;

3. Primary grouting shall be conducted inside the casing, with grout pipe inserted 200–500 mm above the borehole bottom for bottom-up continuous grouting;

4.一次注浆管管口应始终埋设在浆液内,当孔口溢出等浓度浆液后方可停止注浆且不宜补浆;

4. Primary grout pipe outlet shall remain submerged in grout; stop when uniform slurry overflows;

5.热熔锚的二次注浆宜在一次注浆完成后 2～12h 内进行，开环压力不宜低于 2.0MPa;

5. Secondary grouting shall occur 2–12 hours after primary grouting, with initial pressure ≥2.0 MPa;

6.孔口不宜封堵溢浆;

6. Do not seal borehole overflow;

7.宜采取停留注浆、反复注浆及二次注浆管在承载板处开设出浆孔等措施;

7. Use dwell grouting, repeated grouting, and secondary grout pipes with outlets at bearing plates;

8.浆体水灰比应满足可灌性及浆体强度要求，宜通过配合比试验最终确定，初步确定时一次注浆水灰比可为 0.45-0.55、二次注浆水灰比可为 0.5-0.7。

8. Water–cement ratio shall satisfy workability and strength requirements, confirmed through mix design tests. Preliminary ratios: Primary grouting: 0.45–0.55; Secondary grouting: 0.5–0.7

6.2.10 实际注浆量不应小于理论计算值。

6.2.10 Actual grout volume shall not be less than theoretical amount.

6.3 旋喷扩体锚杆钻孔和注浆

6.3 Drilling and grouting of jet-grouted enlarged-body anchors

6.3.1 旋喷扩体锚杆成锚工艺宜符合下列规定:

6.3.1 Construction of jet-grouted enlarged-body anchors shall meet:

1.钻机喷嘴直径宜为 2.0mm-3.0mm;注浆泵功率不应小于 90kW 且柱塞不应小于 50mm;

1. Nozzle diameter 2.0–3.0 mm; pump power ≥90 kW; plunger ≥50 mm;

2.应采用专用钻头钻进,且钻头宜与钻杆采用锥丝、方丝、波纹丝等丝扣形式连接;

2. Use dedicated drill bits connected via tapered, square, or corrugated threads;

3.输送扩体介质的管路长度不宜超过 50m;

3. Grout delivery pipeline length ≤50m;

4.非扩体孔段可采用直接钻进或预成孔,扩体段应采用钻扩一体化同步成孔;

4. Non-enlarged sections may use direct drilling or pre-drilling; enlarged sections shall use integrated drilling and jet-grouting;

5.直接钻进时，自由段宜采用清水引孔，水压宜为 5MPa-15MPa;

5. For free sections, use water flushing at 5–15 MPa;

6.宜采用螺旋钻杆、三叶钻头预成孔，并宜采用膨润土、水泥等护壁材料;

6. Pre-drilling may use auger or triple-wing bits with bentonite/cement wall stabilization;

7.扩体段应采用水泥浆扩孔，扩孔喷射压力不应小于 20MPa，喷嘴给进速度宜为 10cm/min-15cm/min,喷嘴转速宜为 5cm/min-15r/min;

7. Enlarged sections shall be jet-grouted with cement grout at ≥20 MPa; nozzle feed 10–15 cm/min; rotation 5–15 r/min;

8.预制杆应安装在钻杆上,钻杆进尺时应将杆体同步带入;

8. Prefabricated tendons shall be installed on the drill rod and advanced synchronously;

9.钻进时不得退杆;

9. Rod retraction is prohibited during drilling;

10.退杆应匀速并保持方向稳定;

10. Rods shall be retracted uniformly and steadily;

11.旋喷扩体型锚杆可不进行二次注浆。

11. Secondary grouting may be omitted.

6.3.2 扩体锚杆注浆工艺宜符合下列规定:

6.3.2 Grouting requirements for enlarged-body anchors:

1.宜根据注浆工艺、浆体种类、输送距离、设计注浆压力、连续注浆量等因素选用适合的注浆机械设备及装置;

1. Select grouting equipment based on technique, grout type, distance, design pressure, and volume;

2.孔口不宜封堵溢浆且不宜补浆;

2. Do not seal overflow or conduct remedial grouting;

3.水泥浆水灰比宜为 1.0-1.2;

3. Water-cement ratio: 1.0-1.2;

4.钻杆退出时宜停止高压注浆。

4. Stop high-pressure grouting during rod retraction.

6.3.3 施工前，应进行工艺性试验并根据试验结果确定施工参数。

6.3.3 Conduct process trials prior to construction to determine final parameters.

6.3.4 钻孔、混凝土梁处的锚索施工、锚杆钻孔的允许偏差、浆液拌制及储备等应按本规程第 6.2.5-6.2.8 条的规定执行。

6.3.4 Requirements for drilling, installation in concrete beams, allowable drilling deviations, and grout preparation shall comply with Sections 6.2.5–6.2.8.

6.4 杆体制作与安装

6.4 Tendon fabrication and installation

6.4.1 预制杆体的制作，应符合下列规定:

6.4.1 Fabrication of prefab tendons shall comply with:

1.预制杆体宜采用工厂制作;

1. Tendons shall preferably be factory-produced;

2.预制杆体宜在现场与一次注浆管及二次注浆管、定位架及束线环等组装为完整杆体,其中采用自进工艺的热熔锚可不设置定位架及束线环;

2. Tendons shall be assembled on-site with primary/secondary grout pipes, centering frames, and wire rings. Self-advancing anchors may omit frames and rings;

3.杆体应平行顺直,不得相互交叉、扭曲;

3. Tendons shall be straight and parallel, free of crossing or twisting;

4.定位架应沿杆体全长布设,外径宜小于孔径 4mm-6mm,间距宜为 1.5m-2.0m;

4. Centering frames shall run the full length, 4–6 mm smaller than the borehole diameter, spaced at 1.5–2.0 m;

5.钢绞线之间净距不应小于 10mm，定位架间距允许偏差为 100mm，承载板间距允许偏差为 100mm;

5. Strand clear spacing ≥10 mm; frame spacing tolerance ±100 mm; bearing plate spacing tolerance ±100 mm;

6.同一件预制杆的钢绞线内置导线宜采用不同颜色。

6. Embedded wires of a single tendon shall use different colors.

6.4.2 预制杆运输、存放、组装、搬运及安装过程中，应避免引起无粘结钢绞线护套、导线及数据线的机械损伤。

6.4.2 Protect unbonded strand sheaths, wires, and data cables from mechanical damage during transport, storage, assembly, and installation.

6.4.3 杆体组装宜采用尼龙扎带绑扎且严禁使用铁丝绑扎，杆体搬运宜采用吊装带。

6.4.3 Use nylon ties (iron wire prohibited) for tendon assembly. Use lifting straps for handling.

6.4.4 杆体的安装应符合下列规定:

6.4.4 Tendon installation shall meet:

1.安装前，应检查规格、长度、解锁系统及测力系统的完整性;

1. Check specifications, length, unlocking system, and load-measurement system before installation;

2.杆体的套管口和各节套管接头处应平滑，不得有毛刺;

2. Casing mouths and joints shall be smooth and burr-free;

3.应采取防止扭压、弯曲杆体及防止杆体与孔口摩擦的措施;

3. Prevent torsion, bending, and friction at the borehole mouth;

4.应轻装轻卸，严禁投掷或在地上拖拉;

4. Handle gently; throwing or dragging is prohibited;

5.宜在拔出套管前置入杆体，并应采取防止杆体被套管带出的措施;

5. Install tendons before casing extraction and prevent tendon withdrawal;

6.钻孔内杆体的长度安装偏差为 100mm。

6. Tendon installation length tolerance: ±100 mm.

6.4.5 杆体下料长度不应小于钻孔内杆体长度、锚座及数字环厚度与张拉段长度之和。

6.4.5 Tendon cutting length shall be no less than the tendon length inside the borehole plus the thickness of the anchor seat/digital ring and the tensioning length.

6.5 张拉和锁定

6.5 Tensioning and locking

6.5.1 水泥浆体、水泥土及混凝土锚座的标准养护期宜为 28d，最短养护期应根据气候条件、地质条件、工程特点及设计施工参数等条件综合确定。

6.5.1 The standard curing period for grout, cement-soil, and concrete anchor seats is 28 days. Minimum curing period shall be determined based on climate, geology, project characteristics, and design parameters.

6.5.2 张拉与锁定作业应符合下列规定:

6.5.2 Tensioning and locking shall comply with:

1 锚杆张拉装置设备及施工要求应符合本规程附录 F 的规定;

1. Equipment and procedures shall comply with Appendix F;

2 张拉锁定时应达到最短养护期且注浆体强度不应小于设计强度的 80%,混凝土锚座强度不应低于 20MPa;

2. Locking is permitted only after minimum curing period, grout strength ≥80% design strength, and anchor seat concrete ≥20 MPa;

3 已经过第三方检测合格的锚杆可直接加载到放张荷载后锁定，否则宜先张拉自检、后张拉锁定。

3. Anchors certified by third-party testing may be directly tensioned to release load and locked; otherwise conduct self-inspection tensioning first.

6.5.3 热熔锚的张拉自检，应符合下列规定:

6.5.3 Self-inspection tensioning of hot-melt anchors shall meet:

1 不应安装工作锚具及夹片;

1. Working anchorages and wedges shall not be installed;

2 宜采用快速法加卸载，加卸载程序及合格判定标准应符合本规程第 7 章规定;

2. Use rapid loading/unloading per Chapter 7;

3 应对张拉数据进行全程自动记录。

3. Record tensioning data automatically throughout.

6.5.4 当锚杆自检不合格时应采取处置措施。

6.5.4 Corrective measures shall be taken if self-inspection results are unsatisfactory.

6.5.5 热熔锚的放张荷载应通过锁损试验结果确定,试验步骤宜符合下列规定:

6.5.5 Release load shall be determined through lock-loss testing:

1 初定放张荷载，放张荷载可按设计锁定荷载的 1.1 倍～1.3 倍或其它经验值初定;

1. Preliminary release load: 1.1–1.3×design lock load or empirical value;

2 安装锚垫板、数字测力环、工作锚、限位板、千斤顶及工具锚;

2. Install anchor plate, digital load ring, working anchorage, limiter plate, jack, and tool anchorage;

3 加载至放张荷载后放张，进行锚杆锁定;

3. Load to release load, release, and lock anchor;

4 张拉过程中记录数字测力环示值及张拉荷载示值,建立两者的换算曲线或公式，锁定后测读数字测力环，将数字测力环示值换算为张拉荷载示值，该值可判定为实际锁定荷载;

4. Record digital load ring and tensioning values; establish conversion curve/formula; post-locking readings determine actual lock load;

5 实际锁定荷载与设计锁定荷载之差如不大于 10%或满足设计要求时则可判定中止试验,否则应继续试验;

5. Terminate test if actual lock load ≤10% deviation from design; else continue;

6 计算锁定损失荷载,锁定损失荷载应为放张荷载与实际锁定荷载之差;

6. Lock loss load = release load – actual lock load;

7 调整放张荷载，令其为设计锁定荷载与 1.1-1.3 倍(或其它经验值)锁定损失荷载之和;

7. Adjust release load = design lock load + 1.1–1.3×lock loss load;

8 按本条第 3-5 款要求，再次张拉、锁定、换算及分析判定。

8. Repeat steps 3–5 for verification.

6.5.6 当千斤顶行程小于锚杆最大试验荷载下的位移时宜采用分次锁定、大行程千斤顶或两个千斤顶叠加等方法。

6.5.6 If jack stroke is insufficient for maximum test displacement, use staged locking, long-stroke jacks, or combined jacks.

6.5.7 热熔锚分次锁定试验步骤宜符合下列规定:

6.5.7 Staged locking test requirements:

1 按千斤顶最大行程的 60%-90%对应的荷载进行第一次张拉锁定;

1. First-stage tensioning: 60–90% of jack max stroke capacity;

2 进行锁损试验检测锚杆实际锁定荷载;

2. Perform lock loss test to measure actual lock load;

3 按初定放张荷载与实际锁定荷载之差的 1.1-1.3 倍或其它经验值、与实际锁定荷载之和作为二次放张荷载继续张拉锁定;

3. Second release load = actual lock load + 1.1–1.3×(preliminary release load –

actual lock load);

4 进行锁损试验检测锚杆实际锁定荷载，实际锁定荷载与设计锁定荷载之差应不大于 10%或满足设计要求,否则应调整放张荷载继续试验。

4. Verify actual lock load deviation ≤10%; adjust release load if failed.

6.5.8 压力分散锚杆及长度小于 15m 的锚杆宜采用多千斤顶对各束钢绞线实行等荷载同步张拉及锁定，长度大于 15m 的压力型及扩体型锚杆可采用多千斤顶同步张拉锁定，也可采用一个千斤顶等位移张拉锁定。

6.5.8 For pressure-dispersed anchors or anchors <15 m, use multi-jack synchronized loading. For anchors >15 m, use either synchronized multi-jack or single-jack displacement control.

6.5.9 锚杆张拉段在地下室回填前不宜切除。

6.5.9 Do not cut the tensioning segment prior to basement backfilling.

6.6 锚筋回收

6.6 Tendon recovery

6.6.1 热熔锚应在进场后、安装前、安装注浆后及张拉锁定前后分别进行导电测试;电路不通时，应采取更换、重新施工等处置措施。

6.6.1 Conduct conductivity testing after delivery, before installation, after grouting, and before/after locking. Replace or reinstall if circuits fail.

6.6.2 热熔锚导电测试电阻应为 1Ω～15Ω。

6.6.2 Acceptable circuit resistance ranges from 1 Ω to 15 Ω.

6.6.3 锚筋拆除回收作业应具备下列条件:

6.6.3 Tendon recovery requires:

1.基坑肥槽回填、支护结构换撑、锚杆卸载等工况应满足设计要求;

1. Backfilling, bracing replacement, and anchor unloading to meet design conditions;

2.支护换撑结构的强度、刚度及稳定性验算应满足设计要求;

2. Verification that replacement bracing meets strength, stiffness, and stability requirements;

3.施工作业人员及机具设备的工作面应满足安全距离的要求。

3. Safe working clearances for personnel and equipment.

6.6.4 拆筋回收作业宜采用先通电解锁、再拆除外锚具、后回收钢绞线的顺序进行。

6.6.4 Recovery sequence: energize to unlock → remove outer anchorage → extract strands.

6.6.5 热熔锚拆筋回收作业应符合下列规定:

6.6.5 Tendon recovery operations shall meet:

1.应采用自动回收机拔出锚筋;

1. Use automated recovery machines for strand extraction;

2.应设置适合的回收作业平台;

2. Provide suitable work platforms;

3.应采用自下而上顺序分层拆除;

3. Dismantle layer-by-layer from bottom to top;

4.通电热熔时间不宜少于 45min，电压不应高于 36V;

4. Electrification duration ≥45 minutes; voltage ≤36V;

5.宜采用先短后长顺序依次抽出锚筋。

5. Extract shorter strands before longer strands.

6.6.6 当筋体拆除回收失败时，可采取下列处理措施:

6.6.6 If recovery fails, possible measures include:

1.可采用套管钻机套打锚筋或锚固体;

1. Casing drilling to extract strands/anchorage body;

2.可在锚杆周边钻孔后置入高压水枪，解除锚固体与地层的全部粘结或部分粘结，降低锚固体抗拔承载力后将其拔出;

2. Peripheral drilling with high-pressure water injection to reduce bond, then extract;

3.钻孔后置入水刀，可用高压水在锚杆底部切断钢绞线后将其拔出;

3. Use waterjet cutter to sever strands at anchor base;

4 扩体锚固段为水泥土的锚杆，可置入水刀把锚固段水泥土破碎后再将钢绞线拔出。

4. For cement-soil enlarged sections: break the section with waterjet before extraction.

6.6.7 锚筋拆除回收作业宜按本规程附录 D 进行记录与评价。

6.6.7 Recovery procedures shall be documented and evaluated per Appendix D.

7 锚杆试验

7 Anchor Testing

7.1 一般规定

7.1 General Requirements

7.1.1 锚杆荷载试验应符合下列规定:

7.1.1 Anchor load tests shall comply with the following requirements:

1.试验时应达到最短养护期且锚杆浆体强度不应小于设计强度的 80%;

1. Testing shall be conducted only after the minimum curing period has been reached, and the grout strength shall not be less than 80% of the design value.

2.试验时混凝土锚座强度不应低于 20MPa,且不宜低于 25MPa;

2. The concrete strength of the anchor seat during testing shall not be less than 20 MPa, and preferably not less than 25 MPa.

3.宜采用自动张拉记录系统。

3. An automated tensioning and data-recording system is recommended.

4.张拉装置设备及操作要求应符本规程附录 E 的规定。

4. Tensioning equipment and operating procedures shall follow Appendix E of this specification.

7.1.2 热熔锚基本试验宜符合本规程附录 F 的规定,持有荷载试验宜符合本规程附录 G 的规定,数字锚可不进行持有荷载试验。

7.1.2 Basic tests for hot-melt anchors shall comply with Appendix F; holding-load tests shall follow Appendix G. Digital anchors may be exempt from holding-load tests.

7.2 回收试验

7.2 Recovery Test

7.2.1 回收试验应专门制作试验锚杆。

7.2.1 Dedicated test anchors shall be fabricated for recovery tests.

7.2.2 试验锚杆的制作应符合下列规定:

7.2.2 The fabrication of test anchors shall meet the following requirements:

1.锚杆长度、锁定荷载及承载力均应取锚杆中的最大值;

1. Anchor length, locking load, and load capacity shall be taken as the maximum values among all anchors;

2.锚杆试验数量不应少于 3 根;

2. Minimum 3 test anchors;

3.当基坑下半部分岩土层与上半部分岩土层性状差异较大时，应补充不少于 3 根试验锚杆;

3. When significant differences exist between upper and lower geotechnical strata, at least three additional test anchors shall be provided;

4.试验锚杆的岩土层条件、锚杆杆体和参数、施工工艺及施工参数等应与工程锚杆基本相同。

4. Geological conditions, tendon configuration, construction methods, and construction parameters of test anchors shall be consistent with those of production anchors.

7.2.3 试验锚杆施工应符合下列规定:

7.2.3 Construction of test anchors shall meet the following requirements:

1 不应损伤外锚头、钢绞线及解锁电线等用具;

1. Outer anchorages, strands, unlocking wires, and other components shall not be damaged;

2 锚筋护套不应破损,浆液、泥浆等杂物不应漏入护套及热熔锚具内;

2. Strand sheaths shall remain intact; grout, slurry, or debris shall not enter the sheaths or the hot-melt anchorage;

3 张拉段长度应能满足试验及回收操作要求。

3. The length of the tensioning section shall satisfy the requirements for both testing and recovery operations.

7.2.4 同一试验锚杆不得同时用于回收试验与极限性基本试验。

7.2.4 A test anchor shall not be used simultaneously for both recovery testing and ultimate basic testing.

7.2.5 回收试验步骤应符合下列规定:

7.2.5 Recovery test procedures shall comply with the following:

1.进行非极限性基本试验，试验方法宜按本规程附录 F 的规定执行

1. Conduct non-ultimate basic tests in accordance with Appendix F;

2.进行锁损试验;

2. Perform a lock-loss test;

3. 进行张拉锁定，锁定值宜为锚杆设计最大锁定荷载的 1.25 倍;

3. Tension and lock the anchor to 1.25 times the design maximum locking load;

4 进行持荷，持荷时间不宜少于 5h

4. Maintain the load for not less than 5 hours;

5.进行锚筋持有荷载试验，试验方法宜按本规程附录 G 的规定执行;

5. Conduct tendon holding-load testing in accordance with Appendix G;

6.拆除锚具，解锁，回收锚筋。

6. Remove the anchorage, unlock, and recover the strands.

7.2.6 回收试验满足下列规定时应判定为试验合格:

7.2.6 Recovery tests shall be deemed satisfactory when:

1.基本试验维持荷时间内位移稳定;

1. Displacement remains stable during the holding period of the basic test;

2.持有荷载为锁定荷载的 0.7~1.1 倍或按设计要求;

2. The holding load is 0.7–1.1 times the locking load, or meets design requirements;

3. 按预定方式的回收率为 100%。

3. The recovery rate of the strands, following the specified procedure, is 100%.

7.2.7 热熔锚回收试验合格后,方可进行工程锚施工。

7.2.7 Production anchor construction may proceed only after recovery tests have passed.

7.2.8 试验锚杆的回收率不合格时,应分析查明原因并采取处置措施。

7.2.8 If the recovery rate does not meet requirements, the cause shall be identified and corrective measures implemented.

7.3 工程锚杆承载力自检试验

7.3 Self-Inspection of Production Anchor Capacity

7.3.1 工程锚杆最大试验荷载取值应符合设计要求且不宜少于 $1.25N_k$。

7.3.1 The maximum test load for production anchors shall meet design requirements and shall not be less than $1.25\ N_k$.

7.3.2 工程锚杆的加卸载程序宜符合试验要求(图 7.3.2)。

7.3.2 The loading and unloading procedure shall comply with test requirements (Figure 7.3.2).

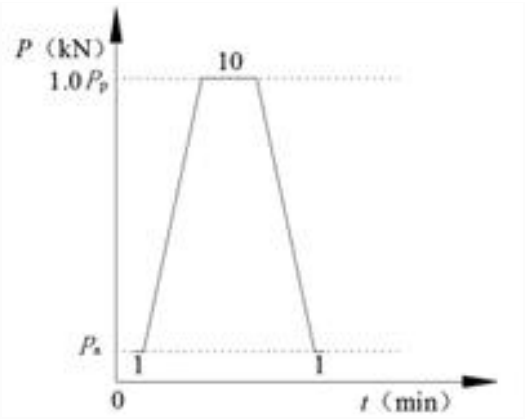


图 7.3.2 承载力自检加卸载程序

hematic loading/unloading procedure:

P_a —试验初始荷载;

P_a: Initial test load;

P_p —试验最大荷载。

P_p: Maximum test load.

7.3.3 当进行工程锚杆承载力自检时宜安装数字测力环并按 1 次/min 频率测读荷载值,连续两次荷载读数变化不超过 0.01P_p(或 1kN)及第 6min-10min 位移增量不大于 0.6mm 时应判定为自检合格。

7.3.3 For self-inspection tests:

- Install digital load rings;
- Record load values at a frequency of once per minute;
- The test shall be deemed satisfactory when:

Two consecutive readings differ by no more than 0.01 P_p (or 1 kN); and;

The displacement increment between the 6th and 10th minute is ≤0.6 mm.

7.4 数字锚测试

7.4 Digital Anchor Testing

7.4.1 当存在下列情况之一时,可采用数字锚进行测试:

7.4.1 Digital anchors may be used for:

1 锚杆荷载试验;

1. Anchor load testing;

2 压力(分散)型锚杆的锚筋摩阻力测试;

2. Measuring tendon frictional resistance in pressure-type or pressure-dispersed anchors;

3 锚杆回收试验;

3. Anchor recovery tests;

4 锚杆持有荷载监测;

4. Holding load monitoring;

5 锚杆锁定值的确定。

5. Locking load determination.

7.4.2 数字锚测试宜按下列步骤进行:

7.4.2 Digital anchor testing shall follow these steps:

1 在锚固体终凝 3d 内检查传感器及线路的完好性;

1. Within three days after final grout set, check the integrity of sensors and wiring.

2 测试前测读初始压力值;

2. Record the initial pressure before testing;

3 按加卸载程序逐级加载至预定最大试验荷载;

3. Apply incremental loading to the specified maximum test load;

4 卸载到初始试验荷载;

4. Unload to initial test load;

5 自动记录加卸载过程中的压力读数。

5. Automatically record pressure throughout loading and unloading.

7.4.3 数字锚的加卸载程序应符合设计要求，当设计无要求时可按照本规程附录 F 的非极限性基本试验要求执行。

7.4.3 Loading and unloading procedures shall comply with design requirements or, if none are specified, follow the non-ultimate basic test method in Appendix F.

7.4.4 数字锚测试结果与外锚头荷载值的差值可作为该级荷载下锚筋摩阻力损失。

7.4.4 The difference between digital anchor readings and outer anchor head loads at each load stage represents the friction loss of the tendons.

7.4.5 数字锚测试结果可用于锚筋持有荷载验收检验。

7.4.5 Digital anchor test results may be used for acceptance of tendon holding loads.

8 持有荷载监测

8 Holding Load Monitoring

8.0.1 热熔锚应进行持有荷载监测。

8.0.1 Holding-load monitoring shall be performed for all hot-melt anchors.

8.0.2 热熔锚持有荷载监测按实施阶段可分为锚杆张拉锁定阶段监测及锁定后长期监测两个阶段。

8.0.2 Monitoring consists of two stages:

Monitoring during tensioning and locking;

Long-term monitoring after locking.

8.0.3 热熔锚的监测仪器设备宜符合下列规定:

8.0.3 Monitoring instruments and equipment shall meet the following requirements:

1 宜采用数字环等传感器或数字锚具;

1. Digital rings, sensors, or digital anchorages should be used;

2 监测仪器设备应满足观测精度和量程要求,且其测量值宜在测力装置全量程 25%～80%之间;

2. Monitoring equipment shall meet accuracy and range requirements, with measured values preferably within 25%–80% of the full measuring range;

3 监测仪器设备应经过校准或标定合格且在规定的校准有效期内使用。

3. Instruments shall be calibrated, verified as qualified, and used within their calibration validity period.

8.0.4 热熔锚锁定后监测点布置应符合下列规定:

8.0.4 Layout of monitoring points after locking shall meet:

1 场地岩土条件复杂地段及锚杆设计承载力较大地段宜布置监测点;

1. Monitoring points shall be arranged in areas with complex geotechnical conditions or where anchors have high design capacity;

2 对于多层锚杆支挡式结构，每层锚杆测点宜布置在同一监测断面;

2. For multi-layer anchored retaining systems, each layer’s monitoring points should be placed on the same monitoring section;

3 锚杆持有荷载和变形监测点宜布置在同一监测断面。

3. Holding-load and deformation monitoring points should be located on the same monitoring section.

8.0.5 热熔锚锁定后监测时间与频率应符合下列规定:

8.0.5 Monitoring timing and frequency shall meet the following:

1 监测时间不宜短于工程施工时间;

1. Monitoring duration shall not be shorter than the construction period;

2 监测频率除应满足设计要求外，尚可按下列规定执行:

2. Unless otherwise specified by design, the following frequencies apply:

1)荷载增加期间宜为 1d～3d;

• During load increase: every 1–3 days;

2)荷载稳定期间宜为 5d～10d;

• During stable load periods: every 5–10 days;

3)工程结束后，宜为 30d～60d 监测一次;

• After project completion: once every 30–60 days.;

3 当监测数据异常或锚杆荷载变幅较大情况时应增加监测频率;

3. Increase monitoring frequency when data anomalies or large load variations occur.;

4 数据稳定时可降低监测频率。

4. Reduce monitoring frequency when data stabilizes.

8.0.6 热熔锚锁定后持有荷载测量，应符合下列规定:

8.0.6 Post-locking load measurements shall meet:

1 数字锚应在进场后、安装注浆后及张拉锁定后分别进行传感信号测试，当线路出现故障时应查明原因并采取处理措施;

1. Digital anchors shall undergo sensor signal tests after delivery, after grouting, and after tensioning/locking. Investigate and resolve circuit faults when present.

2 张拉锁定后应测读锁定荷载,作为锚杆持有荷载的第一次测读数据;

2. The locking load shall be recorded as the first holding-load reading.

3 测量读数应稳定,每次测量时应重复测量 1 次,宜取平均值作为最终观测值;

3. Readings shall be stable; each measurement shall be repeated once, and the average value shall be used.

4 当锚杆需要重新张拉时，张拉前后应分别记录测力计的观测值;

4. When re-tensioning is required, readings shall be taken before and after re-tensioning.

5 每次观测时，应量测环境温度，并应记录工程现场施工和运行情况。

5. Ambient temperature and site construction/operational conditions shall be recorded with each reading.

9 质量检验

9 Quality Inspection

9.0.1 热熔锚质量检验应在施工过程中分阶段进行，并应包括下列内容:

9.0.1 Quality inspection for hot-melt anchors shall be carried out in stages during construction and shall include the following:

1 原材料、部件及预制杆体的进场检验;

1. Incoming inspection of raw materials, components, and prefabricated tendons;

2 成孔、杆体安装、注浆、张拉锁定及回收工序的施工质量检验;

2. Quality inspection for drilling, tendon installation, grouting, tensioning and locking, and tendon recovery;

3 锚杆抗拔承载力检验;

3. Inspection of anchor pullout capacity;

4 数字锚测力系统功能检验。

4. Functional testing of digital anchor load-measuring systems.

9.0.2 热熔锚原材料及部件进场检验应符合下列规定:

9.0.2 Incoming inspection of hot-melt anchor materials and components shall comply with the following:

1 钢绞线、热熔锚具、承载体、导线及数字测力装置应具有质量证明文件，并应进行外观检查;

1. Steel strands, hot-melt anchorages, bearing components, wires, and digital load-measuring devices shall have valid quality certificates and shall undergo visual inspection;

2 预制杆体应核查产品标识，并应抽样检查解锁系统电路导通性;

2. Prefabricated tendons shall have their product markings verified, and sampling inspection shall be carried out to check continuity of the unlocking system circuitry;

3 水泥、外加剂等材料检验应符合现行国家标准《通用硅酸盐水泥》GB175

及《混凝土外加剂》GB8076 的规定。

3. Inspection of cement, admixtures, and related materials shall comply with the current national standards *GB 175 – Common Portland Cement* and *GB 8076 – Concrete Admixtures*.

9.0.3 热熔锚施工质量检验应符合下列规定:

9.0.3 Construction quality inspection for hot-melt anchors shall meet the following requirements:

1 成孔质量检验应包括孔位、孔径、孔深及倾角，允许偏差应按本规程第 6.2.7 条执行;

1. Drilling quality checks shall include borehole position, diameter, depth, and inclination, with tolerances following Section 6.2.7;

2 注浆质量检验应包括浆液配合比、注浆压力、注浆量及浆体强度;

2. Grouting inspection shall include grout mix proportions, grouting pressure, grouting volume, and grout strength;

3 张拉锁定质量检验应包括锁定荷载、持有荷载及锁损率;

3. Tensioning and locking inspection shall include verification of the locking load, holding load, and lock-loss ratio;

4 回收质量检验应包括锚筋回收率及残留物尺寸。

4. Recovery inspection shall include tendon recovery rate and the dimensions of residual fragments.

9.0.4 锚杆抗拔承载力检验应符合下列规定:

9.0.4 Inspection of anchor pullout capacity shall comply with the following:

1 检验方法应按本规程第 7.3 节执行;

1. Testing methods shall follow Section 7.3;

2 检验数量不应少于锚杆总数的 5%且同一条件下不应少于 3 根;

2. The number of anchors tested shall be no less than 5% of the total quantity, and no fewer than three anchors under the same conditions;

3 检验锚杆应随机抽样并应覆盖不同地层及设计参数。

3. Test samples shall be randomly selected and shall represent different geological conditions and design parameters.

9.0.5 热熔锚质量验收应符合下列条件:

9.0.5 Quality acceptance of hot-melt anchors shall meet the following criteria:

1 检验批的原材料、施工质量及承载力检验结果均合格;

1. All raw material inspections, construction quality checks, and pullout capacity tests within the batch shall be satisfactory;

2 数字锚持有荷载实测值为设计锁定荷载的 0.9-1.1 倍;

2. Measured holding loads from digital anchor systems shall be 0.9–1.1 times the design locking load;

3 锚筋回收率不应低于 95%;

3. Tendon recovery rate shall not be lower than 95%;

4 残留物尺寸应符合本规程第 4.0.4 条第 1 款的规定。

4. Dimensions of residual fragments shall comply with Section 4.0.4(1).

附录 A 热熔锚杆体技术要求

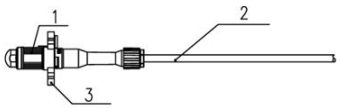
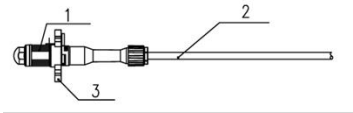
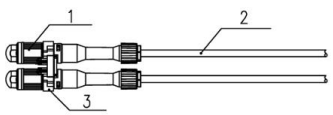
Appendix A Technical Requirements for Hot-Melt Anchor Prefabricated Tendons

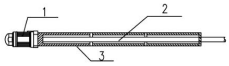
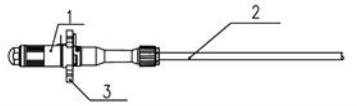
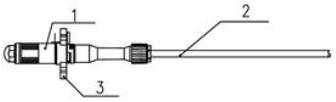
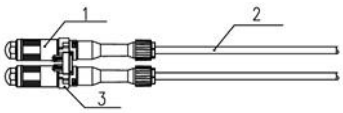
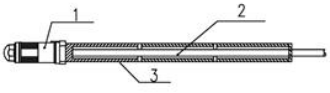
A.0.1 热熔锚的杆体构造应按表 A.0.1 的规定采用。

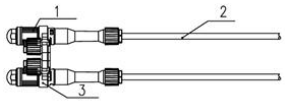
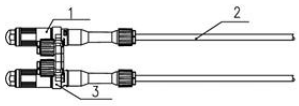
A.0.1 The structural configuration of hot-melt anchor tendons shall comply with the specifications listed in Table A.0.1..

表 A.0.1 杆体构造形式

Table A.0.1 Structural Configuration of Anchor Tendons

形式			锚索杆体图例	部件名称			最大单件残留物长度	金属残留物体积
类型	名称	编号		1	2	3		
等直径锚索	可回收热熔锚	RZ-112		热熔锚具	带标码无粘结钢绞线	Φ112 承载板	0.4	0.34
		RZ-125		热熔锚具	带标码无粘结钢绞线	Φ125 承载板	0.4	0.39
		RZ-135		热熔锚具	带标码无粘结钢绞	Φ135 承载板	0.4	0.43

					线			
		RF-60		热熔锚具	带标码无粘结钢绞线	数模制ϕ60 承载板，可叠加	0.4	0.14
	可回收数字热熔锚	SRZ-112		数字热熔锚具	带标码无粘结钢绞线	Φ112 承载板	0.4	0.39
		SRZ-125		数字热熔锚具	带标码无粘结钢绞线	Φ125 承载板	0.4	0.44
		SRZ-125		数字热熔锚具	带标码无粘结钢绞线	Φ135 承载板	0.4	0.48
		SF-60		数字热熔锚具	带标码无粘结	数模制ϕ60 承载板，可叠加	0.4	0.19

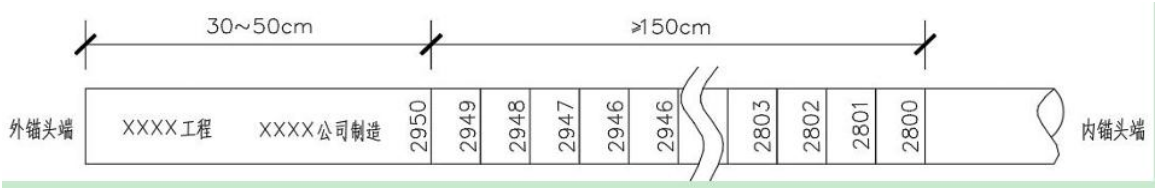
					钢绞线			
扩体锚索	可回收热熔锚	RX-205		热熔锚索	带标码无粘结钢绞线	Φ205 承载板	0.4	0.8
	可回收数字热熔锚	SRX-205		热熔数字锚	带标码无粘结钢绞线	Φ205 承载板	0.4	0.85

A.0.2 热熔锚的杆体标码形式可按表 A.0.2 的规定采用

A.0.2 The marking system for hot-melt anchor tendons shall comply with the specifications in Table A.0.2.

表 A.0.2 热熔锚杆体标码形式

Table A.0.2 Marking System for Hot-Melt Anchor Tendons



注 / Notes:

1.预制杆外端应刻印产品标识，刻印设备宜采用激光打码设备

1. The outer end of prefabricated tendons shall be laser-engraved with product markings;

2.标识信息应包括工程名称、生产企业及锚杆长度，工程及企业名称可采用简称

2. Marking information shall include project name, manufacturer name, and tendon length (abbreviations permitted);

3.标识区应从预制杆外端向孔底方向不少于 2m，其中图文标识区范围宜为 0.3m~0.5m，长度标识区范围不宜小于 1.5m

3. The marking zone shall extend at least 2 m from the outer end toward the

borehole:

图文标识区 / Graphic/text marking: 0.3–0.5 m

长度标识区 / Length-graduation marking: ≥1.5 m

4.标识长度单位宜为 cm，刻度间隔宜为 1cm

4. Length markings shall use centimeters (cm) with a 1cm interval.

Appendix B: 浆体与地层之间粘结强度及锚固体端阻强度表（kPa）

Appendix B: Bond Strength Between Grout and Strata, and End-Bearing Strength of Anchored Body (kPa)

表格说明 Table Notes

1. **粘结强度值适用条件**
   Applicable Conditions for Bond Strength Values

- **中文** ：表中粘结强度值为一次注浆及简易二次注浆的经验值；采用二次分段注浆工艺时可提高 1.1～1.5 倍，岩体中提高倍数较小。
- **英文** ：The bond strength values provided are empirical values corresponding to **primary grouting** and **simple secondary grouting**. When **segmented secondary grouting** is adopted, the bond strength may be increased by a factor of **1.1–1.5**, with smaller multipliers applicable in rock masses.

2. **黏性土层取值原则**
   Principles for Cohesive Soils

- **中文** ：对于黏性土层，干钻成孔、套管护壁、洗孔干净、等待注浆时间较短、注浆压力大、浆体强度高、地下水不丰富等工况下粘结强度取较高值；反之取较低值。
- **英文** ：In cohesive soils, higher bond strength values shall be used when the following conditions are met:
- Dry drilling
- Casing support
- Clean boreholes
- Short waiting time prior to grouting

- High grouting pressure
- High grout strength
- Low groundwater content

Lower values shall be used when the above conditions are not satisfied.

3. 砂土层取值原则
Principles for Sandy Soils

- 中文 ：对于砂土，在密实度相同情况下，粉细砂层取粘结强度较低值，中粗砂层取中值，砾砂层取较高值；粉细砂含量超过总质量的 30% 时取较低值。
- 英文 ：For sandy soils of similar density:
- **Lower** bond strength values apply to silty or fine sand layers.
- **Intermediate** values apply to medium or coarse sand.
- **Higher** values apply to gravelly sand.

If silty/fine sand content exceeds **30%**, lower values shall be used.

强度表 Strength Table

岩土类别 Rock/Soil Category	岩土性状 Condition	粘结强度标准值 Bond Strength (kPa)	端阻强度标准值 End Bearing Strength (kPa)
素填土 Plain Fill	-	-	100–600
淤泥质土	-	10–30	100–300

岩土类别 Rock/Soil Category	岩土性状 Condition	粘结强度标准值 Bond Strength (kPa)	端阻强度标准值 End Bearing Strength (kPa)
Silty Soil			
黏性土 Cohesive Soil	可塑（0.5 < I_L ≤ 0.75） Medium Plastic	35–60	300–700
	硬塑（0.25 < I_L ≤ 0.5） Stiff Plastic	40–80	650–1,200
	坚硬（0 < I_L ≤ 0.25） Hard Plastic	45–100	900–1,300
粉土 Silty Soil	中密（0.75 ≤ e ≤ 0.9） Medium Dense	30–80	500–700
	密实（e < 0.75） Dense	50–120	600–1,000
砂土 Sandy Soil	稍密（10 < N ≤ 15） Loose	20–50	200–500
	中密、密实（N > 15） Medium/Dense	50–200	700–1,200
碎石土 Gravelly Soil	稍密 Loose	60–200	900–1,500
	中密 Medium Dense	80–250	1,200–2,200
岩体 Rock Mass	软岩 Soft Rock	200–600	1,200–2,400
	较硬岩	600–1,600	-

岩土类别 Rock/Soil Category	岩土性状 Condition	粘结强度标准值 Bond Strength (kPa)	端阻强度标准值 End Bearing Strength (kPa)
	Hard Rock		

附注 Additional Notes

1. **符号说明** ：

- I_L = 液性指数（Liquidity Index）
- e = 孔隙比（Void Ratio）
- N = 标准贯入击数（Standard Penetration Test Blow Count）

2. **适用性** ：表中数据为经验值，实际工程需结合现场试验调整。

- **英文** ：All values are empirical and shall be adjusted based on field test results.

Appendix C: 采用旋喷扩体方式的水泥土受压承载力经验数据表

Appendix C: Empirical Compressive Capacity Data for Jet-Grouted Enlarged Cement-Soil Anchors

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表格说明 Table Notes

1. 术语定义

- **旋喷扩体方式** ：通过高压旋喷工艺形成扩大的锚固段。
  - **Jet-Grouted Enlarged Body** : Anchored section enlarged by high-pressure jet grouting.
- **水泥土** ：水泥与土体混合形成的固化体。
  - **Cement-Soil** : Solidified mass resulting from the mixing of cement and in-situ soil.

数据表 Data Table

产品型号 Product Model	外观 Appearance	钢绞线条数 Number of Strands	扩体锚固段长度 Length of Enlarged Section (m)	承载板间距 Spacing of Bearing Plates (m)	承载板直径 Diameter of Bearing Plates (mm)	承载板数量 Number of Bearing Plates	21 天养护期锚固体抗压极限承载力（kN） Ultimate Compressive Capacity (21-day Curing)	14 天养护期锚固体抗压极限承载力（kN） Ultimate Compressive Capacity (14-day Curing)
Y-1	![外观示意图]	2	2–4	0.5–1	205	1	黏性土（可塑 0.5＜IL≤0.75）200–300	粉砂（稍密 10＜N≤15）250–450
Y-2	![外观示意图]	4	2–4	0.5–1	205	2	黏性土（硬可塑 0.25＜	细砂（中密、密实 N＞15）

产品型号 Product Model	外观 Appearance	钢绞线条数 Number of Strands	扩体锚固段长度 Length of Enlarged Section (m)	承载板间距 Spacing of Bearing Plates (m)	承载板直径 Diameter of Bearing Plates (mm)	承载板数量 Number of Bearing Plates	21 天养护期锚固体抗压极限承载力（kN） Ultimate Compressive Capacity (21-day Curing)	14 天养护期锚固体抗压极限承载力（kN） Ultimate Compressive Capacity (14-day Curing)
							IL≤0.5）250–450	300–450
Y-3	![外观示意图]	6	2–4	0.5–1	205	3	黏性土（硬塑 0＜IL≤0.25）350–550	中粗砂（中密、密实 N＞15）400–600

参数说明 Parameter Definitions

1. **液性指数（IL）**

- **中文** ：黏性土的液性指数，反映土体稠度状态。
- **英文** ：Liquidity Index (IL) of cohesive soil, indicating the consistency state of cohesive soils..

2. **标准贯入击数（N）**

- **中文** ：标准贯入试验锤击数，用于评价砂土密实度。
- **英文** ：Standard Penetration Test (SPT) Blow Count (N), Used to evaluate the relative density of sandy soils.

3. **养护期（Curing Period）**

- **中文** ：水泥土固化所需的时间（天数）。
- **英文** ：Time, in day, required for the cement–soil mixture to achieve the corresponding compressive strength.

应用范围 Application Scope

- **黏性土** （可塑至硬塑状态）和 **砂土** （稍密至密实状态）。
  - **Applicable to:**
    - **Cohesive soils ranging from plastic to stiff plastic, and**
    - **Sandy soils ranging from loose to dense.**
- **承载力范围** ：200–600 kN（根据土层条件和产品型号调整）。
  - **Capacity Range** : Typical compressive capacity ranges:

- **200–600 kN**, dependent on soil conditions and anchor model.

注　　：表中数据为经验值，实际工程需结合现场试验验证。

Note　　: Values are empirical and shall be verified through field tests.

Appendix D: 热熔式可回收锚杆施工记录表

Appendix D: Construction Record Sheet for Hot-Melt Removable Anchors

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表 D.0.1 热熔锚导电测试记录表

Table D.0.1 Conductivity Test Record for Hot-Melt Anchors

工程名称 Project Name	锚杆类型 Anchor Type	测试仪型号 Tester Model	测试仪编号 Tester ID

锚杆编号 Anc	锚杆部位 Location	测试阶段 Test	测试日期 Test	电阻（Ω） Resist	故障情况 Fault	故障位置 Fault	备注 Remarks	测试员 Tester	记录员 Recorder	技术负责人 Tec

hor ID		Phase	Date	ance (Ω)	Description	Location			hnical Supervisor
		进场后 Post-Delivery							
		注浆后 Post-Grouting							
		锁定后 Post-Locking							

表 D.0.2 热熔锚回收记录表

Table D.0.2 Recovery Record for Hot-Melt Anchors

工程名称 Project Name	锚杆类型 Anchor Type

锚杆编号 Anchor ID	部位 Location	长度（m） Length (m)	钢绞线总束数 Total Strands	回收束数及长度 Recovered Strands & Length	未回收束数及长度 Unrecovered Strands & Length	回收日期 Recovery Date	备注 Remarks

汇总 Summary

施工工长 Construction Foreman	质检员 Quality Inspector	监理 Supervisor	日期 Date

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填写说明 Instructions

1. **导电测试记录表**
   Conductivity Test Record

- **电阻范围** ：正常值为 1–15Ω，超出范围需标记故障。
  - **Resistance Range** : **Normal resistance range:** 1–15 Ω. Values outside this range shall be marked as faults.
- **测试阶段** ：分“进场后”“注浆后”“锁定后”三个阶段。
  - **Test Phases** : "Post-Delivery," "Post-Grouting," "Post-Locking."
- **故障标记** ：用“√”表示正常，“×”表示异常。

- **Fault Marking** : "√" for normal, "×" for abnormal.

2. **回收记录表**
Recovery Record

- **未回收原因** ：需在备注栏注明（如机械故障、地层卡阻等）。
- **Unrecovered strand causes shall be documented (e.g., mechanical malfunction, geological obstruction).**
- **回收率计算** ：回收率 = 回收束数 / 总束数 × 100%。
- **Recovery rate:**
- $\textbf{Recovery Rate} = \frac{\textbf{Recovered Strands}}{\textbf{Total Strands}} \times \textbf{100\%}$

注 ：所有记录需由相关人员签字确认并存档。
Note : All records shall be signed by responsible personnel and archived.

Appendix E: 锚杆荷载试验设备及操作要点

Appendix E: Anchor Load Test Equipment and Operational Guidelines

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E.0.1 试验设备要求

E.0.1 Test Equipment Requirements

设备/组件 Equipment/Component	技术要求 Technical Specifications
反力装置 Reaction System	- 反力不小于最大试验荷载的 1.2 倍，且满足变形要求。 - Reaction force ≥ 1.2× maximum test load, with deformation compatibility.
千斤顶 Hydraulic Jack	- 双作用液压千斤顶，额定负荷为最大试验荷载的 1.2–2.0 倍。 - Double-acting hydraulic jack; rated load = 1.2–2.0× maximum test load.
测力装置 Load Measurement System	- 采用力传感器或并联压力表，需校准并换算荷载。 - Use load cell or pressure gauge with calibration

设备/组件 Equipment/Component	技术要求 Technical Specifications
	and conversion curves.
位移传感器 Displacement Transducer	- 精度等级 ≥ 0.5 级，量程覆盖预期位移。 - Accuracy ≥ 0.5% FS; range covers expected displacement.
数据采集系统 Data Acquisition System	- 实时采集荷载-位移数据，支持远程传输和故障保护。 - Real-time data logging, remote transmission, and fault tolerance.

E.0.2 操作要点

E.0.2 Operational Guidelines

1. **系统安装**
   System Installation

- 确保千斤顶、反力装置与锚杆轴线重合，锚垫板承压面平整垂直。
  - The jack, reaction system, and anchor axis shall be aligned.
  - Anchor plate bearing surfaces shall be flat and perpendicular.
- 工具锚夹片夹持均匀，预张拉 1–2 次（荷载为最大试验荷载的 0.2–0.3 倍）。
  - Wedges shall be tightened uniformly.
  - Pre-tension cycles (1–2) at **0.2–0.3 × maximum test load** shall be performed.

2. **加载控制**
   Load Application

- 加载速率：1–10 kN/s，均匀连续无冲击。
  - Loading rate: **1–10 kN/s**, uniform and impact-free.

- 维荷期间荷载波动 ≤ 1% 最大试验荷载（或 ≤ 1 kN）。
  - Load fluctuation during holding: **≤1% of maximum test load (or ≤1 kN).**

3. **数据记录**
   Data Recording

- 初始荷载取最大试验荷载的 10%。
  - Initial load = 10% of maximum test load.
- 每级荷载停留时间：
  - Holding time per load step:
    - 常规试验：1 分钟/级，位移稳定后进入下一级。
    - Conventional test: 1 min/step; proceed if displacement stabilizes.
    - 长时试验：延长至 60 分钟，评估蠕变特性。
    - Long-term test: Extend to 60 min for creep evaluation.

4. **安全措施**
   Safety Measures

- 液压泵与油管压力 ≤ 额定工作压力的 80%。
  - Hydraulic system pressure shall not exceed **80%** of rated capacity.
- 位移超限或异常时立即中止试验。

Tests shall be suspended immediately in case of abnormal displacement or system malfunction.

E.0.3 设备校准与维护

E.0.3 Calibration and Maintenance

项目 Item	要求 Requirement

项目 Item	要求 Requirement
校准周期 Calibration Interval	- 力传感器/压力表：每 6 个月或每 100 次试验后校准。 - Load cells/pressure gauges: calibrate every **6 months** or every **100 tests**.
设备检查 Equipment Inspection	- 每次试验前检查千斤顶密封性、传感器连接和数据系统功能。 - Inspect jack seals, sensor connections, and data systems prior to each test.

**注　　**：本表适用于岩土锚杆基本试验、验收试验及长期监测。

**Note　　**: This table applies to anchor basic tests, acceptance tests, and long-term monitoring.

Appendix F: 基本试验
Appendix F: Basic Test

F.0.1 试验目的

F.0.1 Test Purpose

- **中文　　**：验证热熔式可回收锚杆的设计承载力、变形特性及施工工艺适用性。
- **英文　　**：To verify the bearing capacity, deformation behavior, and construction suitability of hot-melt removable anchors.

F.0.2 试验类型与数量

F.0.2 Test Types and Quantity

试验类型 Test Type	要求 Requirements
极限性基本试验 Ultimate Basic Test	- 试验数量 ≥ 6 根。 - 加载至锚杆破坏。 - Quantity ≥ 6 anchors. - Load to failure.
非极限性基本试验 Non-Ultimate Basic Test	- 试验数量 ≥ 3 根。 - 加载至设计荷载的 1.5 倍。 - Quantity ≥ 3 anchors. - Load to 1.5× design load.

F.0.3 加卸载程序

F.0.3 Loading and Unloading Procedure

步骤 Step	荷载分级 Load Levels	停留时间 Holding Time	位移测量 Displacement Measurement
1. 初始荷载 Initial Load	0.1×最大试验荷载 $0.1\times P_{max}$	5 分钟 5 minutes	记录初始位移 Record initial displacement
2. 分级加载 Gradual Loading	0.3, 0.5, 0.6, 0.7, 0.8, 0.9, $1.0\times P_{max}$	每级 15 分钟 15 min per level	每级加载后测读位移 Measure displacement after each load step
3. 卸载 Unloading	反向分级卸载至 0 Unload stepwise to zero	-	记录残余位移 Record residual displacement

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F.0.4 合格判定标准

F.0.4 Acceptance Criteria

指标 Criterion	要求 Requirement
承载力 Bearing Capacity	- 实测极限承载力 ≥ 设计值。 - Measured ultimate capacity ≥ design value.
位移稳定性 Displacement Stability	- 每级荷载下位移增量 ≤ 1.0 mm（5–15 分钟内）。 - Displacement increment ≤ **1.0 mm** within **5–15 min** at each load step.
蠕变率（α） Creep Rate (α)	- α ≤ 2.0 mm（计算时段 $t_b - t_a \geq 30$ 分钟）。 - α ≤ 2.0 mm (for time interval ≥ 30 min).

F.0.5 试验报告内容

F.0.5 Test Report Requirements

1. **荷载-位移曲线（P-s 曲线）**

- **中文** ：绘制各级荷载与对应位移的关系曲线。
- **英文** ：Plot load vs. displacement (P-s curve) for each load level.

2. **蠕变分析**

- **中文** ：计算蠕变率并评估长期变形风险。
- **英文** ：Calculate creep rate (α) and evaluate long-term deformation risks.

3. **结论与建议**

- **中文** ：明确试验是否通过，提出设计或施工优化建议。
- **英文** ： Provide conclusions on test results and recommend for design or construction adjustments.

**注　　**：试验结果应存档并作为工程验收依据。

Note　　: Test results must be archived and serve as acceptance criteria for the project.

Appendix G: 持有荷载试验

Appendix G: Holding Load Test

G.0.1 试验目的

G.0.1 Test Purpose

- **中文**　　：验证锚杆在锁定后的实际持有荷载是否符合设计要求，评估预应力损失。
- **英文**　　：To verify whether the actual holding load of the anchor after locking and evaluate prestress loss.

G.0.2 试验步骤

G.0.2 Test Procedure

步骤 **Step**	**操作内容** **Operation**	**技术要点** **Key Technical Points**
1. **安装测力装置** Installation of load measurement devices	安装数字测力环或传感器于锚头。 Mount digital load cell or transducer at the anchor head.	- 确保测力装置与锚杆轴线对齐。 - Align the load cell with the anchor axis.
2. **分级加载** Stepwise loading	按设计荷载的 5% 逐级加载至最大试验荷载。	- 加载速率 ≤ 10 kN/s。

步骤 Step	操作内容 Operation	技术要点 Key Technical Points
(increments of 5% of design load)	Load stepwise in 5% increments of the design load up to the maximum test load.	- Loading rate ≤ 10 kN/s.
3. **提离法判定** Lift-off verification using feeler gauges	用塞尺检测锚具与锚垫板间隙，判定提离现象。 Check gaps between anchor head and plate using feeler gauge to detect lift-off.	- 间隙 ≥ 0.3 mm 时判定为提离。 - Gap ≥ 0.3 mm indicates lift-off.
4. **数据记录** Recording load and displacement at each level	记录每级荷载下的位移和荷载值。 Record displacement and load values at each step.	- 每级荷载停留 1 分钟。 - Hold each load step for 1 minute.

G.0.3 合格判定标准

G.0.3 Acceptance Criteria

指标 Criterion	要求 Requirement
持有荷载 Holding Load	- 实测持有荷载为设计锁定荷载的 0.8–1.1 倍。 - Measured holding load = 0.8–1.1× design locked load.
位移稳定性 Displacement Stability	- 每级荷载下位移增量 ≤ 0.5 mm（1 分钟内）。 - Displacement increment ≤ 0.5 mm (within 1 min).

G.0.4 试验报告内容

G.0.4 Test Report Requirements

1. **荷载-位移曲线（P-s 曲线）**

- **中文** ：绘制荷载与位移的关系曲线，标注提离点。
- **英文** ：Plot load vs. displacement (P-s curve) and mark the lift-off point.

2. **预应力损失分析**

- **中文** ：计算锁定荷载与持有荷载的差值，分析损失原因。
- **英文** ：Calculate prestress loss (locked load vs. holding load) and analyze causes.

3. **结论与建议**

- **中文** ：判定是否合格，提出调整张拉参数或施工工艺的建议。
- **英文** ：State acceptance status and provide recommendations for adjusting tensioning parameters or construction methods.

注 ：试验结果应作为锚杆工程验收的重要依据。

Note : Test results are critical for anchor acceptance and project handover.

本标准用词说明

Explanation of Wording in This Standard

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1. **严格程度术语**
   Terms Indicating Degree of Rigidity

中文表述 Chinese Wording	英文表述 English Wording	说明 Explanation
必须 Must	严禁 Prohibited	表示强制性要求，违反将导致严重后果。 Indicates mandatory requirements; non-compliance will lead to severe consequences.
应 Shall	不应 或 不得 Shall Not	表示正常情况下均应遵守的规则。 Indicates rules to be followed under normal circumstances.
宜 Should	不宜 Should Not	表示允许稍有选择，条件允许时优先采用。 Indicates a recommendation with flexibility; priority applies when conditions allow.
可 May	允许 Permitted	表示有选择，在特定条件下可采用。 Indicates an option applicable under specific conditions.

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2. **引用标准表述**
   Reference to Other Standards

- **中文** ：条文中指明按其他有关标准执行时，写法为：
  - “应符合……的规定”或“应按……执行”。
- **英文** ：When reference to other standards is required, use:
  - “Shall comply with the provisions of…” or “Shall be executed in accordance with…”.

示例 ：

- 锚具静载锚固性能检验方法应符合《预应力筋用锚具、夹具和连接器应用技术规程》JGJ 85 的规定。

- The static load anchoring performance test method for anchorage shall comply with *Technical Specification for Application of Anchors, Clamps and Couplers for Prestressed Tendons* JGJ 85.

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3. **条文解释权**
Authority of Interpretation

- **中文**　：本标准由中国工程建设标准化协会地基基础专业委员会归口管理，由浙江大学和苏州市能工基础工程有限责任公司负责具体解释。
- **英文**　：This standard is administered by the Foundation Engineering Committee of the China Association for Engineering Construction Standardization. Technical interpretation is provided by Zhejiang University and Suzhou Nenggong Foundation Engineering Co., Ltd.

注　：执行本标准时，术语定义以最新版引用标准为准。

Note　: Definitions of terms shall follow the latest versions of referenced standards.

List of Quoted Standards

引用标准名录

国家标准 National Standards

1. **《混凝土外加剂应用技术规范》GB 50119**

Technical Code for Application of Concrete Admixtures GB 50119

2. **《建筑地基基础工程质量验收标准》GB 50202**

Standard for Quality Acceptance of Building Foundation Engineering GB 50202

3. **《混凝土结构工程施工质量验收规范》GB 50204**

Code for Acceptance of Construction Quality of Concrete Structures GB 50204

4. **《建筑工程施工质量验收统一标准》GB 50300**

Unified Standard for Construction Quality Acceptance of Building Engineering GB 50300

5. **《建筑与市政地基基础通用规范》GB 55003**

General Code for Building and Municipal Foundation Engineering GB 55003

6. **《通用硅酸盐水泥》GB 175**

Common Portland Cement GB 175

7. **《预应力混凝土用钢绞线》GB/T 5224**

Steel Strands for Prestressed Concrete GB/T 5224

8. **《预应力筋用锚具、夹具和连接器》GB/T 14370**

Anchors, Clamps and Couplers for Prestressed Tendons GB/T 14370

行业标准 Industry Standards

1. **《建筑砂浆基本性能试验方法标准》JGJ/T 70**

Standard for Test Methods of Basic Properties of Building Mortar JGJ/T 70

2. **《预应力筋用锚具、夹具和连接器应用技术规程》JGJ 85**

Technical Specification for Application of Anchors, Clamps and Couplers for Prestressed Tendons JGJ 85

3. **《建筑基坑支护技术规程》JGJ 120**

Technical Specification for Retaining and Protection of Building Excavations JGJ 120

4. **《无粘结预应力钢绞线》JG/T 161**

Unbonded Prestressed Steel Strands JG/T 161

5. **《锚杆检测与监测技术规程》JGJ/T 401**

Technical Specification for Testing and Monitoring of Anchors JGJ/T 401

团体标准 Association Standards

1. **《岩土锚杆技术标准》T/CECS 22**

Technical Standard for Geotechnical Anchors T/CECS 22

2. **《可回收锚杆应用技术规程》T/CECS 999**

Technical Specification for Application of Removable Anchors T/CECS 999

注　　：

- 注日期的引用文件，仅所注日期的版本适用于本文件。不注日期的引用文件，其最新版本（包括所有的修改单）适用于本文件。
- **Note　　:**
  - For dated references, only the edition cited applies.
  - For undated references, the latest edition (including any amendments) applies.