THE SAND FIXATION AND STABILIZATION METHOD WHEN SAND IS USED AS A JOINT AND CUSHION MATERIAL IN PAVEMENT CONSTRUCTION

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Summary
The Gelsand Method is an elastic fixation and stabilization method of joint sand and cushion bed of interlocking block pavement et.al. and has such characteristics as prevent degradation and destruction of the flexural pavement property to be caused by washing-away of joint sand and cushion sand due to heavy rainfalls and so on.
The GS Method using a new chemical material can maintain the flexural property of joint sand and cushion bed and the used chemical material is produced in the rubber-like state by hydration polymerization reaction of water soluble prepolymer consisting of isocyanate compounds.
The Gelsand method is to spread Gelsand dissolved in water over the sand layer to form an elastic rubber-like plasticized concretion layer to a certain depth by hydration polymerization reaction.
Usable concentration of Gelsand should be 7-15%.

In pavement construction such as interlocking blocks, colored flag stones and stone pavers where sand for the joint and base is used as a cushion material to prevent breakage by the outside force,GS Method is considered to be an elastic fixation and stabilization method of the sand intended to prevent degradation and destruction of the flexural pavement property of the structure caused by washing-away of joint and cushion sand due to heavy rainfalls.

As sand in the structural layer does not have adhesiveness, it moves and runs out through vibration, water flow and water pressure.Also as there is no adhesiveness among sand particles, they are scattered in the wind.When there is no adhesiveness among sand particles as mentioned above,it becomes quite difficult to maintain the flexural pavement property of the structure when it is affected by heavy rainfalls,outside force and vibration.

In order to cope with these problems, at present they take measures of either inserting such fabrics as sheets and mats between upper base course and cushion sand or fixing with cement.But these measures are not good enough. The former protects cushion sand okay but does not joint sand, and the latter deprives the paving structure of the flexural pavement property because cushion sand gets stiff by cement.Furthermore, if cement be mixed into joint sand, it contaminate the surface of interlocking blocks,colored flag stones and stone pavers marring the appearance of those pavers.

For coping with these problems, GS Method using a new chemical material can elastically stabilize and fixate joint sand and cushion sand maintaining the flexural pavement property.The used chemical material(trade name "Gelsand") is produced in the rubber like state by hydration polymerization reaction of water soluble prepolymer consisting of isocyanate compounds.

Gelsand which is homogeneously dissolved in water is to be sprayed over the sand layer and it forms rubber-like plastic film on the sand-layer surface by hydration polymerization reaction. Being a water solution,it has low viscosity which helps it to permeate into lower layers and it fixates sand particles which form a layer to a certain depth.It fixates sand particles by hydration polymerization reaction eventually forming an elastic rubber-like plasticized concretion layer.

Since Gelsand strongly adheres to sand particles by hydration polymerization reaction,it shows high resistance to rain and wind erosion and sand particle scattering, thus it is also effective to prevent dust scattering.The produced rubber-like film is followed by foaming at the time of hydration polymerization reaction and since the cells are all closed cells having an insulation property, it is effective for preventing frost columns development and frost heaving.

Furthermore, Gelsand dissolves in any water forming homogeneous solutions and the hydration polymerization reaction can be controlled within the time range of 10 min. to 30 min. when excess water is all incorporated into the concretion.

Usable concentration of Gelsand is within the range of 7% to 15% and no concretion takes place when the concentration is less than 6%.When it is in the range of 7% to 15%, the rubber-like elastic film is formed.

[Example 1] An example where cushion and joint sand can be

considered to be washed away due to the grade presence

{Present problems}

In construction where sand is used as a joint and cushion material like for interlocking blocks, colored flag stones and stone pavers, when constructed in a place with the grade of more than 10 degrees,sand moves and is washed away and the elastic pavement property of the structure will deteriorate and collapse making it very hard to maintain the function with heavy rainfalls as sand in the structural layer does not have any adhesiveness.

{Countermeasure and problems of the present situation}

In order to cope with these problems, at present they take measures of either inserting such fabrics as sheets and mats between base course and cushion sand or fixing by cement.But these measures have some problems, the former protects cushion sand okay but doesn't joint sand and the latter deprives the paving structure of the flexural pavement property because cushion sand gets hard with cement, furthermore if cement be mixed into joint sand, it contaminate the surface of interlocking blocks, colored flag stones and stone pavers marring the appearance of those pavers.

{The method in question and its effect}

In construction where sand is used as a joint and cushion material like for interlocking blocks,colored flag stones and stone pavers,a Gelsand and water (15:85) mixture was stirred and sprayed homogeneously over tamped 3cm-thick cushion sand laid at the site with the grade of 15 degrees. The quantity sprayed per unit area was set for 2.0l/sq.m. After that,interlocking blocks were laid and joints were filled with sand.A mixture of Gelsand and water(10:90) was stirred and sprayed homogeneously over the laid interlocking blocks in the quantity of 1.0l/sq.m. Letting it stand for one hour after spraying,water was sprayed uniformly over the garde to see if there is any running-out of sand, but we did not observe any washing-away of sand in the grade whatsoever.The thickness of the layer after Gelsand and water polymerization reaction was approximately 10mm.

[Example 2] An example where wind blown sand is expected to get into the shops in the shopping street

{Present problems}

When interlocking blocks,colored flag stones and stone pavers in which sand is used for joints and cushion beds are paved in shopping streets,joint sand without adhesiveness is apt to be blown in the wind to get into the shops affecting the shop operation.

{The method in question and its effect}

In construction where sand is used as a joint and cushion material like for interlocking blocks,colored flag stones and stone pavers, a Gelsand and water(10:90)mixture was stirred and sprayed uniformly at the spraying quantity of 1.5l/1sq.m.over the laid interlocking blocks with the joints filled with sand.After spraying, we did not at all observe any sand blown in the wind to get into the shops.

[Example 3] An example,when interlocking blocks are paved around a swimming pool,to cope with the case where joint sand is washed away by cleaning water giving difficulty to walk bare-footed; washed-away sand gets into the swimming pool giving it difficulty to maintain

{Present problems}
When interlocking blocks, colored flag stones and stone pavers in which sand is used for joints and cushion beds are paved around a swimming pool,since joint sand in the structural layer does not have any adhesiveness,it is washed away by cleaning water giving difficulty to barefoot walking and causing maintenance difficulty by sand which ran into the swimming pool.
{The method in question and its effect}
A Gelsand and water(10:90)mixture was stirred and sprayed uniformly over the interlocking blocks with the joints filled with sand laid around the swimming pool at the spraying quantity of 1.0l per unit area.After letting it stand for one hour,the surface was continuously and uniformly watered.Sand remained stable without running out at all.Cleaning water didn't cause any washing-away of joint sand and barefoot walking was easy. No running-in of sand into the swimming pool made it easy to maintain.

[Example 4] An example where cushion and joint sand can be considered to move away due to vibration of heavy traffic and heavy duty vehicles on traffic road resulting in deprivation of deflection of pavement and destruction of the pavement structure

{Present problems}
In interlocking block pavement construction where sand is used as a joint and cushion material, when heavy traffic and heavy duty vehicle traffic are expected on the pavement, sand in the structural layer moves away and is washed away by vibrations from all directions and by water flow due to heavy rainfalls as sand in the structural layer does not have any adhesiveness making it very hard to maintain the flexural pavement function of the structure.
{Countermeasure and problems of the present situation}
In order to cope with these problems, at present they take measures of either inserting such fabrics as sheets and mats between base course and cushion sand or fixing by cement.But these measures have some problems, the former protects cushion sand okay but doesn't joint sand and as to the latter,if cement be mixed into joint sand, it contaminate the surface of interlocking blocks, colored flag stones and stone pavers marring the appearance of those pavers.
{The method in question and its effect}
In construction where sand is used as a joint and cushion material like for interlocking blocks,colored flag stones and stone pavers and supposing heavy traffic and heavy duty vehicle traffic, a Gelsand and water (15:85) mixture was stirred and sprayed homogeneously over tamped 2cm-thick cushion sand laid at the site. The quantity spread per unit area was set for 2.0l/sq.m. After that,interlocking blocks were laid and joints were filled with sand.A mixture of Gelsand and water(10:90) was stirred and sprayed homogeneously over the laid interlocking blocks in the quantity of 1.0l/sq.m. After letting it stand for one hour after spraying, we did not observe any washing-away of joint sand from the pavement surface whatsoever.The thickness of the layer after Gelsand and water polymerization reaction was approximately 10mm.



Photo 1. Kagoshima Port Gelsand Construction,Kagoshima-ken;Interlocking block pavement for 12,500 sq.m.

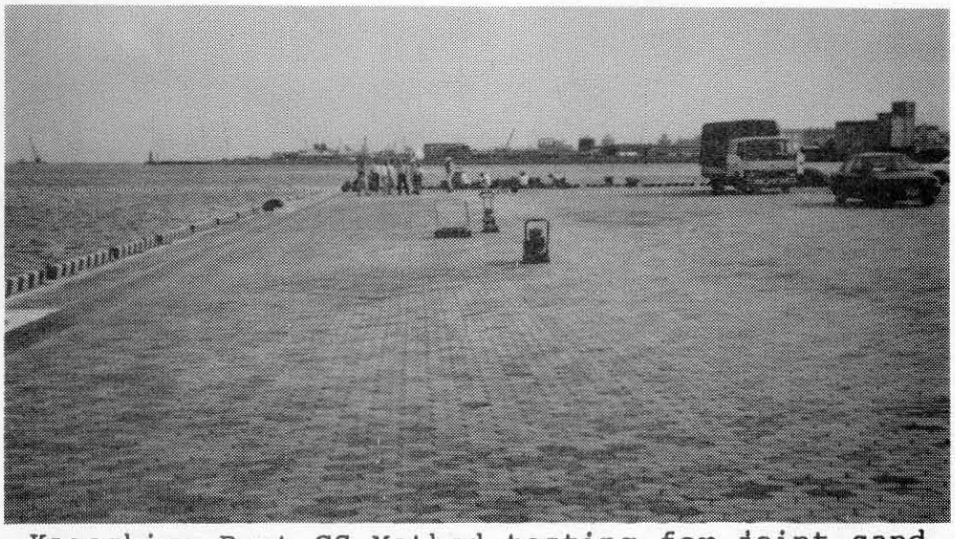

Photo 2. Kagoshima Port;GS Method testing for joint sand stabilization

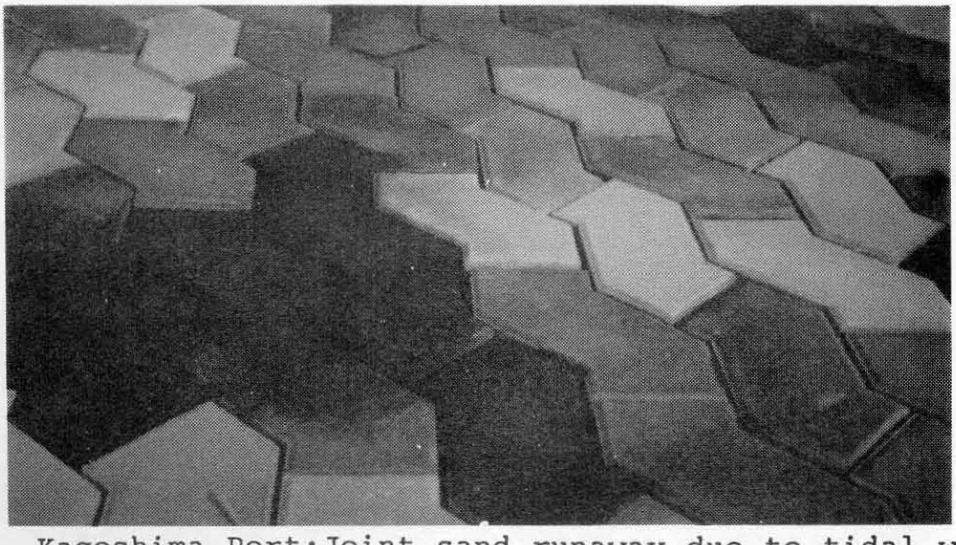

Photo 3. Kagoshima Port;Joint sand runaway due to tidal waves from a typhoon

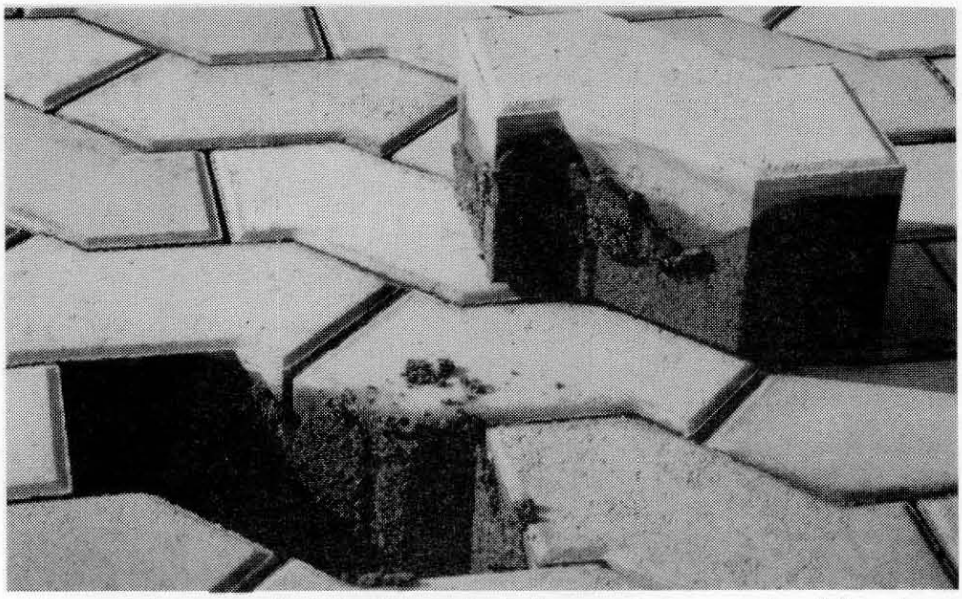

Photo 4. Kagoshima Port;30-40mm joint sand from the block surface ran away.

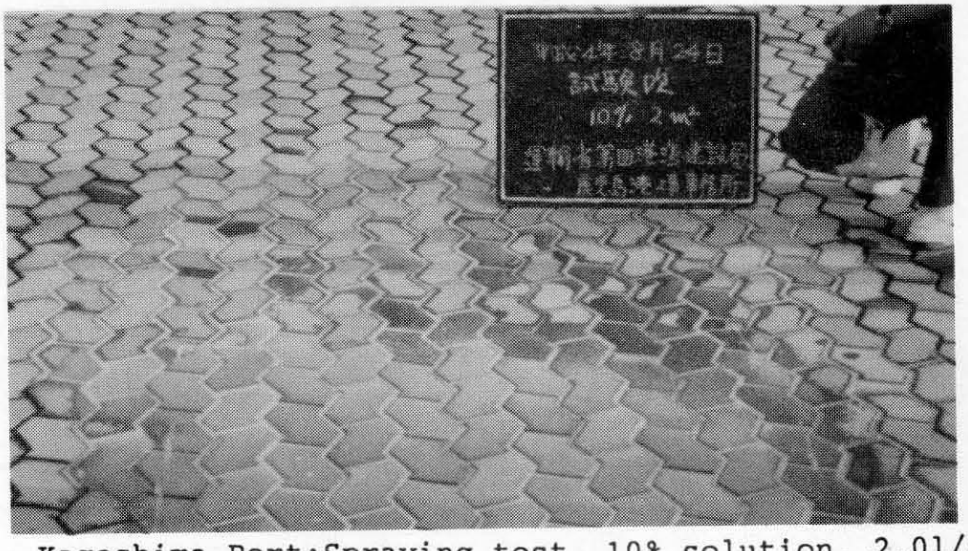

Photo 5. Kagoshima Port;Spraying test, 10% solution, 2.0l/sq.m. sprayed



Photo 6. Kagoshima Port;Spraying test, 10% solution, 2.0l/sq.m. sprayed,the state immediately after spraying

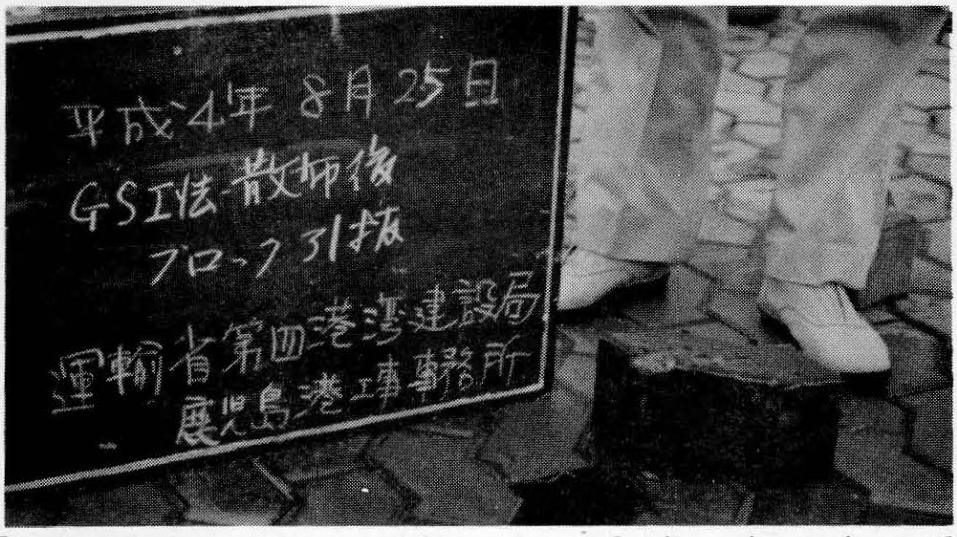

Photo 7. Kagoshima Port;verification of the situation after spraying by plucking blocks out



Photo 8. Kagoshima Port;gelled laminar joint sand maintaining elasticity



Photo 9. Kagoshima Port;approximately 45 mm gelled layer seen from the upper part of the blocks

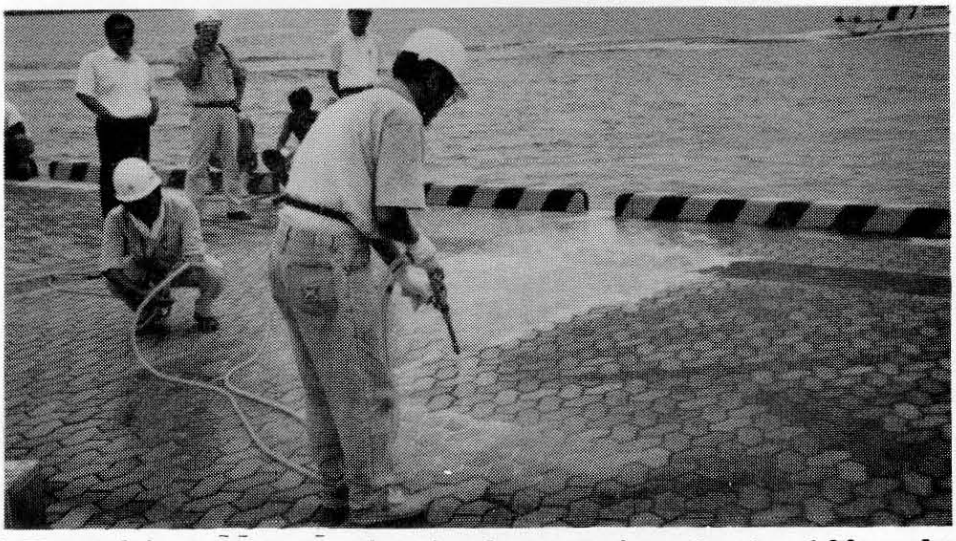

Photo 10.Kagoshima Port;mechanical spraying test, 10% solution, 1.0l/sq.m. sprayed

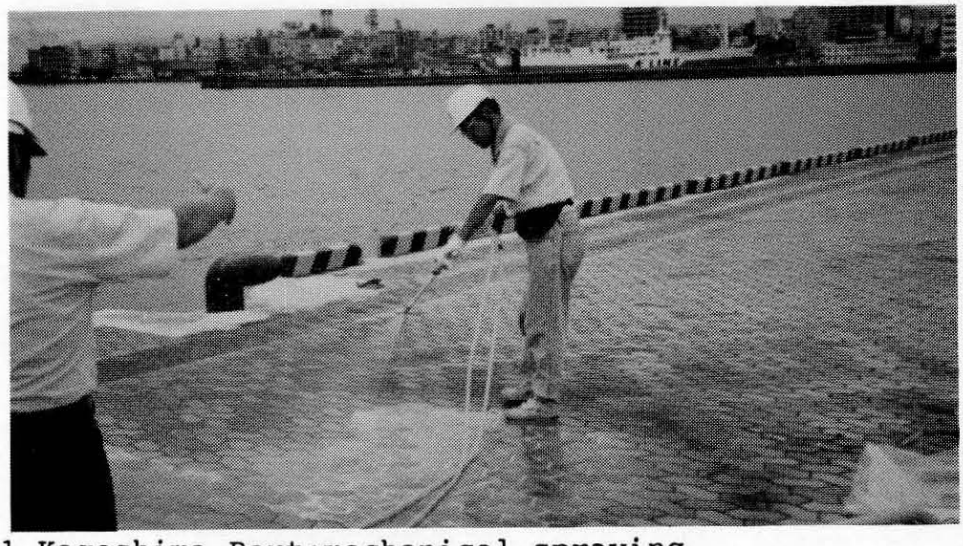

Photo 11.Kagoshima Port;mechanical spraying

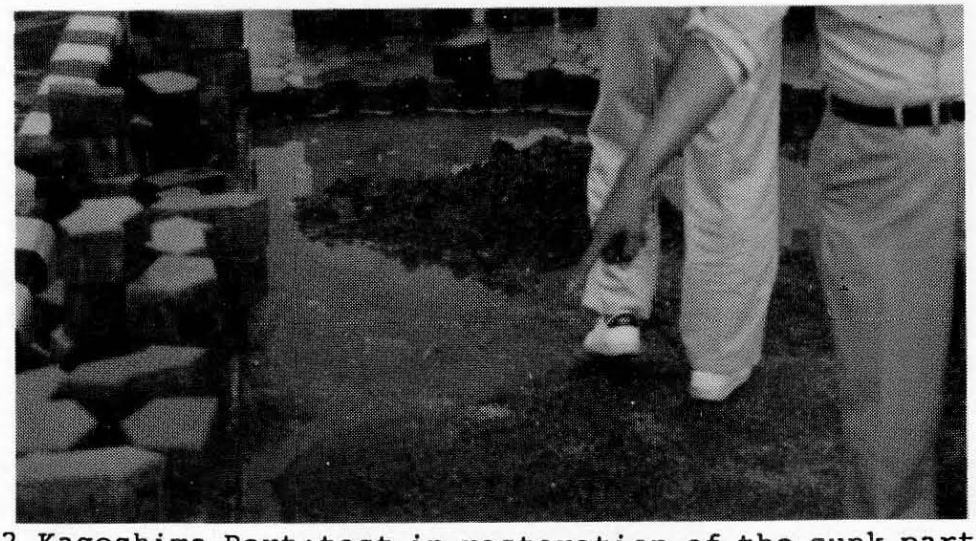

Photo 12.Kagoshima Port;test in restoration of the sunk part, the situation of the sunk part

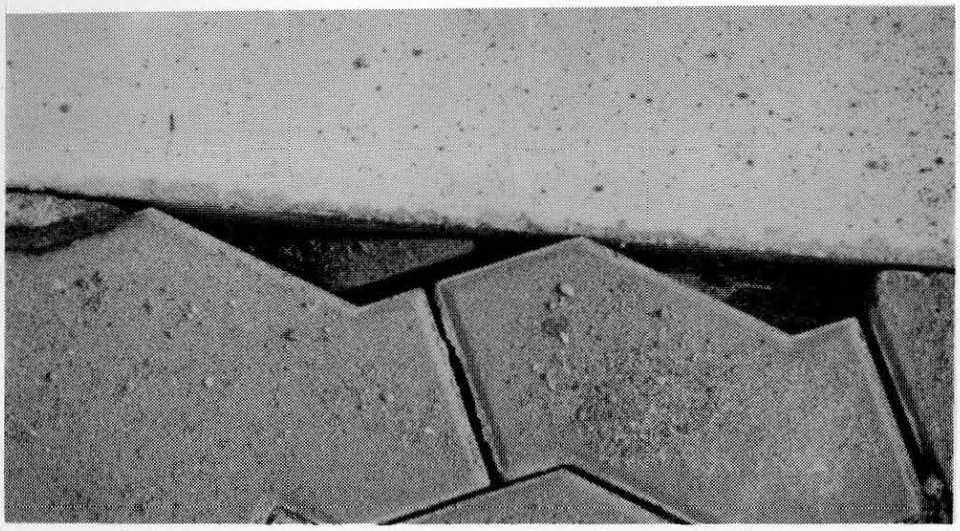

Photo 13.Kagoshima Port;test in restoration of the sunk part, the situation of the sunk part



Photo 14.Kagoshima Port;test in restoration of the sunk part, cushion sand leveling and compression completed



Phot 15.Kagoshima Port;spraying with a watering pot, 15% solution,1.0l/sq.m. sprayed

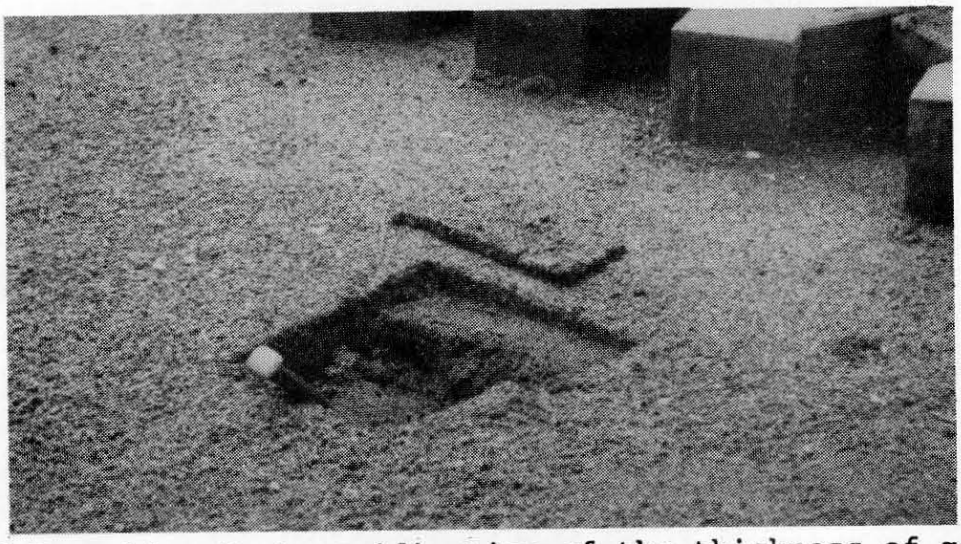

Photo 16.Kagoshima Port;verification of the thickness of gelled cushion sand



Photo 17.Kagoshima Port;the thickness of gelled cushion sand 10-15mm



Photo 18.Kagoshima Port;block laying after Gelsand Method implementation



Photo 19.Toi Port Gelsand Construction, Shizuoka-ken



Photo 20.Toi Port;10% solution, 1.0l/sq.m. spraying



Photo 21.Toi Port;10% solution. 1.0l/sq.m. the state after sprayed



Photo 22.Toi Port;10% solution, 1.0l/sq.m. spraying

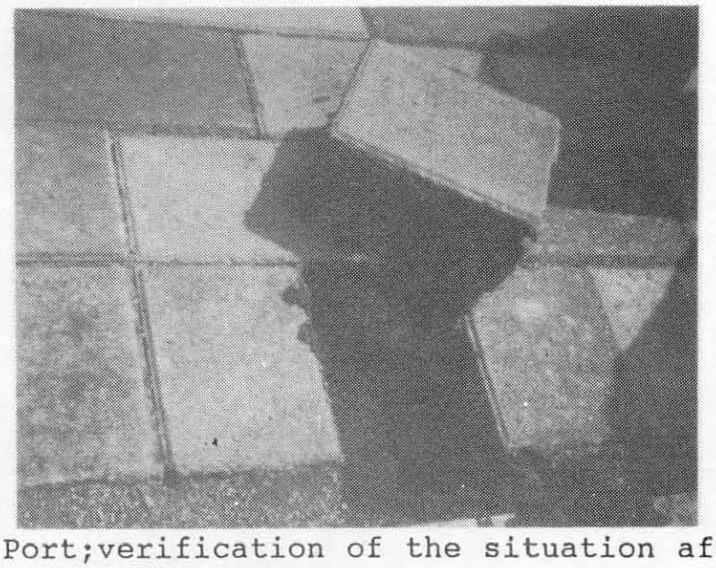

Photo 23.Toi Port;verification of the situation after spraying by plucking blocks out



Photo 24.the state after Gelsand Method implementation