Execution troubles at EPS construction sites of local highway

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Abstract

The EPS method that was introduced into Japan for the main purpose of reducing the settlement of poor subsoil has recorded a very large amount of works done, as it was used to widen mountainous roads because it has a wide range of applications and a high workability. The countrywide spread of the EPS method has resulted in not a few cases where this method caused the significant transmutations or deformations of roads due to the slight human inadvertence to the details. One of these cases was related to a local road located in the so-called rural district of a local region in Japan. In this district, only very small-sized civil engineering companies were operating. Under the topographical conditions, however, this local road was constructed by the EPS method as a widened and filled-up road, as it is now known as "EPS highway". This paper describes the methodological mistake and its impact on the transmutation of the road. In addition, it makes examinations on the settlements of the banking itself due to the creep deformation of styrene foam materials. It also refers to problems arising in the connections of EPS materials and wall bodies (see Fig. 1 Displacement permissible structure) as well as the solutions.

I'll feel happy if this paper can encourage the worldwide parties concerned to make discussions on potential improvements in the EPS method, taking this opportunity of reporting, and find out more effective solutions for problems, though they may considered that it will be difficult to publish such improvements and solutions.

1. Introduction

The EPS civil engineering method has been used in Japan for 15 years since this technology was introduced into our country in 1985. The total amount of works done by using the EPS method reached 2 million cubic meters at the end of 1999.

With regard to the work as mentioned in the title, this paper describes the cases of problems and solutions concerning the "insufficient instructions of work execution methods and explanation of structures constructed by the EPS banking method" and the "compressive deformation of EPS".

It is known in many fields that insufficient explanations made for civil engineering contractors using the EPS banking method have resulted in the misunderstanding that "EPS materials are light and may cause no land subsidence". On a land other than bedrock, the banking of materials having

a certain density may generally cause the land to have compressive deformations, or settlements due to consolidation. Even in any normal or not-poor subsoil, it is well known that similar settlements have been observed during banking work. On the work execution stages (such as banking, leveling and rolling compaction), any work may be completed to the final formation level within the allowable error by taking measures such as the control of results and the processing of biting materials. As for the D-20 type of EPS material having a density of 0.20 KN/m^3, it is loaded with upper materials such as concrete floor slabs, upper floor slabs, pavement asphalt mixture and subbase course materials depending on the height of banking. From the viewpoint of soil-mechanics, it is natural that this load may cause the compressive deformations of subsoil and EPS material. These compressive deformations may be small, compared with those of the soil & sand banking on any poor subsoil and the general materials for civil engineering works. However, I suppose it will be generally understood that such compressive deformations can be considered as one of the factors causing the settlement of EPS banking. In reality, the most important problem is apparently the settlement of EPS layers not due to its chemical characteristics, but mainly caused by the fact that civil engineering contractors did not sufficiently understood the structures constructed by the EPS banking method on the work execution stages, including the clearances formed by connecting metals as well as the intermediate floor slabs cut to control the height of banking. In the recent years, worldwide attentions have been directed to problems such as the quality and standardization of civil engineering works. Concerning EPS works, the case has been gradually observed that civil engineering contractors gave troubles to customers due to their misunderstanding and insufficient recognition of these problems as well as their lack of common sense about general works.

2. Reasons and Solutions for a Case of Incomplete Local Work

(1) Functional damages in the back drainage layer constructed by the banking method in a slope land, due to the insufficient understanding of the drainage layer

It is now known that the excessive deformations of the EPS banking might be caused by various factors, including the reduced drainage capacity of the slope land due to the contractors' insufficient understanding of the necessity of drainage layer as well as the related impact of water pressure (not considered on the design stage) on the banking, the increasingly displaced protective wall supports and the lowest EPS blocks. It is also pointed out that these factors had the highest possibility of depressing the banking body because the incompletely constructed back drainage layer (of crushed stones for backfilling) prevented underground water from flowing out of the banking, as shown in Fig. 2. As one of the solutions, crusher-runs are now being replaced with crushed stones having a single grain size. Refer to Fig. 2.

(2) An incomplete part of the widened banking structure due to the deformation property of EPS

Refer to Photo 1.

Steel supports (H-section steel) for wall face members were deformed and damaged by the incomplete construction of the displacement permissible structure.

The defective displacement permissible structure that was constructed by a civil engineering contractor who did not understand the structures constructed by the EPS method did not function well, and this caused to deform steel supports, crack upper floor slabs and damage the structure itself, and consequently deform the whole EPS banking. As a part of the solutions, it is now planned that more detailed working instructions will be given to civil engineering contractors, and that the displacement permissible structure will be replaced with that which may be constructed even by those who do not understand the necessity of the structure. See Fig. 3,Photo.3 and Photo.4

(3) Deformation of upper EPS blocks caused by large-sized heavy machines running on upper floor slabs before the completion of the pavement

As one of the reasons for the excessive settlements of the EPS banking caused before its completion, it was recently reported that in the work section where a large structure such as bridge was being constructed, the constructors who did not understand the allowable stresses of EPS blocks had run heavy machines directly over the just-installed upper floor slabs of the EPS banking or over the spread subbase course materials of 30cm in thickness, as shown in Fig. 5, to cause the excessive deformations of upper EPS blocks and the excessive subsidence of the EPS banking. This report describes the onerous case that the bridge constructors suppressed the fact that they had run large-sized heavy machines over EPS blocks, and made it difficult to be revealed, while the Owner pointed out the defects of EPS blocks and demanded the constructors to take countermeasures. To cope with such a case, it is imperative to cure the installed upper floor slabs, and strengthen the guard system to prevent heavy machines from running over the pavement not yet reaching the minimum allowable thickness. Refer to Fig. 5 and Photo 5.

(4) The settlements of EPS banking caused by the failure to grade and preliminarily roll the surface of the field foundation

The failure to grade and preliminarily roll the surface of the foundation, as specified in the Common Specification for Civil Engineering Works, caused the settlements of the EPS banking due to the insufficient supporting force of the foundation surface. These settlements were not partially, but entirely caused so that it was difficult to match the EPS banking with the field subsoil. This phenomenon was considered to be due to defective EPS blocks, and consequently pointed out as the

problem of the EPS method itself. To prevent such settlements, therefore, it is necessary to give civil engineering contractors the thorough instructions on the reliable grading and preliminary rolling of the field foundation, and establish such a quality assurance system as to allow them to report that there is no problem of EPS blocks.

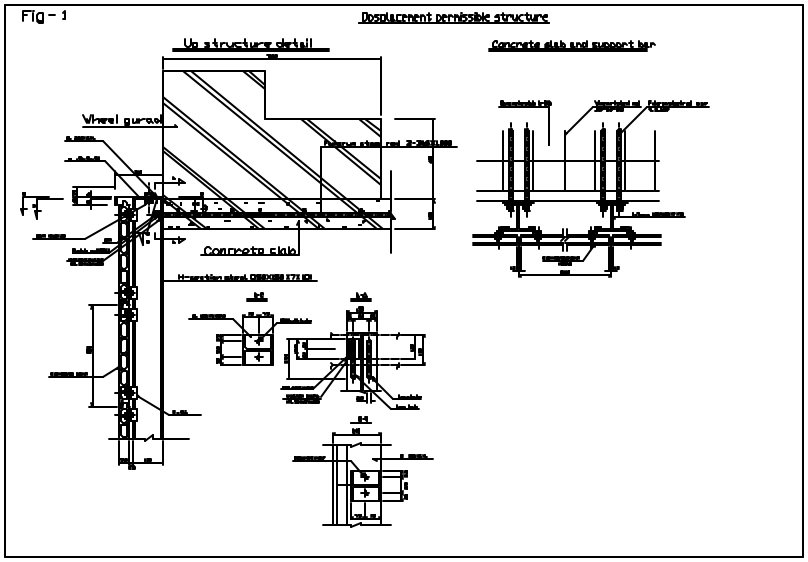
(5) The uneven settlements of interfaces between field foundation, soil & sand banking layer and EPS banking layer due to the lack of a sufficient damper structure

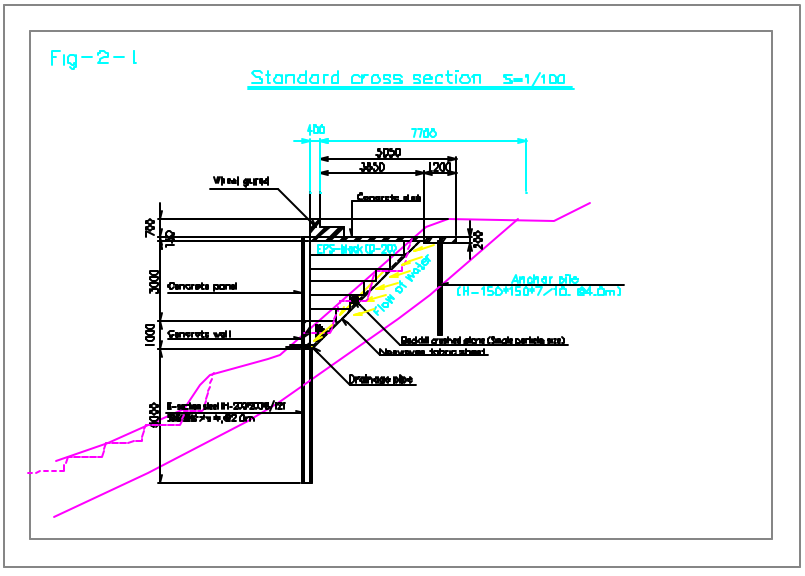
In the banking on any poor subsoil, the settlements of the soil & sand banking layer caused those of the EPS banking layer, which in turn provoked the bending deformations of concrete floor slabs. To solve these problems, an idea was proposed that measure would be taken after having early understood the conditions of the subsoil in the field. In addition, a settlement following structure (including flexible joints) was added to the jointed parts if anchors and other devices were used. Or it is guiding constructing the concrete of a joint portion later .See Fig. 4.

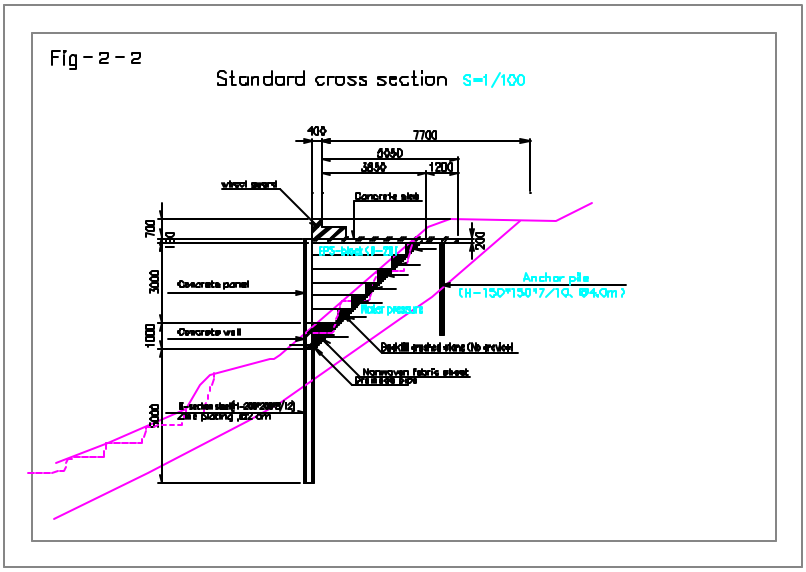
3. Considerations (Conclusion)

It is supposed that the problems as described above were caused by the fact that civil engineering contractors had neglected the common sense of most civil engineering works, including the case as described above, and executed their works in an easygoing way without understanding the EPS method sufficiently. It can be considered as another cause that civil engineering contractors have taken cost reduction measures and failed to take any indispensable action without the Owner's approval.

To eliminate the defects of any EPS banking not due to the quality of EPS blocks, we have the intention of ensuring that the new revision of Standards will contain requirements including the very basic points and the above-described measures, considering the background as described above. In addition, we plan to presume unexpected phenomena, add detailed requirements and not-confirmed items onto design drawings, give more effective instructions on the EPS method and structures to civil engineering contractors, and replace the existing types of EPS structures with the new types that even local civil engineering contractors may construct with a few defects.


Fig－1
Displacement permissible structure
Up a structure shotsil
Concrete slab and support bar
Wheel guard
Concrete slab


Fig－2－1
Standard cross section S=1/100
400
7700
5000
3850
1200
Wheel guard
Concrete slab
700
150
200
3000
1000
4000
Concrete panel
Concrete wall
Flow of Water
Anchor pile
Drainage pipe


Fig－2－2
Standard cross section S=1/100
400
7700
6650
3650
1200
Concrete slab
700
150
3000
1000
5000
200
Concrete panel
Concrete wall
Anchor pile
(H-150*150*7/10, @4.0m)
Water pressure
Backfill crushed stone 0to 40mm
Nonwoven fabric sheet
Drainage pipe

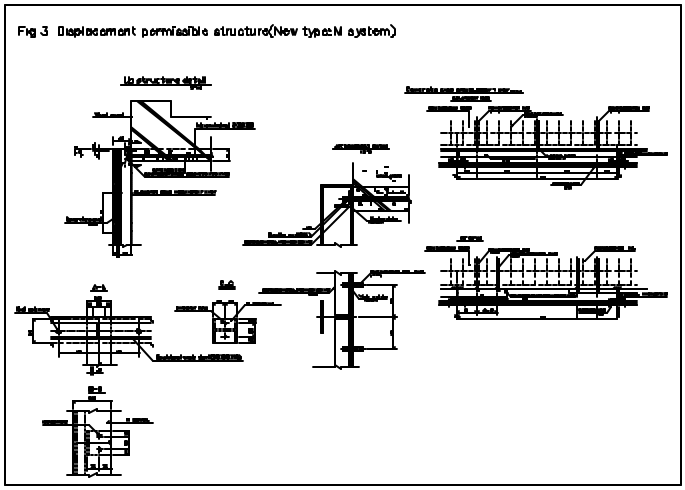
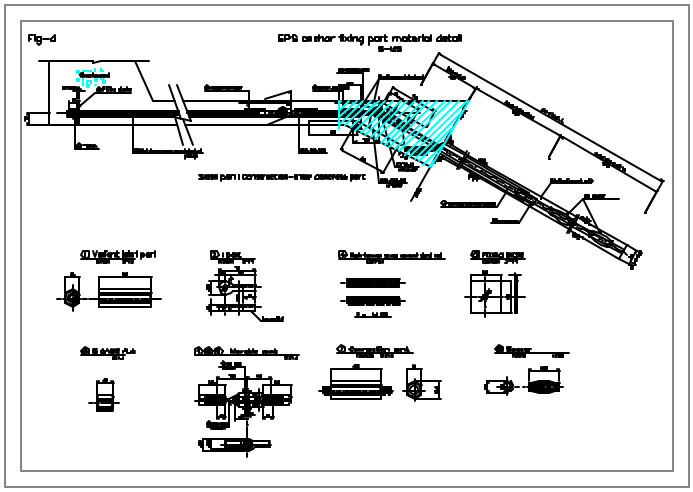


Fig.3 Displacement permissible structure(New type:N system)



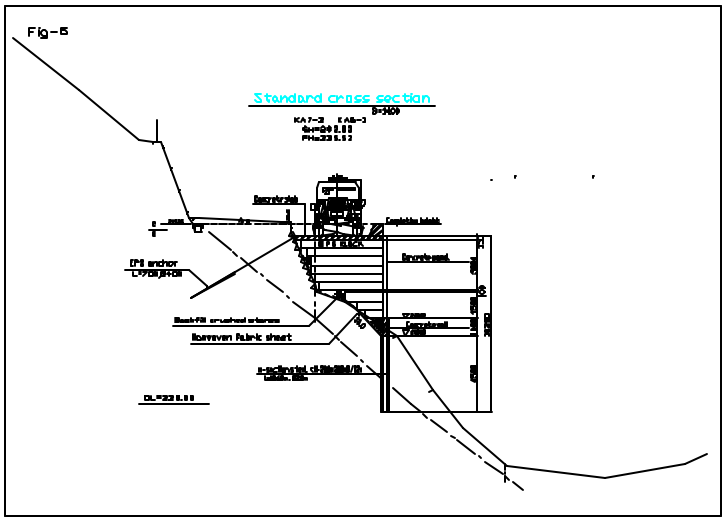


Photo.1 ＊＊＊ The example of concrete pouring into gap generated due to H section steel deformation

ǂ Wall deformation due to H-section steel deformation

Photo.2 ǂ ǂ ǂ crushed stones having a single size at drainage layers

Photo.3 ǂ ǂ ǂ Execution failure of Displacement Permissible Structure

Photo.4 ｷ ｷ ｷ the crack of a concrete wall

Photo.5 ｷ ｷ ｷ Execution failure of H section steel

Photo. 6 ｷ ｷ ｷ Execution failure of movable joint part of EPS anchor