Hydrosky Construction method

Maintenance and rehabilitation of concrete structures on expressways

Ministry of Land, Infrastructure and Transport NETIS New Technology Information System
NETIS number: KT-160095-A
New technology name: Hydrofit construction method(Impregnated composite injection method)

HYDROSKY

Hydrosky Co., ltd.,
4-11-3,Narihira,Sumida-Ku,Tokyo.Japan
Tel.+81-3-5637-8834 Fax.+81-3-5637-8874
URL://www.hydro-sky.co.jp
E-mail:hydro@hydro-sky.co.jp

Maintenance and rehabilitation of concrete structures on expressways

The role of concrete in social infrastructure development is extremely large, and to date a large amount of concrete structures have been supplied, supporting the prosperity of humanity from the foundation. On the other hand, the idea for the life expectancy of concrete structures totally changed, triggered by the early deterioration problem caused by salt damage, alkali silica reaction, etc., which became manifested in various places from the late 1970s to the early 1980s.
Silicate-based surface impregnant (liquid glass) is a material that improves concrete by densifying the surface of concrete by reaction with calcium hydroxide in concrete.
In other words, the durability of concrete structures greatly varies depending on the environment and materials used, and it became clear that appropriate maintenance and management should be planned in design and construction.

The hydrofit method realizes chemically reacting inside the concrete skeleton to realize the restoration and stabilization of the strength, and it has become clear that there is a self-restoring effect of the concrete.

Maintenance and rehabilitation of concrete structures on expressways

Emergency repair work for highway tunnel collapse accident is also caused by deterioration of concrete. The material of Hydro Sky which has been further evolved is a composite construction method of impregnating agent which causes chemical action and cementitious powder, impregnating the hydrofit method into the body, injecting silica blended blast furnace slag paste, It saturates the hollowed part and restores it to sound concrete.

Moreover, by adding vibration of this silica blended furnace slag paste for a certain period of time at the time of injection, we will form a densified concrete layer and solidify it steadily. These can penetrate into the concrete skeleton and gaps in reaction gels with calcium hydroxide in the voids where the alkali silica reaction has occurred, filling voids can fill and complement the missing strength.

Measurement of true strength of cement paste is extremely difficult test

With W / C less than 30%, it does not matter so much but as W / C becomes larger, a separation phenomenon occurs inside the specimen, the cement particles settle down, and contrary to this, water Is increased. For this reason, there was a difference depending on whether admixture was used or not, but in the lower part of the specimen, it became a cement-rich dense paste hardened body due to sedimentation and consolidation of cement particles and on the upper part of the specimen due to sedimentation of cement particles and rise of water , The actual W / C increases as it goes upward, and in the case of blending such as W / C exceeding 60% to the surface of the specimen, it is 30% or more of the height of the specimen We often form fragile layers like bleeding water and latency. In addition, the paste layer beneath this bleeding and the resistance layer also increases W / C significantly more than the initial value due to the rise in moisture and sedimentation of cement, so the paste strength inside the specimen is not uniform , The lower part is strongest, and the strength decreases as going upward.

W / C is further abruptly increased at the surface portion to form a fragile layer having extremely low strength.

Measurement of true strength of cement paste is extremely difficult test

Therefore, in the compressive strength test, the result varies greatly depending on the extent to which this brittle layer and the large portion of W / C are treated and tested.
In addition, since the separation greatly varies depending on the launch height, it is obvious that the separation process is noticeable in the latter case when it is carried out with the Ø50mm × Ø100mm specimen and the Ø100mm × Ø200mm specimen , It seems that there is a high possibility that the process of strength reduction will increase.
Sedimentation of cement particles is unlikely to occur due to the restraint of the side of the specimen on the side of the specimen and the central part of the specimen with the smallest constraint is the most likely to occur, so the intensity distribution will also be different in the horizontal direction. For this reason, it is considered that the specimen does not break down to kinematic shape or drum shape like breakage when uniform stress distribution, it is likely to cause vertical crack shape like uneven load or partial loading. On the other hand, separation occurs even in the case of concrete with the same W / C, but as separation of water and cement sedimentation will be blocked by the fine aggregate and coarse aggregate close to the paste, paste Since there is no difference in W / C or organizational composition due to the upper and lower specimens extremely, the large strength reduction is less likely to occur as much as in the case of Fig.

Overview

A major cause of deteriorating concrete structures is cracking caused by water. As opposed to conventional repair work, this purpose is to modify and reinforce the deteriorated part due to the inorganic material, rather than simply bonding and curing by V cut or U cut as opposed to this crack. The hydrofit method uses a surface treatment agent HYDRO Sky SKY-G1 and SKY-SP for integrating the framework by injecting a paste of blended furnace slag cement containing fine powder silica, a highly permeable liquid penetrates deeper than water, It is an excellent construction method to improve integration and durability of the building body by preventing water absorption, insolubilization of free alkali, restoration of alkali strength etc. in deteriorated surface layer. This construction method is completed in the same construction method even in places where the construction range is large or in small places.

waterproof

Waterproof treatment to prevent water from penetrating from the surface

By painting and sheets. The effect immediately appears, but waterproofing is lost due to damage due to UV degradation and peeling of the coating film. Painting every few years is necessary.

Water stop

Stop water treatment to prevent water from penetrating from the surface into the interior of the building

Water penetrates due to deterioration and cracks in the building, further making the concrete brittle and even threatening the strength. The integrated body is regenerated due to the combined processing of the impregnated material.

Factors of alkali aggregate reaction and measures and remediation

Conditions under which alkaline aggregate reaction occurs

Alkali-aggregate reactions are caused either at the time of manufacturing concrete structures or from outside aged. At the time of manufacturing, concrete has high alkalinity inherently, and alkali concentration abnormally increases due to use of cement and sea sand containing a lot of alkali content, causing a chemical reaction with aggregate and aggregate. When absorbing water as an alkali silica gel, the reaction product expands the concrete and causes deterioration phenomenon due to cracks and abnormal decrease in strength / elastic modulus. From the outside, it is a cryoprotectant or splashes of seawater, so-called chloride permeation, also due to the supply of moisture to concrete.

Degradation Properties of Concrete Structures by Alkali Aggregate Reaction

As degradation by alkali aggregate reaction proceeds,

1) The occurrence of cracks,
   2) Pop out
   3) contamination of the concrete surface due to precipitates,
   4) Variations in appearance such as occlusion, breakage, and displacement of joints due to partial expansion.
2) In the pop out, the aggregate particles near the concrete surface expand and the concrete on the surface part pops out.
3) Expansion of concrete by alkali aggregate reaction causes tensile stress which was not assumed in the design for reinforcing bars and PC tensioning agent, and in some cases breaks the reinforcing bars and lowers the strength of the structure.

Method for diagnosing alkali aggregate reaction

Collect cores and investigate whether alkali-reactive aggregate is used or observation with polarizing microscope. In case of confirmation, carry out the accelerated expansion test of the core. It is difficult to confirm the presence of alkali silica gel as a reaction product. Determination of alkali content in concrete is almost impossible to guess.

Factors of alkali aggregate reaction and measures and remediation

Measures for preventing alkali aggregate reaction

① Avoid using alkaline reactive aggregate,
② alkali amount of concrete exceeding the limit value,
③ Water supply to concrete,
If any condition is lacking, alkali aggregate reaction does not occur.
Avoiding the condition (1) has no way of judging domestic aggregate circumstances, distribution processes, and alkali-reactive aggregates at the site. It is considered difficult to cut off the supply of ③ water, and it becomes a method to limit the total amount of alkali in ② concrete. There is no method to stop the alkali aggregate reaction even if the total alkali is specified as 3 kg / m 2.
That is insight in the past.

Mixing or injection of calcium

When calcium is added, calcium ions (plus ions) serve as adhesives to agglomerate particles inside the concrete. At this time, surplus hydroxide ions (minus ions) induce pozzolanic reaction while fixing heavy metals. Strength is due to the formation of crystalline minerals in pozzolanic reaction, so it is expressed in the long term. In the pozzolanic reaction, crystalline minerals are formed in a gel state in concrete gaps and crystallize while combining with moisture in the surroundings, so the hydrides are high in hydration and less in the gas phase (space). Therefore, the strength increases as the crystallization mineralization progresses, and the permeability coefficient decreases. This effect progressed in pozzolanic reaction even under water, and there is the development of strength.

Impregnation method

It is possible to prevent long-term neutralization by suppressing neutralization by using impregnation type coating agent and by performing waterproof treatment by injection treatment of blast furnace slag, and it can also be expected to suppress alkali aggregate reaction. Latency treatment is possible by applying silicate type (sodium silicate + lithium silicate) to the process of bleaching phenomenon and water-stopping treatment of the connecting surface of concrete, and the cold joint is suppressed.

In addition, the adhesion of the concrete placing surface is enhanced, and the strength of the frame itself is also increased. The surface layer part is normally protected by a water repellent effect using a silane type impregnating agent, but under the present circumstances such as ultraviolet light permeability can only be expected for several years. In addition to combinations of these materials and mineralized modified silicones, various effects and long-term stability can be expected with a combination of materials hybridized with fluorine silicone coupling agent.

Water leak repair by hydrofit method

Hydro Sky SKY-G1 has fine rare silica blended blast furnace slag cement SKY-CSP and rust preventive effect of internal rebars by mixing with cement, induces pozzolanic reaction by fixing heavy metals. Furthermore, by dispersing cellulose fiber of natural material in SKY-CSP, compliance and shearing also appeared. SKY-CSP slag paste is injected into concrete and the inside of the frame, and when vibration is applied by vibrator, ultrasonic wave or the like, it is filled up to the void details inside the crack, giving insufficient calcium and raising adhesion strength. In addition, liquid is easier to penetrate into a body that is difficult to inject such as fine-grained cement, and gels are formed in the gap or crystallized by expansion hydration reaction. For this reason, saturation of gaps that can not be filled with ordinary crystals, high hydration, low gas phase, strength increases as the crystallization mineralization progresses and permeability coefficient decreases. This makes it possible to prevent efrosensence and protect against frost damage and salt damage.

Water leak repair by hydrofit method

Hydrofit SKY-G1 has the effect of inhibiting silica gel by combining cement hardened body and aggregate particles. Since this curing reaction proceeds from a pozzolanic reaction to a carbonation reaction over a long period of time, it has an **action (healing property) of restoring cracks by itself.**

Since SKY-G1 is not hydraulic and also white, it is easy to visually observe, and variation in uneven mixing and strength is small. Refers to a reaction in which an object to be treated that has absorbed calcium ions is further cured while reacting to form a stable crystalline mineral over a long period of time. This reaction proceeds only in an alkaline atmosphere. As a construction method, cracks in neutralization of existing concrete structures are sufficiently impregnated with SKY - SP, and finely powdered silica - blended blast furnace slag cement containing SKY - CSP is crushed by filling with paste like SKY - G1.

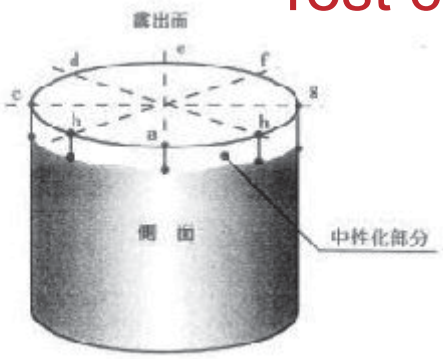
Surface part is protected by applying SKY-MX or SKY-CVL (Civil Trust). It prevents neutralization by salt damage by protecting it from seawater splash and acid rain etc. As an achievement, the eleventh coast guard office off the coast of Miyakojima was selected as a material to use for the [FUDEIWA] Lighthouse and the heliport renovation work, and the salt damage and the neutralized concrete were covered with marine water.

(Reference material at the end)

Water leak repair by hydrofit method

Hydrofit method effectively prevents various deterioration by hybrid construction method using Hydro-sky products and fine powder silica blast furnace slag cement, injection tool. As mentioned above, Hydro Sky gradually reacts with free alkali and amorphous silica inside the concrete as a neutralization inhibitor to become a water insoluble inorganic compound and terminate the reaction, thereby stabilizing the alkalinity.
Silicone molecules similarly undergo chemical reactions on the surface and pores, and change concrete into substances that do not allow water to enter inside the capillaries, water gaps, voids, and so on.
The feature of this method is that it is effective for things that can not be replaced or rebuilt, such as bridges and underground structures, even if the construction site is small or small, there is no phytotoxicity of the material, and it can be used immediately after construction.
In addition to the scenery protection by SKY-MX color, which adds color expression to maintenance of aesthetic appearance and repair of deteriorated surface layer part, it can lead to environmental preservation and expansion of expression.

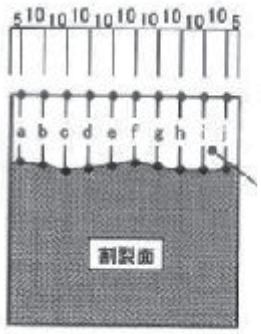
Test construction of permeable concrete modifier



Measurement of core neutralization depth

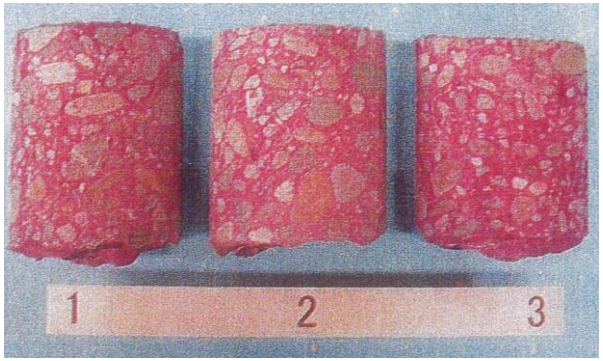
1) Carrying neutralization depth Core divided into 8
2) Method for promoting neutralization and neutralization depth measurement method after accelerated neutralization treatment

· Installed in promotion neutralizer according to JIS A 1152 and started the test
· The neutralization depth was taken out from the test apparatus at the promotion period of 13 weeks and measured at 10 split planes

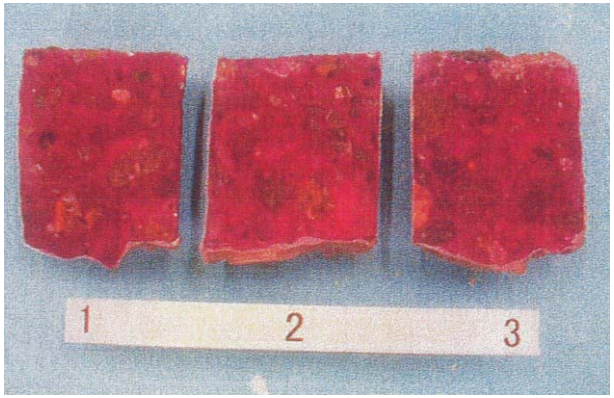


Neutralization part

Confirmation of neutralization depth by core removal



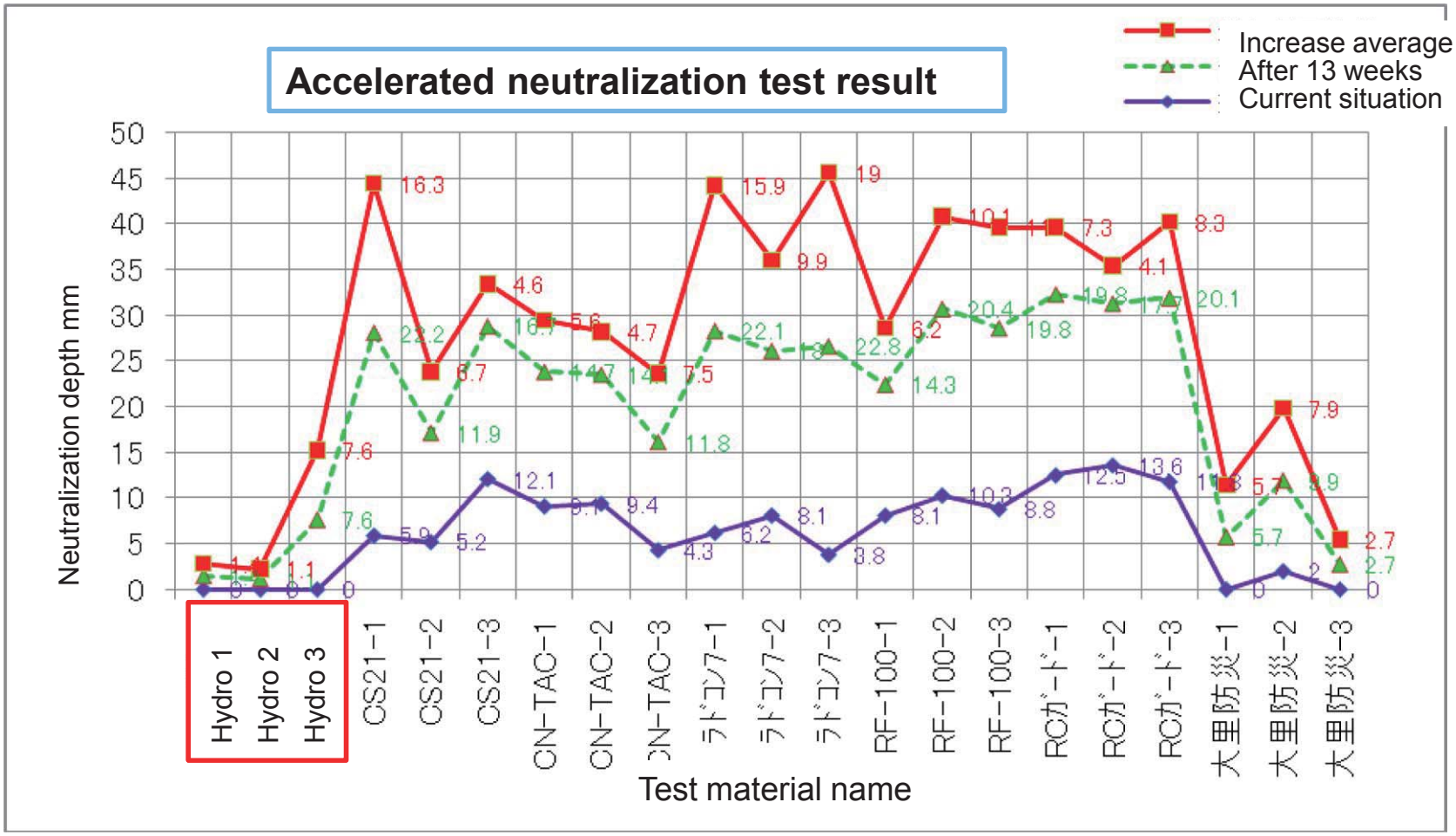
Neutralization situation (when carried in)



Neutralization situation (after promotion)

Test construction of permeable concrete modifier

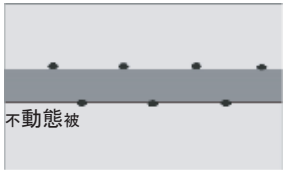
"Results of test construction of permeable concrete modifier" is as follows. The results of the accelerated neutralization test at the building material test center are shown in the graph below. The deeper the neutralization depth from the graph, the more concrete is neutralized by the carbon dioxide in the air, and the alkalinity of the concrete is declining.



Factors of alkali aggregate reaction and measures and remediation

Proposal of hydrofit method

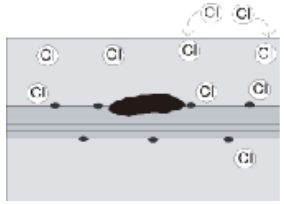
A large amount of calcium hydroxide is present in the concrete.It maintains a strong alkalinity of PH 12 or higher.



Reinforcing bar is protected by passive film and does not rust.
Chloride ions and chloride ions supplied from the outside gradually penetrate into the interior due to sea breeze or the like.

Neutralization

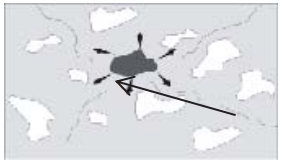
Calcium hydroxide (Ca (OH) 2) in the concrete reacts with carbon dioxide to form calcium oxide and the pH decreases.



Chloride ions gradually penetrate into the interior. Chloride ion contaminated with sea sand etc.

Alkali aggregate reaction

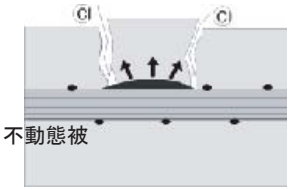
The reactive aggregate reacts with the alkali component in the cement to produce alkali silica gel (substance having water-swellable property).



The silica gel absorbs and expands and cracks occur in the concrete.

Reactive aggregate

Salt damage



Cracking occurs in concrete due to expansion pressure of rust.
Chloride ions destroy the passive film and the reinforcing bars rust.

⇩

Further, the reinforcing bars rust out

Cause of alkali aggregate reaction

● The alkali aggregate reaction of concrete is not an alkali of calcium but sodium and silica (silicon) contained in the aggregate react to form a gel-like compound. It is alkaline silica gel. And alkali silica gel has the action of swelling by absorbing moisture.

●Salt damage of concrete means that calcium hydroxide contained in concrete moves to the center due to the supply of salt contained in aggregate and exterior salt in the process of carbonation by atmospheric carbon dioxide, concentrating, reinforcing bar It is said to corrode the effect.

● Tulales seen in concrete, so-called ephroresenses, are those in which calcium hydroxide is eluted due to rainwater and the like, combines with carbon dioxide in the atmosphere and turns into calcium carbonate, and carbonated concrete is eluted by acid rain (converted to calcium hydrogen carbonate), It releases carbon dioxide and water into the atmosphere and returns to calcium carbonate again.
The former is not premised on acid rain (in the case of acid rain, calcium hydroxide does not dissolve but becomes calcium carbonate), so the latter with acid rain as the factor is the dominant theory.

Measures against alkali aggregate reaction

● In Hydro Sky, calcium type HT-G1 is added to stabilize alkalinity at the time of incorporation of concrete or during casting. Calcium PH will be involved in the natural world as a slaked lime slaked lime (lime water or lime milk) with low solubility. In the natural world, rainwater and soil are inclined toward acidic side, so the alkali buffering effect works, but rather calcium acts as acidic neutralizing agent. Therefore, unless intentionally and intensively used, PH of calcium rarely becomes a problem in the natural environment.

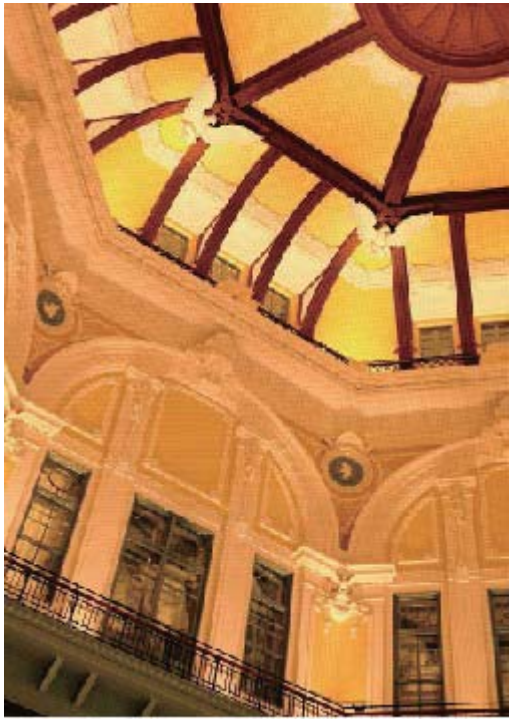
●Avoiding the use of alkali-reactive aggregate is often difficult in the field, and pay attention to rich alkali during casting and kneading.

●Consider combined operation of lithium silicate, calcium solution and blast furnace slag which is said to be effective also as impregnating solvent and infusate.

●Stop water treatment. These materials are also intended to protect against freezing and salt damage by using impregnated water repellent and waterproof agent with moisture permeability.

Tokyo Station Marunouchi station building construction and seismic reinforcement preservation construction

HYDROSKY
For Professional use



The dome ceiling is beautifully decorated. When I think that Hydro-Sky, a neutralization inhibitor, firmly protects the eyes of the people looking up, I feel "romance" in the space transcending the century.

Proposal of hydrofit method

Injection stop water work

National Assembly building, station Home leakage construction. Tokyo subway Co., Ltd.

A large amount of water leaked around this area.

Proposal of hydrofit method

Injection stop water work

Drill holes for drilling with a hammer drill

Water blows out from the periphery of the two injection plugs

Water is overflowing from the surroundings while installing the injection plug

Groundwater blows more than 20 L / min from this area

When you remove the water stop plate, the groundwater blows out in large quantities

Inject the HydroSky SKY-CSP paste with a chemical pump.

National Assembly building, station Home leakage construction. Tokyo subway Co., Ltd.

Aid suppressed water during plug fixation

Proposal of hydrofit method

Injection stop water work

When SKY-SP is injected, crystal acceleration is promoted inside the building

Preparation of hydro-paste

National Assembly building, station Home leakage construction. Tokyo subway Co., Ltd.

Proposal of hydrofit method

Injection stop water work

Confirm plug-off after infusate

Filling plug and injection situation

Transparent hose in front is used for groundwater drain and return

A large amount of water leakage has ceased completely and groundwater is bleeding slightly from the periphery

プラグ周辺からの漏水は無くなった

National Assembly building, station Home leakage construction. Tokyo subway Co., Ltd.

Plug traces filled with resin mortar and completed

The area around this area leaked a lot

Water-stopping by hydrofit method can chemically stop water leak promptly and promptly by impregnation from the surface and injection of composite material.

After completion of injection stoppage, wet surface of the surface is impregnated with HYDRO Sky SKY-SP. SKY - SP decomposes moisture by hydration reaction and makes the surface dry.

National Assembly building, station Home leakage construction. Tokyo subway Co., Ltd.

HYDROSKY

Renovation work on the Agano river agricultural water dam

Construction method

During washing, wash water curing is carried out firmly with river water pumped in advance, and mosses and pop out are removed.Application of degradation prevention and base conditioning agent, HYDRO Sky SKY - SP. Coverage is 0.2 kg / m 2 on average

Repair of defective part and junka part. Effectively use fine powder silica blended blast furnace slag cement. After drying,

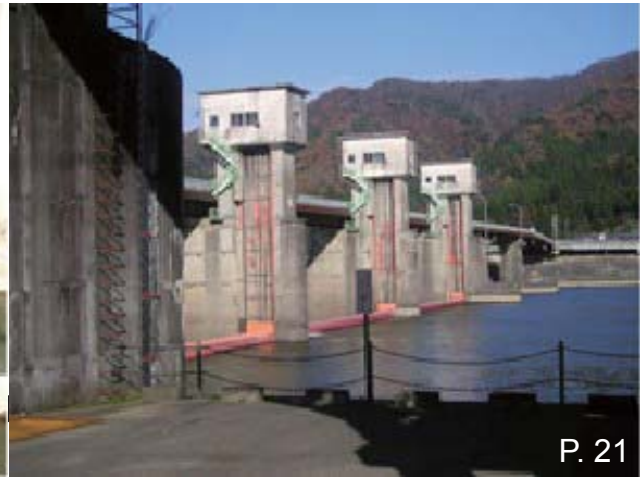
adjust the color tone with SKY-MX color(Landscape protection)

Waterproof protective finish completed with SKY-CVL.

Agano river front is a fish road

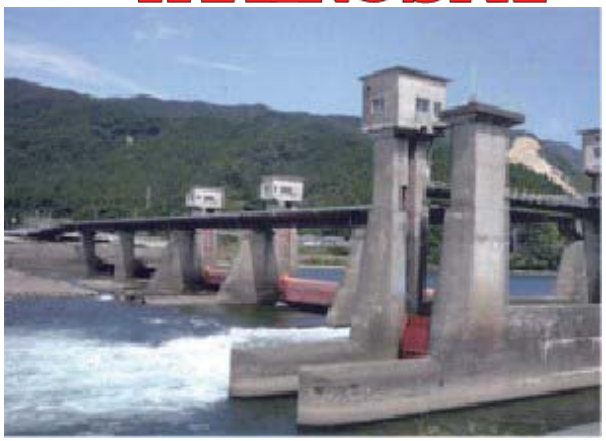
Full view of the Agano River fish way

Before construction of Agano River



HYDROSKY

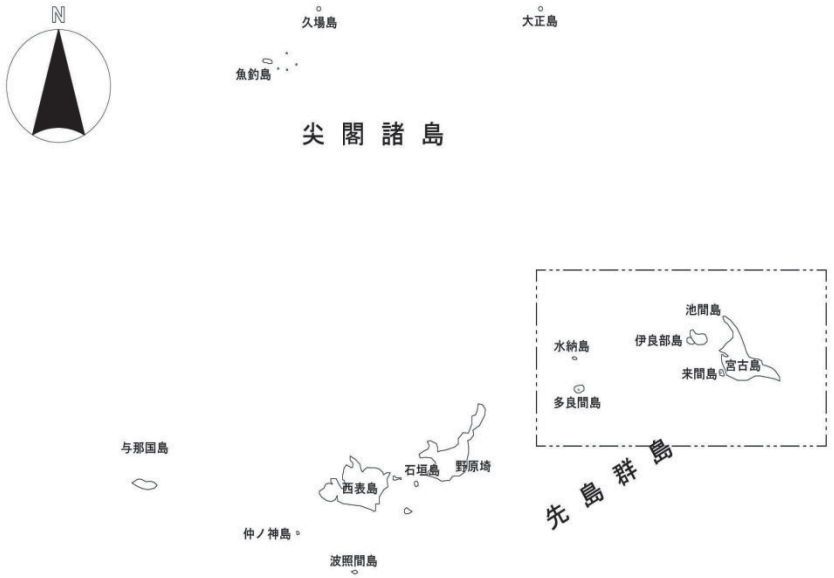
Before construction of Agano Rivers



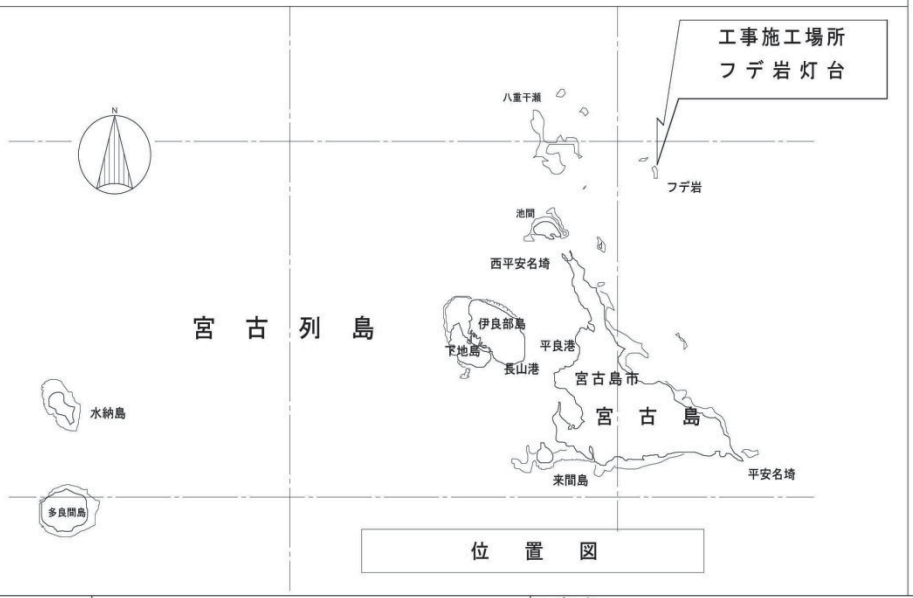
After the construction of the Agano river

HYDROSKY

Senkaku Islands, Fudelwa lighthouse deterioration protection renovation work



案　内　図



位　置　図

フデ岩　平面図

平成２１年度	[redacted]	工事名	作成年月	設計	製図	原図	縮尺	図面	図面番号
		フデ岩灯台改良改修工事	平成21年 7月	y.matsumoto				案内図・位置図・平面図	P-01

Senkaku Islands, Fudelwa lighthouse deterioration protection renovation work

HYDROSKY