

DESCRIPTION
LINING PLATE

Technical Field

The present invention relates to a lining plate structured by connecting H-steel beams mainly used for civil engineering and construction.

Background Art

Lining plates are used for constructing an erection ground, an erection floor and the like to ensure traffic above a construction space when performing underground work in an urban district and the like. Fig. 10 illustrates an example thereof. The illustrated lining plate is structured to be a planar rectangle having certain thickness by welding flange end parts 4 of a plurality of H-steel beams 1 which are arranged in parallel and attaching side plates 3, and then, is reinforced with lateral ribs 13.

In general, lining plates are required to have functions of (1) load-resistant force and durability against vehicle passing, (2) surface frictional resistance for generating driving force via vehicle tires, and (3) reduction of noise and vibration during vehicle passing. Sizes of H-steel beams to be used as members, specifications of welding parts, and sizes of side plates and lateral ribs are determined for a steel-made lining plate to satisfy the above function (1).

Patent Literature 1 discloses a lining plate, satisfying

the above functions (2) and (3), in which protrusions are shaped at a flange outer face of H-steel beams structuring the lining plate and inner face material having a vibration insulating function and a noise absorbing function such as rubber material containing air bubbles is attached to the inner face thereof. As illustrated in Fig. 9, protrusions 21 at the flange outer face of the H-steel beam are formed into a lattice-like shape having the axes parallel to the longitudinal direction of the H-steel beam and to the perpendicular direction to the longitudinal direction of the H-steel beam.

Cited Literature

Patent Literature

Patent Literature 1: Japanese Patent Application

Laid-Open No. 7-247506

Patent Literature 2: Japanese Patent Application

Laid-Open No. 62-107802

Summary of Invention

Technical Problem

By the way, owing to increased requirement level of performance improvement of slide frictional resistance at rainfall time and countermeasures for noise and vibration, it is becoming popular to perform surface coating on protrusions with resin-based material, asphalt material or the like.

The lattice-like protrusion shape illustrated in Fig. 9 considered to perform an important function for fixing surface

coating is designed originally on the condition of being directly exposed but not on the assumption of applying surface coating. With respect to the lattice-like protrusion shape of the related art, since the protrusions are formed in two directions, at least two types of mil rolls have been required and two or more rolling passes have been required (Fig. 8).

Accordingly, the present invention has an object to provide a lining plate having an outer face protrusion shape which improves fixing stability of surface coating and reduces processing cost than before.

Solution to Problem

The object of the present invention can be achieved with the following means.

1. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned, wherein each H-steel beam has a flange outer face on which stripe-like protrusions are formed in a single direction.
2. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes is the same and of which heights of flange outer faces and longitudinal directions are aligned, wherein each H-steel beam has a flange outer face on which stripe-like protrusions are formed in the longitudinal direction.
3. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights

of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in the longitudinal direction and an H-steel beam of which flange outer face has stripe-like protrusions in a direction being perpendicular to the longitudinal direction are alternately connected.

4. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in the longitudinal direction and an H-steel beam of which flange outer face has no protrusion are alternately connected.

5. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in a direction being perpendicular to the longitudinal direction and an H-steel beam of which flange outer face has no protrusions are alternately connected.

6. The lining plate according to any one of claims 1 to 5,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam has a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2.

Advantageous Effects of Invention

According to the present invention, processing cost required for protrusion forming can be reduced compared to a case that lattice-like protrusions are processed on a flange outer face of an H-steel beam. Accordingly, an inexpensive lining plate of which fixing stability of surface coating is the same or more than that in a case of a lattice-like protrusion shape can be obtained as being remarkably effective for industry.

Brief Description of Drawings

Fig. 1 is an explanatory perspective view of a lining plate according to an embodiment of the present invention viewing from an obliquely upper side.

Fig. 2 is an explanatory perspective view of an H-steel beam used for the lining plate illustrated in Fig. 1.

Fig. 3 is an explanatory view of stripe-like protrusions.

Fig. 4 is an explanatory perspective view of a lining plate according to another embodiment of the present invention viewing from an obliquely upper side.

Fig. 5 is an explanatory view of sample bodies used as examples.

Fig. 6 is a view indicating relation between horizontal shear loads and push-out slide amounts.

Fig. 7 is a view indicating relation between a ratio h/P of a protrusion height h and a protrusion interval P and maximum horizontal shear load.

Fig. 8 is an explanatory view of a method of processing a lattice-like protrusion shape.

Fig. 9 is an explanatory view of the lattice-like protrusion shape.

Fig. 10 is an explanatory view of a lining plate.

Fig. 11 is an explanatory perspective view of a lining plate according to another embodiment of the present invention viewing from an obliquely upper side.

Fig. 12 is an explanatory perspective view of a lining plate according to another embodiment of the present invention viewing from an obliquely upper side.

Description of Embodiments

A lining plate according to the present invention adopts H-steel beams having stripe-like protrusions formed on flange outer faces thereof in a single direction. In the following, the present invention will be described in detail with reference to the drawings.

Fig. 1 is an explanatory view of a lining plate according to an embodiment of the present invention. Fig. 2 is an explanatory view of an H-steel beam used for the lining plate illustrated in Fig. 1. Both drawings are perspective views viewing respectively from an obliquely upper side.

The lining plate is structured by welding a plurality of H-steel beams 1 of which sectional shapes are the same and of which heights of flange outer faces 11 and longitudinal directions are aligned while adjacent flange end parts 4 are

welded. The H-steel beam 1 located at an end part of the lining plate has a side plate 3 attached between upper and lower flanges at a side being a side face of the lining plate. A rolling direction of the H-steel beam 1 is the longitudinal direction and the flange outer face 11 of the H-steel beam 1 is provided with stripe-like protrusions which have a plurality of protrusions 21 processed in the longitudinal direction at regular intervals.

Fig. 3 is an explanatory view of stripe-like protrusions. A stripe-like protrusion 21 is formed to define a ratio h/P between a protrusion height h and a protrusion interval P so as to ensure fixing stability of surface coating and to obtain operational friction force necessary for vehicle driving.

Operational friction force (a shear load) calculated from a T live load (a two-wheel load of a large-sized vehicle) used in specifications for highway bridges is 45 kN in sample body width conversion equivalent as follows. There may be a case to be described as generated friction force level (45 kN) due to the T live load. The present invention has a performance target to ensure fixing stability of lining plate surface coating against a shear load being 90 kN or larger in consideration of approximate twice as a safety factor for long-term usage against the abovementioned operational friction force level.

Wheel load (T live load) : 100 kN (per each wheel)

Impact load : $100 \text{ kN} \times 1.4 = 140 \text{ kN}$

Friction coefficient at dry road surface (asphalt) : μ

$\mu = 0.8$

Operational friction force : $140 \text{ kN} \times 0.8 = 112 \text{ kN}$ (per each wheel)

45 kN in sample body with respect to width conversion
sample body width (200 mm) / tire width (500 mm) $\times 112$
 $= 45 \text{ kN}$

Table 1 indicates a test result of influence of the protrusion height h and the protrusion interval P to fitting strength of surface coating. Each sample body was obtained by cutting an H-steel beam with stripe-like protrusions ($0 \leq h/P \leq 0.25$ as the protrusion height being 0 to 2.5 mm and the protrusion interval being 10 mm) to be 200 mm in length and performing surface coating.

A horizontal shear load was measured by horizontally pushing out a surface coating fixing part in a state of being restricted in the vertical direction after attaching a loading jig to each sample body with a strong adhesive of a reactive acrylic type (tensile shear strength is 24 N/mm^2 or larger).

[Table 1]

Case	Shape	Protrusion height h (mm)	Protrusion interval P (mm)	h/P	Maximum horizontal shear load (kN)
1	No protrusion	0	—	0	33
2	Shape in the present invention (Stripe-like protrusions in a single direction) 	0.5	10	0.05	59
3		0.7	10	0.07	102
4		1.0	10	0.1	115
5		2.0	10	0.2	148
6		2.5	10	0.25	151

Fig. 7 illustrates relation between the ratio h/P of the protrusion height h and the protrusion interval P and the maximum horizontal shear load. When h/P is smaller than 0.07, a bearing effect due to the protrusions is not sufficient. Accordingly, the surface coating slides and sufficient fixing cannot be obtained. As a result, the maximum horizontal shear load cannot reach the target performance approximately being 90 kN or larger.

On the other hand, when h/P exceeds 0.2, the fixing strength is not increased owing to occurrence of shear fracture of the surface coating itself. Accordingly, it is defined to satisfy $0.07 \leq h/P \leq 0.2$. Here, the protrusion height h is set to be 1.0 mm or higher to ensure fixing stability of the surface coating and to prevent performance from being drastically decreased even if dust and the like are stuck to the surface during attaching operation of the surface coating.

In an H-steel beam, stripe-like protrusions are processed on one flange outer face or both flange outer faces in accordance with necessity of surface coating of a lining plate. The

stripe-like protrusions having a plurality of the protrusions 21 in the longitudinal direction at regular intervals are processed with hot rolling by using a down roll (e.g., a U2 down roll in Fig. 8) to which grooves are arranged in the roll circumferential direction at regular intervals.

In the lining plate according to the present invention, the protrusions at the flange outer face of the H-steel beam are shaped like stripes in a single direction parallel to the longitudinal direction of the H-steel beam. Accordingly, processing cost required for protrusion forming can be reduced compared to a conventional lattice-like protrusion shape.

Currently, the most inexpensive method of protrusion forming is to form protrusions at the same time when performing roll forming of an H-steel beam (Patent Literature 2). In the present invention, owing to that the protrusions are shaped into single-direction protrusions, the protrusion forming can be performed with one type of a mill roll and one time of rolling pass. Accordingly, processing cost for manufacturing an H-steel beam can be reduced by approximate 10%.

Further, since the protrusions are shaped into single-direction stripe-like protrusions, the protrusions have less defective parts compared to traditionally-shaped (lattice-like) protrusions. Accordingly, contacting surfaces between the protrusions (steel material) and surface coating material are increased and fixing stability of the surface coating is increased.

The lining plate of the present invention can provide

superior horizontal shear load even when being installed so that the direction of the stripe-like protrusions is parallel to a direction of vehicle passing. However, it is more preferable to be installed as being perpendicular thereto under adverse conditions.

Fig. 4 is an perspective view, viewing from an obliquely upper side, of a lining plate formed by alternately laying an H-steel beam of which flange outer face has stripe-like protrusions in the longitudinal direction of the H-steel beam and an H-steel beam of which flange outer face has stripe-like protrusions in a direction being perpendicular to the longitudinal direction of the H-steel beam. The protrusion height h of each H-steel beam is 1.0 mm or higher as satisfying $0.07 \leq h/P \leq 0.2$.

Since excellent horizontal shear load can be obtained regardless of the vehicle passing direction, the illustrated lining plate is preferably used at an intersection and the like. Here, two types of H-steel beams are required to form the illustrated lining plate. However, since the processing cost of each H-steel beam is inexpensive compared to a traditional protrusion shape (lattice-like shape) as described above, it is possible to manufacture the lining plate approximately at the same cost as the traditional protrusion shape (lattice-like shape).

Fig. 11 is an perspective view, viewing from an obliquely upper side, of a lining plate formed by alternately laying an H-steel beam of which flange outer face has stripe-like

protrusions in the longitudinal direction of the H-steel beam and an H-steel beam of which flange outer face has no protrusion. The protrusion height h of each H-steel beam having protrusions is 1.0 mm or higher as satisfying $0.07 \leq h/P \leq 0.2$. Cost reduction can be further performed by partly using H-steel beams without protrusions. Since material of the surface coating such as resin-based material and asphalt material is rich in elasticity, fixing force is transmitted without causing cracking and breakage as long as protrusions partly exist on the lining plate surface. Accordingly, the above structure can be adopted.

Fig. 12 is an perspective view, viewing from an obliquely upper side, of a lining plate formed by alternately laying an H-steel beam of which flange outer face has stripe-like protrusions in the direction being perpendicular to the longitudinal direction of the H-steel beam and an H-steel beam of which flange outer face has no protrusion. The protrusion height h of each H-steel beam having protrusions is 1.0 mm or higher as satisfying $0.07 \leq h/P \leq 0.2$. Cost reduction can be further performed by partly using H-steel beams without protrusions. Since material of the surface coating such as resin-based material and asphalt material is rich in elasticity, fixing force is transmitted without causing cracking and breakage as long as protrusions partly exist on the lining plate surface. Accordingly, the above structure can be adopted.

Here, the drawings described above illustrate structures having protrusions on both upper and lower faces of the lining plate. However, it is also possible to adopt a structure that

protrusions are formed only on an upper face of a lining plate to be a vehicle passing face.

Examples

A test was performed to examine fixing strength of surface coating by using H-steel beams each having a different processing state on a flange outer face thereof. Fig. 5 illustrates tested sample bodies being a sample body having a protrusion shape (lattice-like protrusions) according to the related art, a sample body having a shape (stripe-like protrusions) according to the present invention, and a sample body without protrusions as reference.

Each sample body was obtained by cutting an H-steel beam with protrusions having each shape to be 200 mm in length and coating was performed. The test was performed with a method of horizontally pushing out a surface coating fixing part in a state of being restricted in the vertical direction after attaching a loading jig to each sample body with a strong adhesive of a reactive acrylic type (tensile shear load 24 N/mm^2 or larger).

Fig. 6 indicates relation between horizontal shear loads and push-out slide amounts. The maximum shear loads at the surface coating parts of the present invention shape (stripe-like protrusions) and the conventional protrusion shape (lattice-like protrusions) were in the same range. However, initial shear stiffness (denoted by a slide amount when obtaining the maximum shear load) of the shape (stripe-like protrusions) of the present invention largely exceeded that of

the protrusion shape (lattice-like protrusions) of the related art. Any large sliding did not occur between the surface coating section and the H-steel beam of the shape of the present invention, so that enhanced fixing stability of the surface coating was confirmed compared to that of the protrusion shape of the related art.

Here, with each sample body having protrusions (the shape (stripe-like protrusions) of the present invention and the protrusion shape (lattice-like shape) of the related art), the above exceeded the generated friction force level (45 kN) due to the T live load on the order of 2.5 times. On the contrary, the sample body without protrusions was low in fixing strength as falling below the generated friction force level (45 kN) due to the T live load.

Reference Signs List

- 1 H-steel beam
- 2 Lattice-like protrusion
- 3 Side plate
- 4 End part
- 5 H-steel beam without protrusions
- 11 Flange outer face
- 13 Lateral lib
- 21 Protrusion

CLAIMS

1. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein each H-steel beam has a flange outer face on which stripe-like protrusions are formed in a single direction,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam have a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2,

wherein the sectional shape means a shape of the H-steel beam excepting cross-sections of the stripe-like protrusions, and

wherein the lining plate is used with the surface coating applied on at least one flange outer face provided with the stripe-like protrusions.

2. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein each H-steel beam has a flange outer face on which stripe-like protrusions are formed in the longitudinal direction,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam have a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2,

wherein the sectional shape means a shape of the H-steel beam excepting cross-sections of the stripe-like protrusions, and

wherein the lining plate is used with the surface coating applied on at least one flange outer face provided with the stripe-like protrusions.

3. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in the longitudinal direction and an H-steel beam of which flange outer face has stripe-like protrusions in a direction being perpendicular to the longitudinal direction are alternately connected,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam have a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2,

wherein the sectional shape means a shape of the H-steel beam excepting cross-sections of the stripe-like protrusions, and

wherein the lining plate is used with the surface coating applied on at least one flange outer face provided with the stripe-like protrusions.

4. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in the longitudinal direction and an H-steel beam of which flange outer face has no protrusion are alternately connected,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam have a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2,

wherein the sectional shape means a shape of the H-steel beam excepting cross-sections of the stripe-like protrusions, and

wherein the lining plate is used with the surface coating applied on at least one flange outer face provided with the stripe-like protrusions.

5. A lining plate formed by connecting a plurality of H-steel beams of which sectional shapes are the same and of which heights of flange outer faces and longitudinal directions are aligned,

wherein an H-steel beam of which flange outer face has stripe-like protrusions in a direction being perpendicular to the longitudinal direction and an H-steel beam of which flange outer face has no protrusions are alternately connected,

wherein the stripe-like protrusions at the flange outer face of each H-steel beam have a protrusion height being not less than 1.0 mm and a ratio between the protrusion height and a protrusion interval being not less than 0.07 and not more than 0.2,

wherein the sectional shape means a shape of the H-steel beam excepting cross-sections of the stripe-like protrusions, and

wherein the lining plate is used with the surface coating applied on at least one flange outer face provided with the stripe-like protrusions.