Overview of CS-21 Series Products and Methods

Version 3.5

Introduction

Concrete renovation CS-21 is an inorganic, colorless and transparent water solution.

By permeating (impregnating) by way of coating (spreading) on or injecting in hardened concrete, it can fill up existing minute voids and the new voids formed after construction.

Around 1993 when this product was first developed, it was regarded as Water Sealing by Injection material in water leakage repair work. Then, the application as a coating material began, and now it is widely used for surface protection of concrete structures, waterproofing of the body, treatment of placing joints, crack repair, and so on.

Work Experience of CS-21 Methods (as of September 2017)

Methods:	Number of Projects:	
Surface protection (Bridges, box culverts, tunnels, dams, etc.)	628	Approx. 451,000 m^2
Waterproofing of body (Parking lots, roofs, basements, water tanks, bridge face, etc.)	745	Approx. 1,481,000 m^2
Treatment of placing joints and imprinted holes of separator ends	94	
Refurbishment, section repair (Water channel, etc.)	227	Approx. 38,000 m^2
Crack repair, water leakage repair	226	Approx. 46,000 m
Total	1,920	

- The data above is based on the reports from the members of Aston Association.
- For the details of the works, please refer to our official website (http://www.cs21.jp/).

As its use application extends, we are developing and planning new product series and auxiliary agents that correspond to each method. Therefore, in order to elicit the desired effect, it is important to understand the reaction properties of each material and to select suitable method and material for the work according to the condition of the concrete and the environment.

Examples of CS-21 Series Products and Work Method Corresponding to the Purpose of Use

Purpose	Material	Use application	Method
Body waterproofing	CS-21	Waterproofing of parking lots, roofs, basements, water tanks, etc.	Spreading (Spraying)
Surface protection	CS-21 Neo	Improvement of quality and durability of new structures	
	CS-21 Builder	Preventive maintenance and long-life of existing structures	
Protective decoration	CS-21	Preventive maintenance and long-life of existing structures	Spreading (Spraying) ＋Coating
	CS Filler	Decoration by inorganic coating material	
Treatment of placing joints	CS-21	Prevention of water leakage from joints Inhibition of deterioration	Spraying (Spreading)
Minute crack repair	CS-21*	Full coating for body waterproofing and surface protection and partial coating for crack repair	Spreading
	CS-21 Neo, Builder		
	CS-21 Crack Repair Set (CS-21 Clear + CS Putty)	Improvement of durability of cracks and recovery of beautiful appearance	Spreading+ Filling
Crack injection	CS-21*	In some cases, used with fine cement	Injection
Water leakage repair (Water sealing)	CS-21*		
	CS-21 Moisture		
	CS-21 Quartz		
Section repair	CS-21 Clear CS Mortar	Reinforcement of the base + inhibition of void forming on the interface + protection of filling material Restoration of lost parts	Spraying (Spreading) + Filling

* In some cases, used as liquid mixture with the Auxiliary agent (CS-21SP)

In order to elicit the effect of selected CS-21 method efficiently, Aston Inc., the developer, manufacturer, and distributer, established Aston Association together with its agents all over the nation and their contracted firms. Then, it has committed to improving technology, including cultivating supervisors, and implemented the work system that is conducted by the responsible Aston members or through providing technical guidance.

This document contains the overview of CS-21 Series Products and construction methods.

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Overview of Products

Overview of Methods

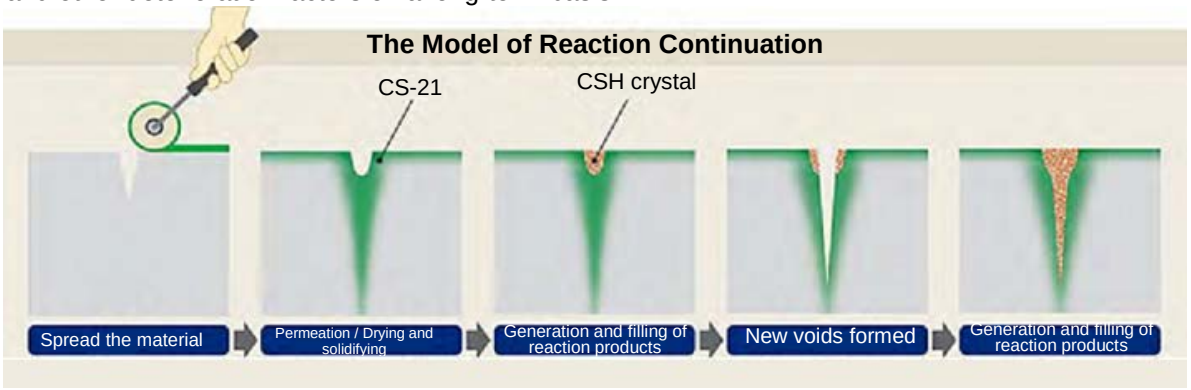
Basic Properties of CS-21Series Products

CS-21 Series products are colorless, transparent, and odorless inorganic water solution whose main component is sodium silicate.

By spreading or spraying on the surface of hardened concrete and permeating (impregnating), dried and solidified substance (unreacted constituent) fills up the voids, such as minute cracks, together with stable reactant (CSH crystal) generated through reaction with calcium component, etc. in the concrete.

Even after dried and solidified, the main component left unreacted after the permeation generates stable reactant (CSH crystal) as it dissolves with the water supplied, filling up new voids such as minute cracks that are formed after work.

Through these reactions, the products densify the voids on the surface part including the deep part of cracks, inhibiting entry of water and other deterioration factors on a long-term basis.



※ The ability becomes effective immediately after the work and inhibits entry of water and other deterioration factors by densifying the surface part.

※ The reaction continues as water is supplied by precipitation and morning dew, increasing the filling rate in the voids over time.

Background of the Development

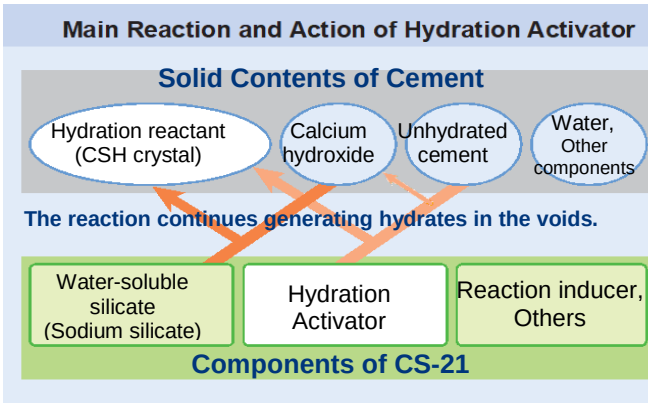
∗ Problems of the conventional materials whose main component is silicate:

The materials whose main component is silicate is more effective as they react with calcium hydroxide in concrete. However, concrete neutralizes gradually from the parts exposed to air, which decreases the quantity of calcium hydroxide over time and makes existing concrete less reactive.

∗ Countermeasures:

In order to improve the reactivity of neutralized concrete, where the quantity of calcium hydroxide is small, the new material, CS-21, was developed in 1993; its main component is silicate and it contains the new element, **hydration activator**.

The CS-21 Series Products have the capability in common to react even in neutralized parts, and they work effectively not only on aged existing concrete but also on the new voids formed after several years of aging from the application on the new structures.



The Features Common in CS-21 Series Products

Contains hydration activator → Effective regardless of concrete ages

Repairs minute cracks by coating on the surface → Densifies surface parts, including deep parts of cracks

Continuously fills minute voids → Keeps cover concrete sound on a long-term basis

※ As both the main component and the reactants are inorganic, it is as durable as the concrete body.

※ It does not contain harmful substances such as organic solvent. CS-21, CS-21 Neo and CS-21 SP have been confirmed the safety applicable to water and sewage facilities (JWWA Z 108). [Experienced in full coating on reservoirs for water supply.]

Body Waterproofing Material【Sodium Silicate-based Surface Penetrant 】

CS-21

For the methods covered by 10-year warranty of waterproofing

＊ Features

For the purpose of increasing fill rates in the voids, it is recommended to use the highly concentrated liquid without diluting.
Body waterproofing of concrete structures (parking lots, roofs, basements, water tanks, etc.) is possible.
Developed in 1993, follow-up researches have confirmed the effect duration of more than 15 years.

＊ Product Outline

Appearance	: Colorless and transparent liquid
Main component	: Sodium silicate
Specific gravity (Density)	: 1.24 - 1.28 (g/cm^3)
pH value	: 11.3 - 12.3
Dry solid content	: 31.5 - 33.5 (%)

＊ Intended Use

Coating method: Body waterproofing, surface protection, treatment of placing joints, crack repair, etc.

Injection method: Water leakage repair, crack repair (used alone or with other cement materials)

＊Package

5 kg plastic container

2 kg plastic container

＊ Warranty of waterproofing

A 10-year warranty of waterproofing is available for waterproofing newly constructed parking lots and roofs (subject to prior consultation).
Available for waterproofing of roofs and roof tops covered by Housing Warranty Insurance (see below)
Anshin Insurance Co., Ltd./ Organization for Housing Warranty Ltd./ Japan Housing Insurance Inspection Organization Co., Ltd./ House G-men Co., Ltd./ House Plus Housing Insurance Co., Ltd.

※Please refer to the Body Waterproofing section (p. 14 - 16) for the details of waterproofing by CS-21.

＊ Registration Information

- New Technology Information System (NETIS) – Ministry of Land, Infrastructure, Transport and Tourism
  Upon the expiration of the registration period for NETIS (February 2003 – March 2017), it is now included in *The List of the Technology that Expired the NETIS Registration Period*. (No.: CB-020055)
- Agricultural and Rural Development Information Center's Private Sector Technology Data Base (NNTD) / Reg.: 0236 (Concrete Renovation CS-21)
- The Bureau of Construction of Tokyo – New Technology Data Base / Reg.: 0301022 (CS-21 Method)

Permeation Type Water Sealing Material【Sodium Silicate-based Surface Penetrant 】

CS-21/RS

For the Refresh-shower method only

＊ Features

CS-21 especially for the Refresh-shower method.

The Refresh-shower method (Patent No.:4433302) is the technique to repair water leakage on the ballast bed type railway bridges, where water leakage is present, without removing the ballast but by spraying permeation type water sealing material from the track.

It is the method jointly developed by Kyoto University, Aston, and other six enterprises in the workshop by Railway ACT in 2004. As royalties will accrue when CS-21 is used for this method, the label only is changed for distinction.

＊Package

5 kg plastic container

＊ Intended Use

Spraying method: Water leakage repair (used alone or with CS-21P/RS [permeation type water sealing material in the form of powder], etc.)

※For the Refresh-shower method, please refer to the official website (http://www.cs21.jp/)

Surface Protective Material 【Sodium Silicate-based Surface Penetrant 】Technology to be promoted

CS-21 Neo

NETIS Registration No.: CG-160013-VE

＊Features

Optimized for **new** concrete placing on site and PCa method (secondary product) for relatively sound surface parts.

High workability with excellent permeability, which does not need to spray water before and after the work.
Contributes to reduction of work period and cost by further improvements in quality and durability.

＊Package

＊Product Outline

Appearance	: Colorless and transparent liquid
Main component	: Sodium silicate
Specific gravity (Density)	: 1.10 - 1.14 (g/cm^3)
pH value	: 11.0 – 13.0
Dry solid content	: 15.0 – 20.0 (%)

＊Intended Use

Coating method: Surface protection of new concrete structures (concrete placing on site, secondary products) whose surface parts are relatively sound., etc.

Surface Protection Material【Two-liquid mixing type Sodium Silicate-based Surface Penetrant】

CS-21 Builder

NETIS Registration No.: CG-170009-A

＊Features

By supplying the body with calcium hydroxide, best suited for surface protection of **existing** structures.

High workability with excellent permeability, which does not need to spray water before and after the work.

It permeates and stays in the voids as it gelates, which continues reactions and improves density.

＊Package

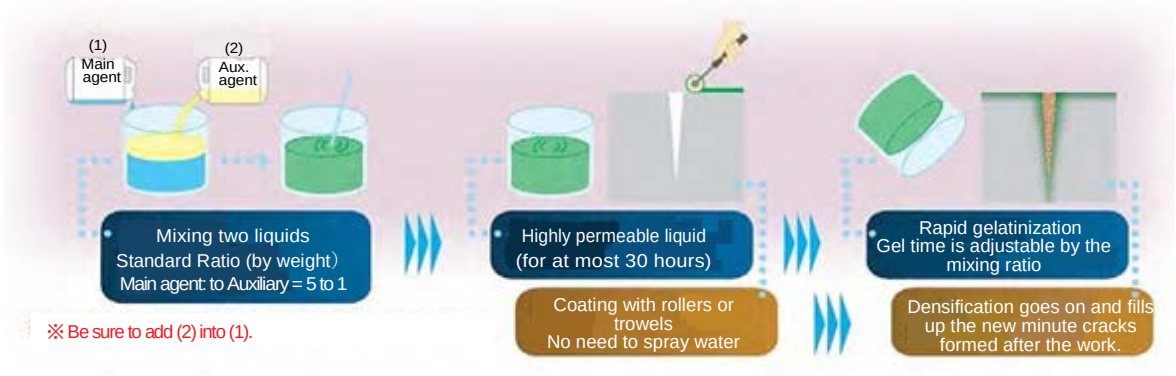
＊Product Outline: As in the standard formulation (Weight ratio of main to Auxiliary agents: 5 to 1)

Appearance	: White or pale pink liquid
Main component	: Sodium silicate (Main agent), calcium hydroxide (Auxiliary agent)
Specific gravity (Density)	: 1.18 - 1.22 (g/cm^3)
pH value	: 11.0 - 13.0
Dry solid content	: 25.0 - 29.0 (%)

＊Gel Time
Approx. 30 hours
(Standard formulation at 20℃)

＊Intended Use

Coating method: Surface protection of existing concrete structures, crack repair, etc.



※ For surface protection by CS-21 Neo and CS-21 Builder, see Surface Protection Section (p.10, 11).

Water Sealing by Injection Material【 Sodium Silicate-based Surface Penetrant 】

CS-21 Moisture

＊Type pf Packing

5 kg plastic container

＊ Features

Maintaining the basic performance of CS-21, the following points have been improved:

- Highly concentrated product has an increased quantity of reactants.
- Highly viscous product has improved water retention curing property.
- Optimized for Water Sealing by Injection material for high pressure injection.

＊ Product Outline

Appearance: Colorless and transparent liquid　　Main component: Sodium silicate
Specific gravity (Density): 1.27 - 1.31 (g/cm^3)　　pH value: 11.6 - 12.6

＊ Intended Use

Injection water sealing material for high pressure injection in water leakage repair, etc.
(Not suitable for coating method)

Water Sealing by Injection Material【 Sodium Silicate-based Surface Penetrant 】

CS-21 Quartz

＊Package

5 kg plastic container


450 g bellows type cartridge

＊ Features

Excellent reactivity with neutralized concrete.
Optimized as the injecting material for water leakage repair of aged concrete.
Using packer plugs, etc., injection by grease gun is possible.

＊ Product Outline

Appearance: Colorless and transparent liquid　　Main component: Sodium silicate
Specific gravity (Density): 1.16 - 1.20 (g/cm^3)　　pH value: 10.4 – 11.4

＊ Intended Use

Injection water sealing material for high pressure injection in water leakage repair, etc.
(Not suitable for coating method)

Auxiliary Material【 For Water Sealing by Injection, Crack Repair 】

CA-21

＊Package

4 kg plastic container

＊ Features

CA-21 is a water solution whose main component is calcium hydroxide.
Used as liquid mixture with CS-21 (**CS-21 SP**).

CS-21 SP, the liquid mixture of CS-21 and CA-21, has the following **new features** that CS-21 alone does not have, which is very effective in water sealing of existing concrete structures (water leakage repair):

- Supplies calcium hydroxide, which decreases in amount, in concrete
- Gelates and stays in the voids it permeates, showing its effectiveness promptly
- The reaction continues after gelatinization, keeping filling minute cracks even after the work.

＊ Product Outline

Appearance　　: White or pale pink liquid
Main component: Calcium hydroxide
Specific gravity (Density): 1.02 - 1.06 (g/cm^3)
pH value　　: 12.8 - 13.8

＊ Intended Use (as **CS-21 SP**)

Water Sealing by Injection material, crack repair material, etc.

＊Gel time of **CS-21 SP** (By mixing ratio)

CS-21 : CA-21 [Weight ratio]	Gel Time (20℃)
1 : 1	10 minutes
2 : 1	50 minutes
3 : 1	3 hours
4 : 1	6 hours
5 : 1	9 hours

● Gel time can be adjusted by changing the mixing ratio.

Crack Repair Material

Technology to be promoted

CS-21 Crack Repair Set

NETIS Registration No.: CG-110003-VE

＊ Outline

The method to improve the durability as well as to recover the beautiful appearance by coating and permeating CS-21 Clear and by filling CS Putty in the cracks formed in hardened concrete.

CS-21 Clear densifies the inside of cracks and inhibits entry of water and other deterioration factors.

With CS Putty, colors can be matched and recover the appearance so that repaired parts will not stand out.

＊ Features

The putty in three colors (silver-white, silver, and gray) can be used alone or mixed so that the beautiful appearance can be recovered without accentuating repaired parts.

Being inorganic, it is more resistive to deterioration by ultraviolet light, etc. compared to organic materials.

It is also safe as it does not contain harmful substances such as organic solvent.

As CS Putty is dry hardening type, there is no worry about dry-out unlike cement materials.

＊ Product Outline

CS-21 Clear:

Appearance: Colorless and transparent liquid
Main component: Sodium silicate
Specific gravity: 1.05 - 1.09
pH value: 11.3 - 12.3
Volume: 120 g

CS Putty:

Appearance: Gray paste
Main component: Calcium carbonate
Silica dioxide
Lithium silicate
Specific gravity: 1.90 or more
pH value: 10.5 or more
Volume: 100 g

＊Package

Color Sample of CS Putty

※This would be a general guide since the colors shown above and the real colors might be different due to various conditions.

＊ Intended Use: Crack repair other than that covered by injection method (e.g. for cracks smaller than 0.2 mm wide / small behavior / non-progressive / no water leakage)
As a sealant for injecting cracks (This can omit the process of removing sealant in the conventional methods.), etc.

＊ Quantity for work: For cracks of 0.2 mm wide, approx. 10 m per set.

Priming Treatment / Surface Protection Materials【 Sodium Silicate-based Surface Penetrant 】

CS-21 Clear

＊ Features

Maintaining the basic performance of CS-21, the followings have been improved:

- As water spraying before and after the work can be omitted, work periods can be shortened.
- Optimized as priming treatment material for repairing with polymer-cement mortar.
- Can be used as surface protection material for section repair material, etc.

＊ Package

＊ Product Outline

Appearance	: Colorless and transparent liquid
Main component	: Sodium silicate
Specific gravity (Density)	: 1.05 - 1.09 (g/cm^3)
pH value	: 11.3 - 12.3

＊ Intended Use

Priming treatment material for section repair, surface protection material for section repair material, etc.

Powder Type, Fast Curing Polymer-cement Mortar

CS Mortar # 100 PS

* Features

Just by mixing with water on site, stable polymer-cement mortar can be prepared.
Practical strength can be attained in a short period of time.
It also has excellent strength developing property on a long-time basis.
Having reasonable usable time, it has an excellent workability.
Excellent adhesive property to body concrete.
Reinforced with fiber, it has good resistivity against cracks and separation.
With long-term stability in the physical properties, it has excellent durability and weather resistance.

* Product Outline

Form : Premix mortar Specific gravity (Density) : 2.9 kg/cm^3
Main component : Rapid hardening cement, acrylic powdered resin, aggregate, fiber, specialty mixing agent

* Intended use

Section repair and surface coating by plastering method, etc.

*Package

25 kg bag

Powder Type, Normal Polymer-cement Mortar

CS Mortar # 100 P

*Package

25 kg bag

* Features

Just by mixing with water on site, stable polymer-cement mortar can be prepared.
It has excellent strength developing property and excellent adhesive property to body concrete.
Reinforced with fiber, it has good resistivity against cracks and separation.
With long-term stability in the physical properties, it has excellent durability and weather resistance.

* Product Outline

Form : Premix mortar Specific gravity (Density) : 2.7 kg/cm^3
Main component : Portland cement, acrylic powdered resin, aggregate, fiber, specialty mixing agent

* Intended Use

Section repair and surface coating by plastering method, etc.

Powder Type, Surface Coating Material, Polymer-cement Mortar

CS Filler # 120 P

*Package

25 kg bag

* Features

Just by mixing with water on site, stable polymer-cement mortar can be prepared.
Smooth finish of thickness of 1 – 2 mm can be achieved easily.
Can be applied by spreading with trowels, paint rollers, brushes, and by spraying.
It has excellent strength developing property and excellent adhesive property to body concrete.
With long-term stability in the physical properties, it has excellent durability and weather resistance.

* Product Outline

Form : Premix mortar Specific gravity (Density) : 2.8 kg/cm^3
Main component : Portland cement, acrylic powdered resin, aggregate, fiber, specialty mixing agent

* Intended Use

Decorative treatment by plastering method, brush coating, spraying, etc.

Coating Method

Applicable Conditions for Coating Method

＊ Scope of Application

Applicable material : Concrete and mortar including cement component (regardless of the age)

Not applicable to : Materials that does not contain cement component such as resin concrete.
In case measures against ARS or chemical attack is included in the intention of the work (deterioration factor) at the places where water resistant property has already been added by permeable water absorption preventing material.

Applicable surface : Applicable regardless of the spreading direction (downwards, sideways, or upwards).
When spread upwards (sideways), dripping prevention measures are needed.

Environment for work

- Temperature : Applicable from 5℃ to 30℃. Where above 30℃, it is recommended to apply after lowering the temperature by spraying water. Where below 5℃, temperature control during work would be necessary for curing (There are no problems if it goes below 0℃ after work.)
- Weather : In case of rain, work can be done if the rain does not wash away the material. If it rains so hard as to wash away the material, curing is necessary.
- In case it is very windy, measures to prevent scattering is necessary.

Conditions of the surface parts of concrete

- If there are no attached matters, work is possible. If attached matters are present, work is not possible; it is workable after the matters are removed.
- If it is dry, work is possible. 【CS-21: Spray water, then apply the material when it is half dried.】
- If it is wet, work is possible.【Where there is bleeding, remove it or wait until it becomes dry.】

＊ Note:

At the time of design: Specific treatment such as injection into cracks or section repair is necessary as needed.

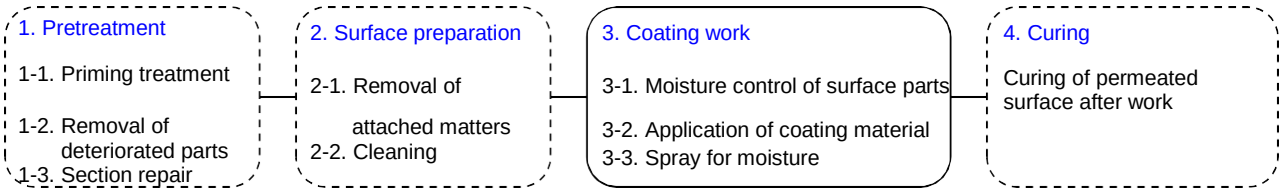
At the time of work : Curing measures are necessary; e.g. not to directly touch the parts other than concrete.

At completion : After completing the work (when dry to touch is confirmed after the final process), it becomes possible to walk or drive on the coated surface, to cover with sheets and place materials on them, and to backfill.

Application of other methods on the coated surface:

- As CS-21 Series Products react where water is present and fill up voids, the finish should be exposed in principle. However, after the curing period (more than two weeks) has passed, application of other methods can be considered just like ordinary concrete surfaces whose surface parts are dense.
- Adhesion of waterproof layer on floor boards and of delamination prevention nets, decoration of buildings, lines on parking lots, etc. can be applied as needed.
  (When other methods are considered, please consult in advance Aston Association members in charge of CS-21.)
- After aged, re-coating of CS-21 Series Products as well as other repairs and reinforcements can be applied.

Outline of the Coating Method and Definition of the Terms



1. Pretreatment

The process to carry out priming treatment, removal of deteriorated parts, and section repairs depending on the conditions of the target surface and surface parts.

2. Surface preparation

The process to remove factors that will hinder permeation of the coating material, CS-21 Series Products, depending on the conditions of the target surface and surface parts.

3. Coating work

The process to carry out moisture control of the target surface, application of the coating material, and water spraying for moisture, depending on the dry conditions of the target surface and the kinds of

coating material.

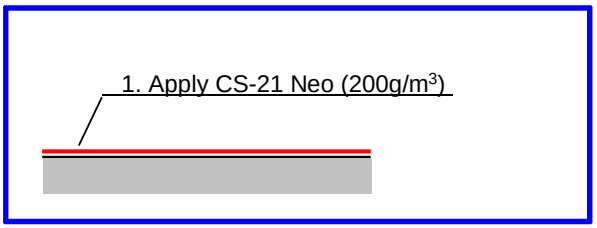
4. Curing (Curing permeated surface after work)

In case of outdoor environment where water is supplied by rain or morning dew, additional treatment is not necessary, leaving the exposed condition as it is.

This is the process to maintain the wet conditions in indoor environment or for waterproofing of body, in order to prevent drying out by spraying water or by sheet curing after coating work is finished, and to promote reaction.

Standard Process Drawings of Coating Method

Coating Method of CS-21 Neo (One-time application)



Work Process (Surface protection of new construction)

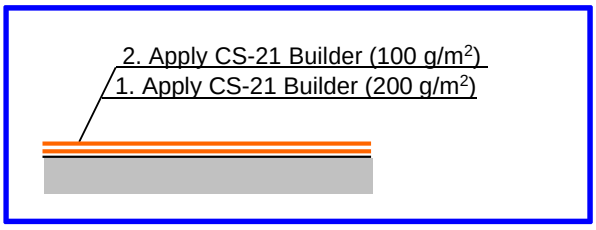
NETIS：CG-160013-VE

Surface preparation → Application of CS-21 Neo

＊Surface preparation includes high-pressure washing, simple cleaning, etc.

List price: ￥1,400/m²

Coating Method of CS-21 Builder (Two-time application)



Work Process (Surface protection of existing construction)

NETIS：CG-170009-A

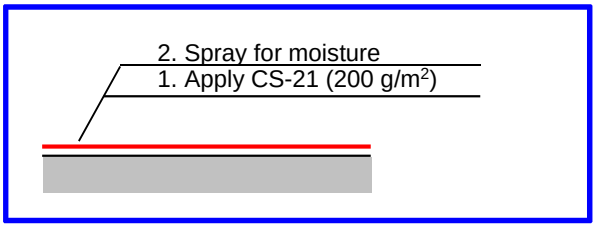
Surface preparation → Application of CS-21 Builder → Application of CS-21 Builder

＊Surface preparation includes high-pressure washing, scraping off by angle grinder, etc.

Time intervals for re-coating: Approx. 60 minutes (After confirming dry to touch)

List price: ￥3,100/m²

Coating Method of CS-21 (One-time application)



Work Process (Surface protection of new construction)

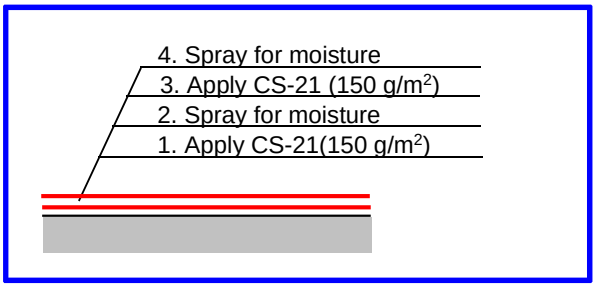
Surface preparation → Moisture control of the surface part → Application of CS-21 → Spray for moisture

＊Surface preparation includes high-pressure washing, simple cleaning, etc.

Time intervals between the processes of coating and water spraying: Approx. 60 minutes (After confirming dry to touch)

List price: ￥2,500/m²

Coating Method of CS-21 (Two-time application)



Work Process (Body waterproofing, surface protection of existing construction)

Surface preparation → Moisture control of the surface part → Application of CS-21 * → Spray for moisture *

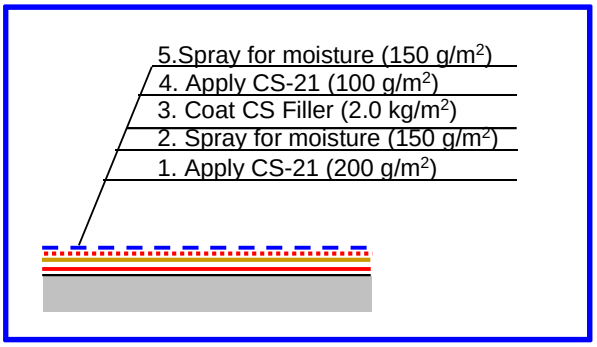
* Repeat

＊ Surface preparation includes high-pressure washing, scraping off by angle grinder, etc.

Time intervals between the processes of coating and water spraying: Approx. 60 minutes (After confirming dry to touch)

List price: ￥3,800/m²

CS-21 Protective Decoration



Work Process (Surface protection of existing construction, and recovery of beautiful appearance)

Surface preparation → Moisture control of the surface part → Application of CS-21 on the body → Spray for moisture on the body → Coating CS Filler → Application of CS-21 on the coating → Spray for moisture on the coating

＊ Surface preparation includes high-pressure washing, scraping off by angle grinder, etc.

In some cases, application and spraying on the body are done two separate times.

※ The application quantities shown in the process drawings above are subject to change due to the conditions of the surface parts of the target concrete.

※ For the way to select the work methods, see Surface Protection (p. 12) and Body Waterproofing (p.14 - 16).

※ For the details of the list prices (cost of material and work) such as quantity survey and unit price, see the unit price list of each method.

Surface Protection

While concrete is an excellent material in durability, partial voids such as cracks are formed due to various factors at the time of construction and aging, allowing water and other deterioration factors enter the voids, which constitutes the cause of deterioration.
Minute cracks that cannot be visually checked constitute another cause of deterioration.

By applying on the surface of hardened concrete, CS-21 Series Products fill up existing minute cracks and voids and densify the surface parts. They also fill up the voids such as minute cracks formed after work. This feature helps inhibit entry of water and other deterioration factors on a long-time basis.

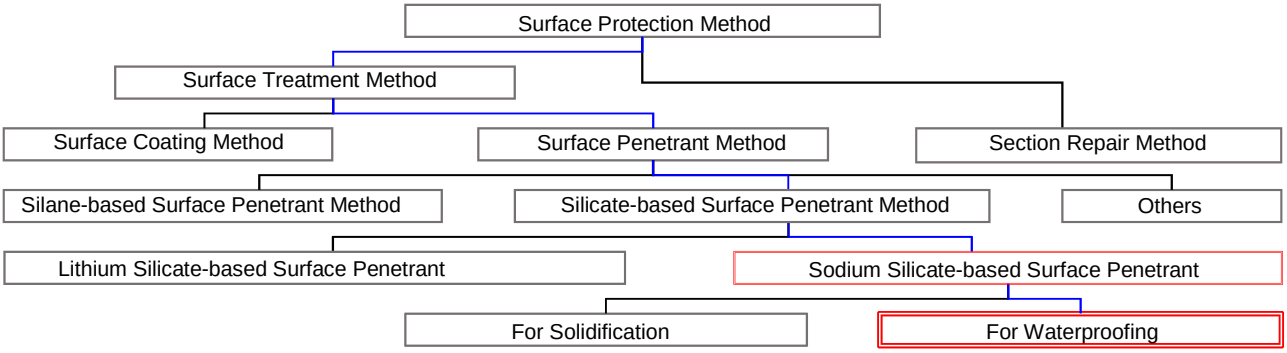
◆ Advantages in using CS-21 as a surface protection material

To keep cover concrete sound and inhibit steel corrosion	⇨	Long-life of structures
Coating on the surface permeates deep parts of cracks and densifies the deep parts	⇨	Repairs minute cracks that cannot be visually checked
Safe material usable at the places where tap water touches	⇨	Suppress environmental loading
With no changes in appearance, visual inspection can be done even after work	⇨	Easy inspection, no impairment of fine appearance
Unlikely to be affected by drying or moistening of the base	⇨	Workable even if the body is wet
No limitation in other methods (including repairs) in applying after aged	⇨	The same condition as normal concrete surfaces

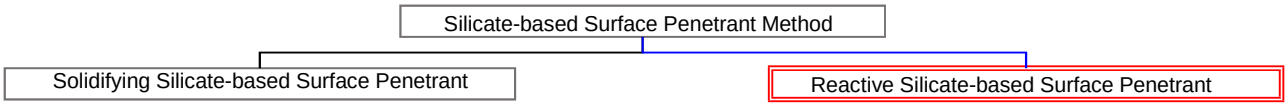
◆ Classification of Surface Protection Methods Using CS-21

CS-21 Series Products are classified as “reactive silicate-based surface penetrant” under “sodium silicate-based surface penetrant (for waterproofing)” in the following Guidelines Related to Surface Protection Methods* by Japan Society of Civil Engineering (JSCE).

* The Guidelines Related to Surface Protection Methods (Draft): Concrete Library 119 (Published in 2005)



* The Guidelines for Design and Work of Silicate-based Surface Penetrant Method (Draft): Concrete Library 137 (Published in 2012)



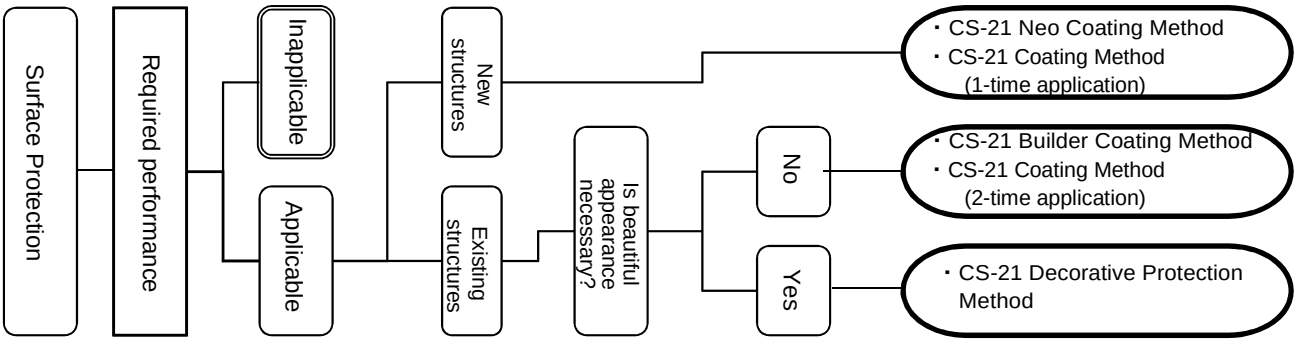
◆ Applicability and Effect of Deterioration Phenomena and Mechanisms of CS-21 Series Products

Concrete Standard Specifications – Volume of Maintenance established by JSCE in 2013 lists ten deterioration phenomena and mechanisms of concrete structures.
The applicability and effects of CS-21 Series Products to each deterioration phenomenon and mechanism are as follows (when used alone for the stages from new to existing constructions with the deterioration process still latent):

Deterioration Phenomena and Mechanisms	Applicability	Effect
Moistening by water	○	Inhibit permeation of water
Cracks	○	Minute crack repair by coating or injection
Steel corrosion	○	Inhibit entry of water and other deterioration factors
Neutralization	○	Inhibit progress of neutralization, inhibit permeation of water
Salt damage	○	Inhibit permeation of chloride ions, inhibit permeation of water
Freezing damage	○	Inhibit scaling, inhibit entry of water
Chemical attack	―	Inapplicable
Alkaline-silica reaction	―	Inapplicable
Fatigue	△	Preventive maintenance in combination with other methods (Inhibit permeation of water)
Abrasion	○	Reduce the speed of abrasion (Abrasion resistance improved)

Key: ○: Applicable, △: Needs consideration, ―: Inapplicable

◆ Flow chart of selecting work method for surface protection

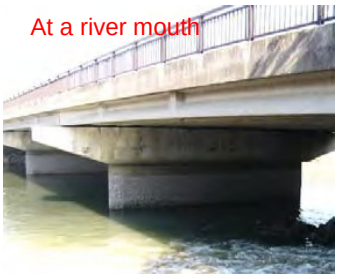


※ For the scope of required performance, see the chart of applicability concerning deterioration phenomena and mechanisms (p.12).

※ For the processes in each method, see the process drawings of coating method (p.10).

◆ Examples of the Surface Protection Work

Measures against freezing damage on the existing floor slabs paved with concrete



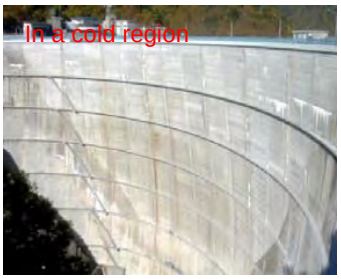
Measures against salt damage on the bottom surface of existing floor slabs and wheel guard

Measures against neutralization on the bottom surface of existing floor slabs and abutment

Measures against salt damage on the newly constructed bridge footing

Measures against freezing damage and neutralization on the newly constructed bridge footing

Measures against cracks on the lining concrete of the bridge footing



Measures against freezing damage on the existing dam body

Measures for long-life of a water tower

Measures for durability improvement at a newly constructed service reservoir

◆Examples of the Decorative Protection Work

Measures for long-life and recovery of decorative appearance of the existing wall of a clean water plant (a water supply facility)

Body Waterproofing

Waterproofing of concrete structures by CS-21 methods is not by forming a membrane (impervious layer) as in the membrane waterproofing method; it is by coating and permeating inorganic, colorless and transparent water solution onto hardened concrete to make the concrete body itself waterproof.

While concrete is a highly watertight material, various factors at the time of construction may form partial voids such as cracks, decreasing water-tightness and causing water leakage.
Minute cracks that are difficult to detect visually also constitute the cause of decreasing water-tightness.

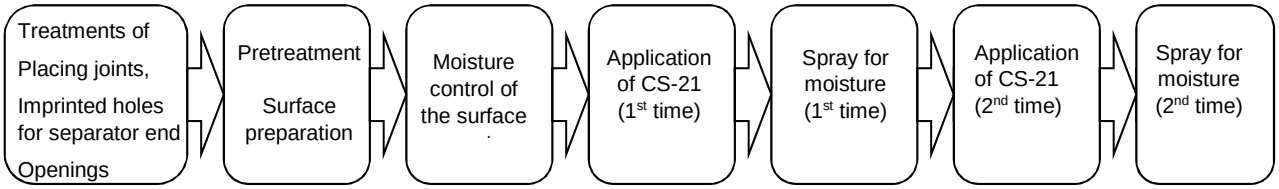
CS-21 is the material that enhances the water-tightness of concrete by filling up the voids such as minute cracks formed on the concrete. It also has the feature of filling up the minute cracks newly formed after work. CS-21 methods make body waterproofing possible by processing placing joints, imprinted holes for separator end, and openings (penetrating member) in conjunction with whole surface coating.

When adopting the methods, in order to prepare watertight concrete, it is necessary for the designer, the general contractor, the contractor for concrete body, and the contractor for waterproofing to cooperate. (Details are found in the technical document, *Waterproofing of Concrete Body*.)

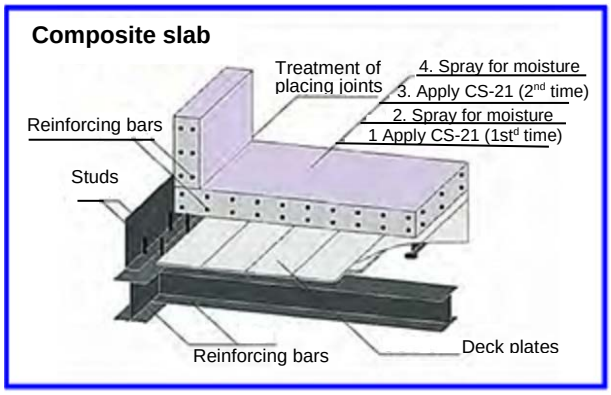
Waterproofing of Parking Lots and Roofs

CS-21 method for waterproofing parking lots and roofs does not need waterproof layers or protective layers that are necessary in the membrane waterproof method. That makes it is possible to reduce loads and shorten work periods. The method has many advantages; it is excellent in durability and the body can be visually checked easily; it is easy to conduct in-service inspection and partial repair; and there is no need to remove existing coated films at the time of rework.
(CS-21 method for roof waterproofing can be applied to the structures covered by Housing Warranty Insurance.)

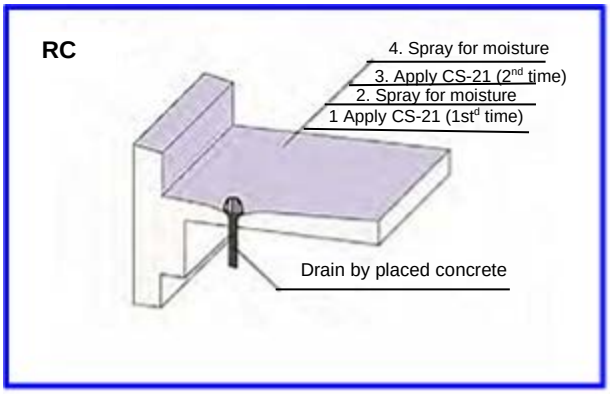
Procedure of Waterproofing Work at Parking Lots and Roofs



Outline Drawing of the Method:
Waterproofing of parking lots



Outline Drawing of the Method:
Waterproofing of roofs



Scenes of parking lot waterproofing

1) Inspection of reinforcing bars

2) Joint inspection of installation

3) High-pressure washing

4) Application of CS-21

5) Spray for moisture

6) Treatment of placing joints

Examples of Waterproofing Work of Parking Lots and Roofs

Waterproofing of a parking lot on the roof

Waterproofing of a parking lot on the roof

Waterproofing of a multilevel parking tower

Waterproofing of a multilevel parking tower

Waterproofing of a roof

Waterproofing of a roof

Waterproofing of Floor Slabs

CS-21 method for waterproofing floor slabs is utilized in waterproofing faces of road bridges and railway bridges; it does not need waterproof/protective layers that are necessary in the membrane waterproof method, thus vehicles can pass just after work without paving and rework is easy even at the palces where it is hard to schedule work periods after the service is started. (It is possible to pave after work.)

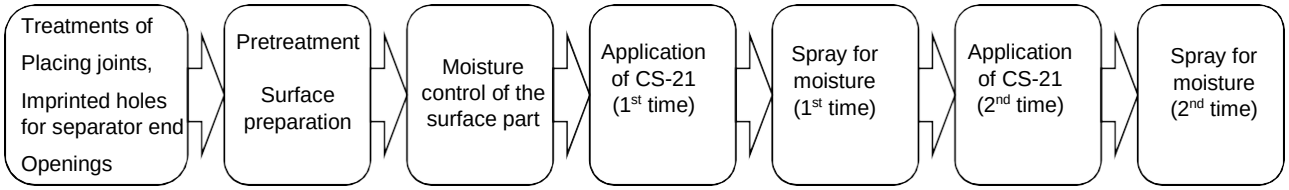
Waterproofing of floor slabs of a road bridge

Waterproofing of floor slabs of a railway bridge

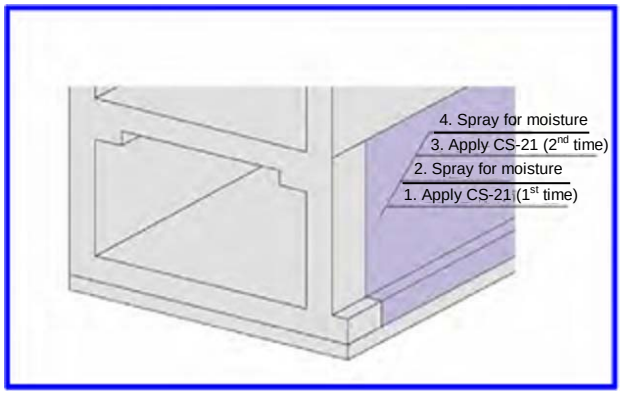
Waterproofing of Basements and Water Tanks

CS-21 is utilized in the waterproofing of water tanks at water supply facilities and in the exterior waterproofing of underground facilities that are in contact with groundwater, as the safety applicable to the concrete that comes in direct contact with tap water is ensured.

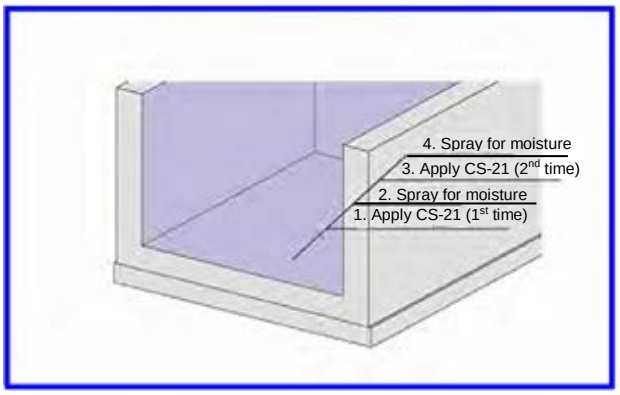
Procedure of Waterproofing Work at Basements and Water Tanks



Outline Drawing of the Method:
Exterior waterproofing of Underground Facilities



Outline Drawing of the Method:
Waterproofing of Water Tanks



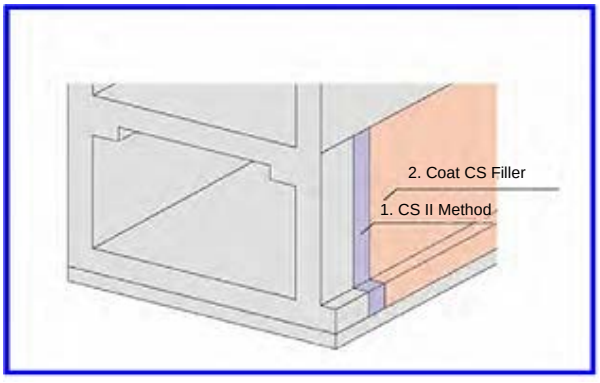
Examples of Waterproofing Work of Basement and Water Tank

Exterior waterproofing of a basement

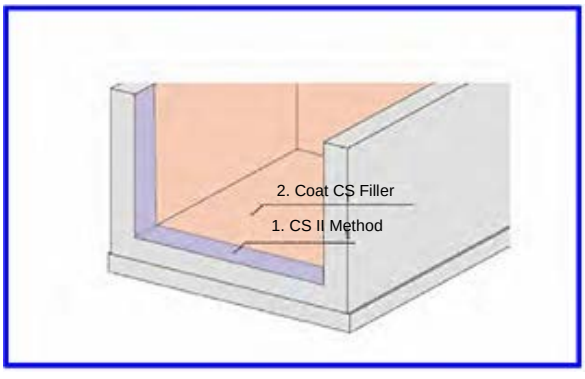
Waterproofing of a water tank

※ For waterproofing of basements and water tanks, CS II method (Two-application method of CS-21) can shorten the curing period and enhance the waterproof performance by coating CS Filler # 120 P after work.

Outline Drawing of the Method:
Exterior waterproofing of Underground Facilities
(CS II + CS Filler)



Outline Drawing of the Method:
Waterproofing of Water Tanks (CS II + CS Filler)

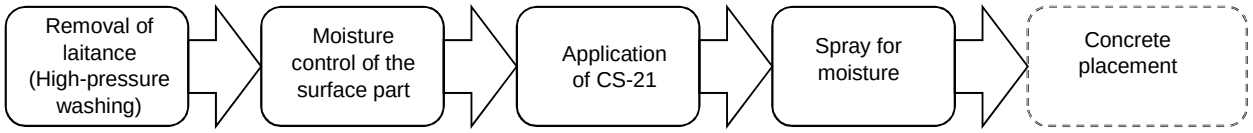


※ CS Filler # 120 P can be sprayed as well as coated with trowels and brushes.

Treatments of Placing joints, Imprinted Holed for Separator End, and Openings

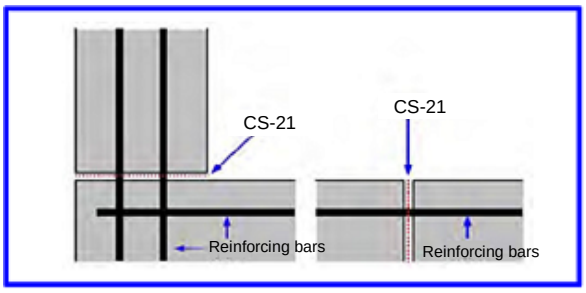
Body waterproofing by CS-21 methods needs treatments of placing joints, imprinted holes of separator end, and openings (penetrating member) in combination with whole surface coating.

Procedure of Placing joints Treatment

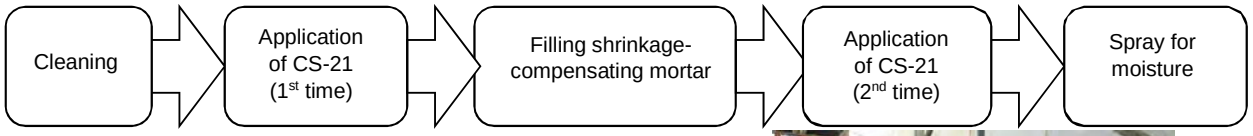


※ In some cases, coating/spraying can be done twice separately.

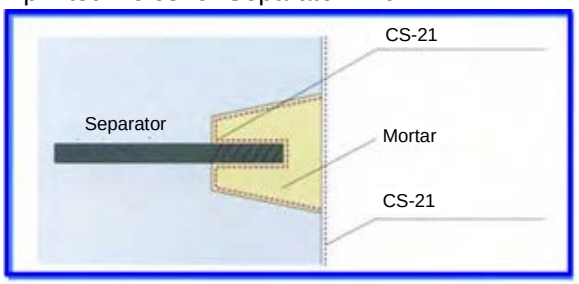
Outline Drawing of the Method:
Treatment of placing joints



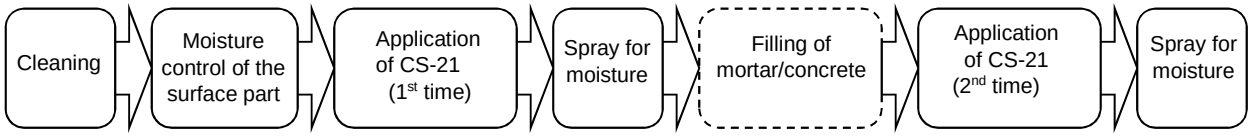
Procedure of Treatment of Imprinted Holes for Separator End



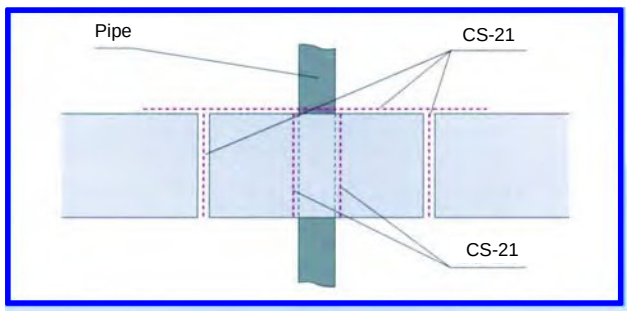
Outline Drawing of the Method:
Imprinted Holes for Separator End



Procedure of Treatment of Openings

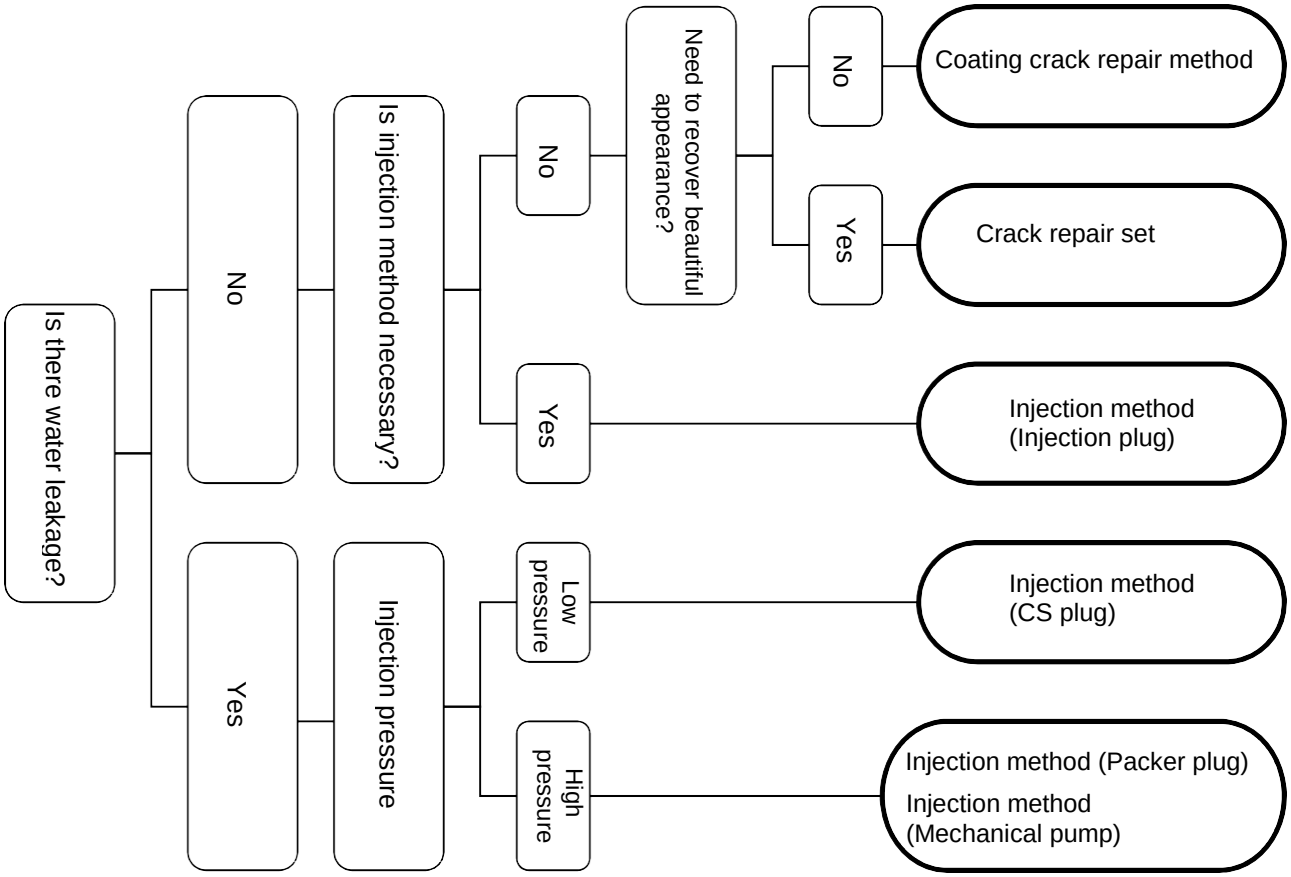


Outline Drawing of the Method:
Treatment of Openings



CS-21 Crack Repair / Water Leakage Repair Methods

Flow Chart of Selecting Work Methods for Crack Repair and Water Leakage Repair

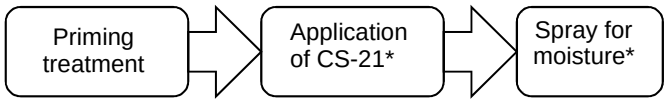


※ For the necessity of injection method, see *the Guidelines for Investigation, Repair and Reinforcement of Cracks* (2009, 2013: JCI).

CS-21 Coating Crack Repair Method

Coating crack repair method is the technique for the cracks which are smaller than 0.2 mm wide and are determined that repair by injection method is not necessary. It inhibits entry of water and other deterioration factors and improves the durability of the cracking parts by densifying the deep parts of cracks with CS-21 Series Products that are coated on the surface and permeates the cracking parts.

Procedure of CS-21 Coating Crack Repair Work



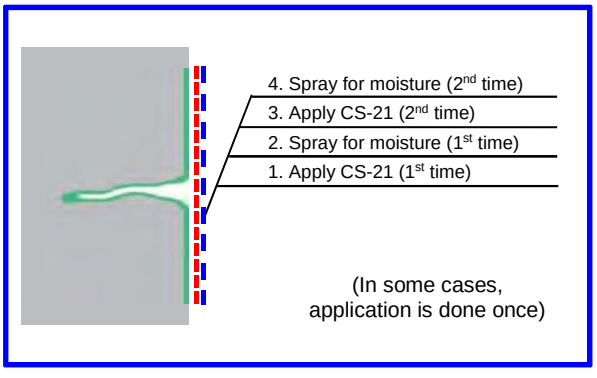
* Repeat

* Coating Area:

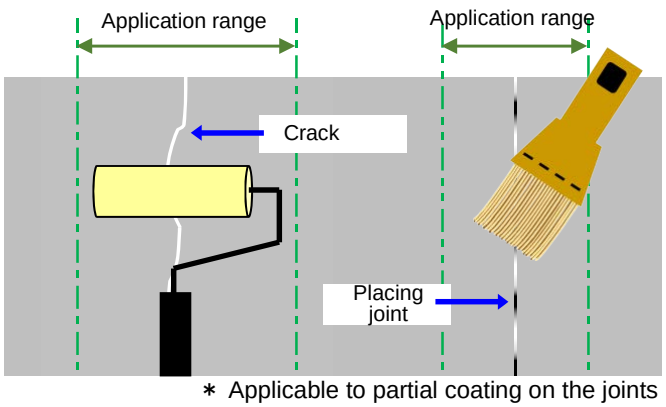
Partial coating: When cracks are scattered, coat along the cracks (See Outline Drawings).

Whole surface coating: When cracks are crowded, coat the whole area (See the photo on p.19).

Outline Drawing of the Method:
CS-21 Coating Crack Repair Method



Outline Drawing of the Work



* Applicable to partial coating on the joints

Examples of CS-21 Coating Crack Repair Work

On an abutment: Spreading CS-21

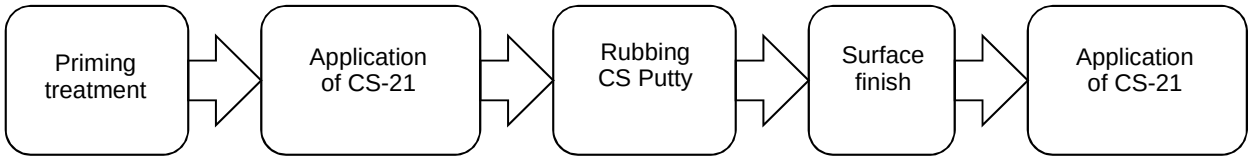
At a downstream side of a dam body: Spraying CS-21

CS-21 Crack Repair Set

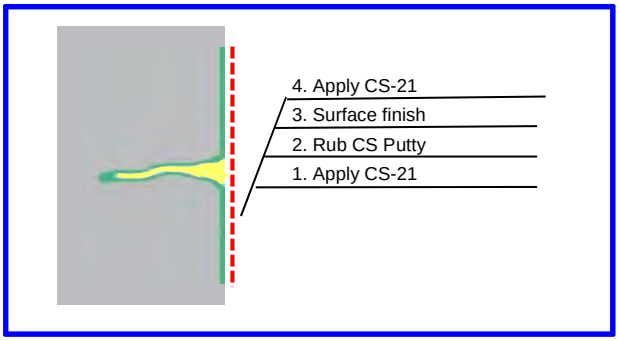
Crack repair method by CS-21 Crack Repair Set is the technique for the cracks which are smaller than 0.2 mm wide and are determined that repair by injection method is not necessary. It recovers beautiful appearance and improves the durability of the cracking parts; CS-21 permeating the deep parts of cracks densifies them and inhibits entry of water and other deterioration factors, and then rubbing CS Putty, which comes in three colors that can be used alone or mixed, makes the cracks inconspicuous.

It can also be used as a sealant in injecting cracks so the process of removing sealant in the conventional work method can be omitted.

Procedure of Crack Repair Set Work



Outline Drawing of the Method: Crack Repair Set



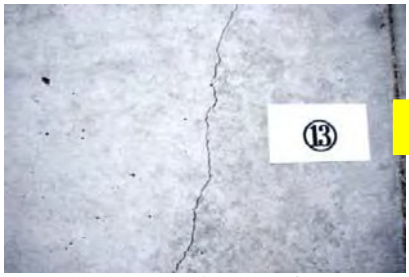
Rubbing CS Putty

Work completed

(One part of the top is not repaired)

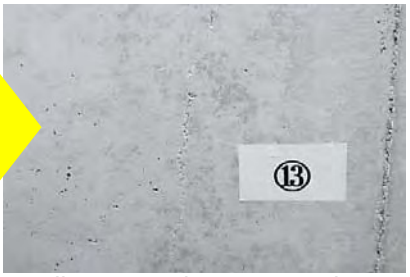
※ Our official website (http://www.cs21.jp/) offers the demonstration video of the crack repair work.

Examples of the Work by Crack Repair Set



Before work

After the work is completed



Follow-up review: 3 years later

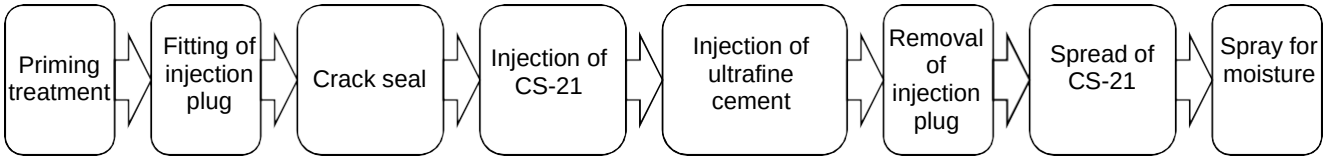
A repair work by “Crack Repair Set” (color: silver-white) was conducted at the crack of 0.2 mm wide formed at an abutment. The result of a follow-up review conducted three years after the work showed no defects at the part of repair.

CS-21 Injection Method

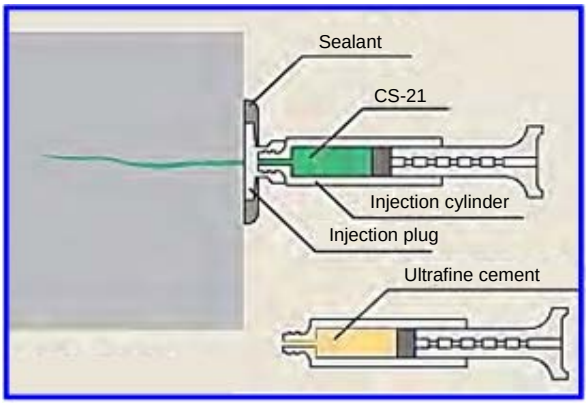
CS-21 injection method has an effect of filling up voids with reactants. CS-21 Series Products selected according to the purpose and conditions of work can permeate even minute voids smaller than 50 ㎛, which are hard to fill by conventional methods.
It is the technique, when used in combination with fine particle cement, that the reactants can prevent deterioration of flowability of injection material and fill up the voids formed by hardening shrinkage, inhibiting water leakage and entry of deterioration factors.

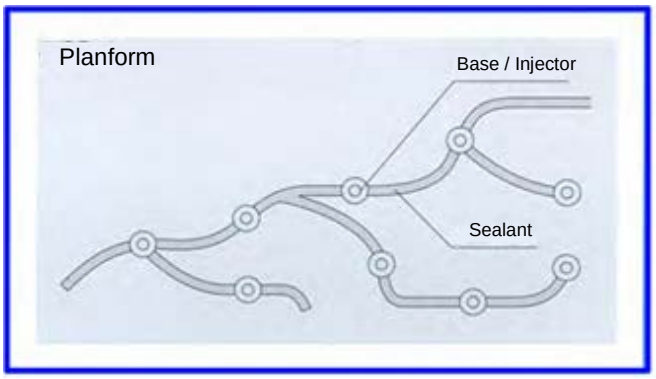
CS-21 Injection Method (Injection Plug): Crack Repair

Procedure of CS-21 Injection Method (Injection Plug)

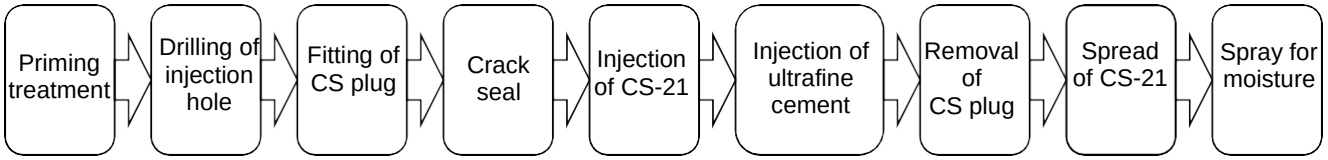


Outline Drawing of the Method: CS-21 Injection Method (Injection Plug)

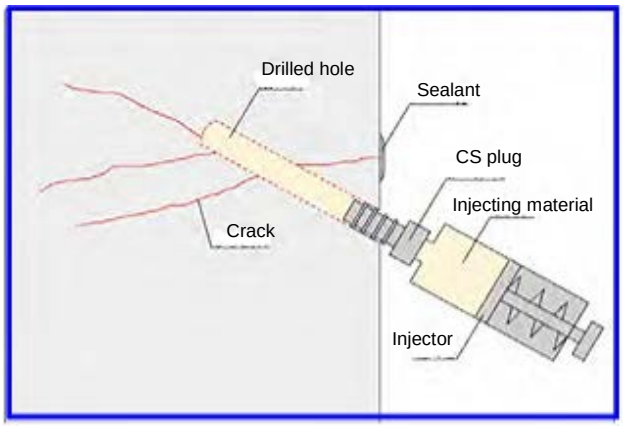




Procedure of CS-21 Injection Method (CS Plug)



Outline Drawing of the Method: CS-21 Injection Method (CS Plug)



Product name: CS Plug

Material: Polypropylene

Size: Head: OD 16.0 mm / Length 19 mm
Insertion section: OD 11.5 mm / Length 30 mm
Drilling section: OD 10.5 mm

Advantages of using CS Plug

- As it can be used by drilling and lightly knocking in for injection, there is no need to wait for adhesive to harden.
- There are no troubles caused by adhesion failure due to soil or moisture on the adhesion surface.
- After injection, just fill the drilled hole and there is no need to remove the adhesive with a sander, etc.

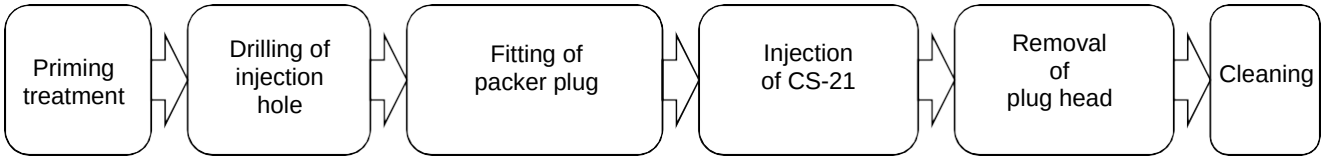
Examples of CS-21 Injection Work

Crack repair at a bridge footing: Injection plug

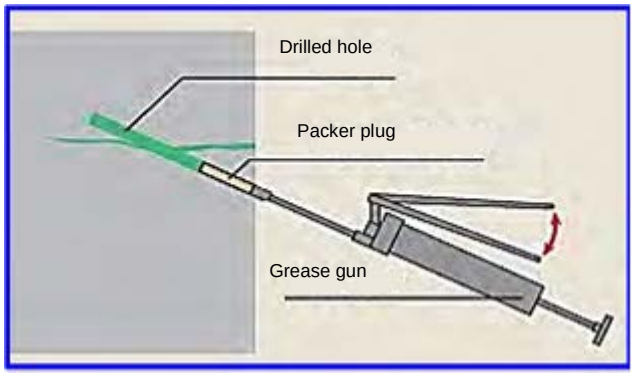
Water leakage repair at a floor slab: CS Plug

CS-21 Injection Method (Packer Plug): Water Leakage Repair

Procedure of CS-21 Injection Method (Packer Plug)

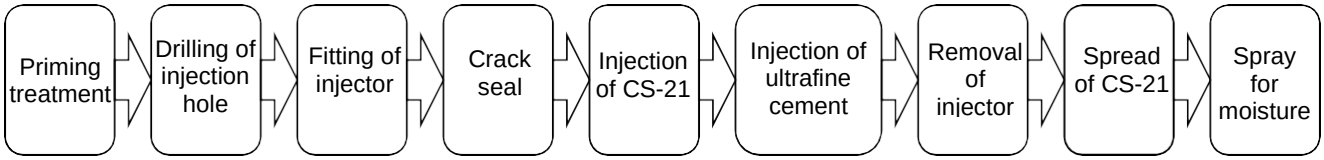


Outline Drawing of the Method: CS-21 Injection Method (Packer Plug)

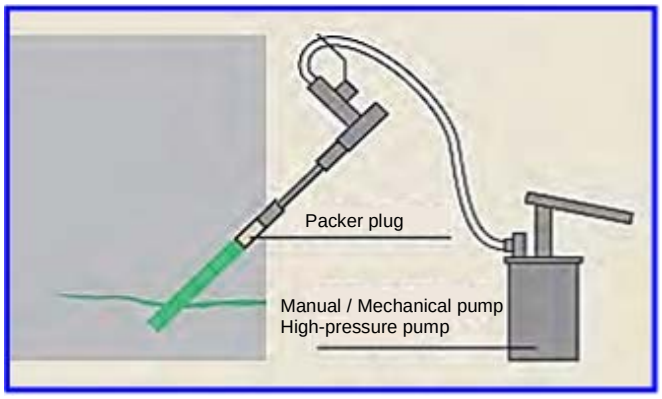


CS-21 Injection Method (Manual / Mechanical Pump): Water Leakage Repair

Procedure of CS-21 Injection Method (Mechanical Pump)



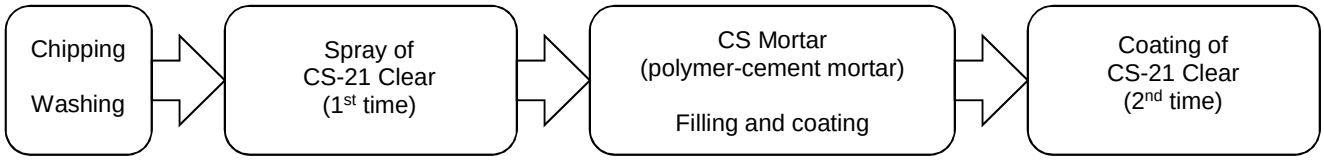
Outline Drawing of the Method: CS-21 Injection Method (Mechanical Pump)



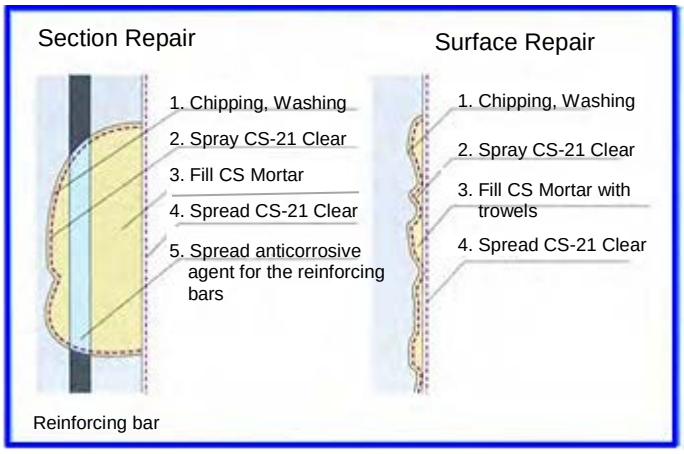
CS-21 Section Repair Method

CS-21 Section Repair Method is the technique to inhibit entry of water and other deterioration factors from the interface with the existing member. By coating (spraying) and permeating (impregnating) CS-21 Clear as the priming treatment material and surface protection material for the section repair parts, 1) the surface part of the base concrete is densified so that the adhesion ability of the section repair material is fully exercised; 2) the reactants inhibit formation of voids at the interface; and 3) rapid dry out of the section repair material is prevented.

Procedure of CS-21 Section Repair Method



Outline Drawing of the Method: Section Repair



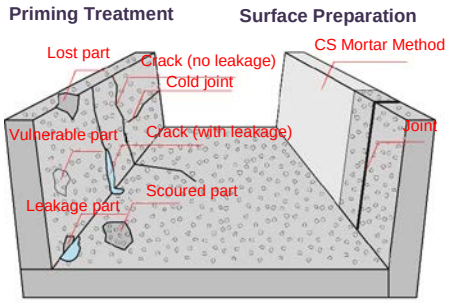
CS Mortar Method (Waterway Repair and Improvement Method)

CS Mortar Method (Patent No. 4664949 / NNTD Registration No.1022) is the technique to repair and improve open channels such as irrigation facilities that combines silicate-based surface penetrant method and inorganic coating method (surface renovation combined method).

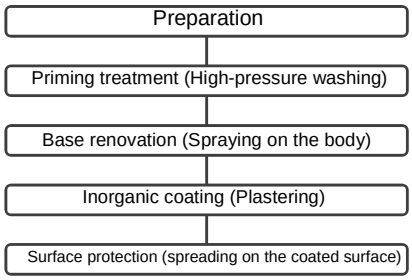
The combined method has the advantage of ensuring the necessary durability even if the coating thickness using CS Mortar by plastering method is kept thin and keeping reduction-of-area of existing canal cross section minimum.

※ For more details, please refer to the website of Workshop of Waterway Repair and Improvement (http://www.i-care.gr.jp/).

Outline Drawing of the Method:



Process Flow



Examples of the Works

Constructions (Waterproofing)


Waterproofing of a parking lot on the roof


Waterproofing of a multilevel parking tower


Waterproofing of a roof

Civil engineering (Waterproofing, surface protection)


Waterproofing of floor slabs


Surface protection of floor slabs


Surface protection of a box culvert


Waterproofing of a water tank


Surface protection of a dam
(dam crest, overflow section)


Surface protection of a tunnel lining

Treatment of Placing joints and Imprinted Holes for Separator End


Treatment of placing joints
(Horizontal joints)


Treatment of placing joints
(Vertical joints)


Treatment of imprinted holes for
separator end

Repair


Low-pressure injection for crack repair


High-pressure injection for crack repair


Section repair

※ For more examples, please refer to our official website (http://www.cs21.jp/).

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