

Description

DECK PLATE AND CONCRETE STRUCTURE

Technical Field

[0001] The present invention relates to a deck plate and a concrete structure for use in constructing a floor structure or a ceiling structure of buildings.

Background Art

[0002] Deck plates are widely used as formworks for constructing floor structures and ceiling structures of buildings. A deck plate is installed so that the deck plate spans between beams, and both end portions of the deck plate are fixed to the upper surfaces of the beams. After the deck plate is fixed, a floor structure or a ceiling structure is constructed by pouring concrete on the deck plate and solidifying the concrete.

[0003] The deck plate is formed by roll-forming a single piece of thin plate material (metal plate). Ribs for enhancing rigidity are formed on the deck plate (see, for example, Patent Literature 1). Since the upper surface of the deck plate is flat, there is no resistance on the boundary surface (contact surface) with respect to the lower surface of the floor structure or the ceiling structure. Therefore, the deck plate is used as a formwork material having rigidity capable of bearing the load until the concrete solidifies. It is often the case that, after the concrete solidifies, the deck plate cannot be removed and often is left therein.

[0004] On the other hand, there is disclosed a deck plate capable of preventing cracking of concrete by forming a large number of uneven grooves on the upper surface of the deck plate so that adjacent positions thereof are

displaced from each other, and thereby improving adhesion with respect to the poured concrete (see, for example, Patent Literature 2).

Further, there is disclosed a deck plate in which a plurality of embossments are formed on a flat portion of the deck plate so that adjacent positions thereof are displaced from each other (see, for example, Patent Literatures 3 and 4).

Document List

Patent Literatures

[0005]

Patent Literature 1: Japanese Patent Application Publication No. H07-238621

Patent Literature 2: Japanese Utility Model Application Publication No. H01-122111

Patent Literature 3: Japanese Patent Application Publication No. H07-269003

Patent Literature 4: Japanese Patent Application Publication No. H08-100476

Summary of Invention

Technical Problem

[0006] By the way, since a horizontal load like a seismic load acts on the floor structure or the ceiling structure, a structure that can withstand the load is required, but the deck plate does not have a resistance on the boundary with concrete, and therefore, even when the deck plate is left, the deck plate has almost no function to resist against the horizontal load, and the friction force between the boundary surfaces of the deck plate and the concrete is not large. Moreover, since the deck plate is produced by a roll forming machine, oil of rollers adheres to the surface, and since the deck plate is used outside, rainwater, etc. adheres, and consequently the friction coefficient that the surface

should originally have is often decreased. Thus, the friction force on the boundary between the deck plate and the concrete may be insufficient. In Patent Literature 2, the uneven grooves are formed on the flat portion of the deck plate, and, in Patent Literatures 3 and 4, embossments are formed on the flat portion of the deck plate, but a technique of compensating for the decrease in the friction coefficient is not considered in either of the cases.

Further, in the deck plate, wrinkles are created on the flat portion due to the stress difference between the ribs which have undergone large bending processing and the flat portion for which the processing is not performed, and therefore it is difficult to form the deck plate of high quality.

Furthermore, since the flat portion between the ribs has an insufficient rigidity compared with the periphery of the ribs, there is a concern that the flat portion is deformed by the weight of the poured concrete and the workers walking during construction.

In addition, since the deck plate is formed from a metal plate, if there are a lot of flat regions, the deck plate is slippery, and there is a further concern that works may be hindered by the reflection of the light and the working efficiency may be lowered.

[0007] Hence, the present invention has been made in consideration of the above problems, and an object of the invention is to provide a deck plate capable of compensating for the decreased friction coefficient, enhancing the quality and rigidity, and reducing the lowering of the working efficiency.

Solution to Problem

[0008] In order to solve the above problems, the present invention is a deck plate formed from a metal plate, and characterized by comprising: ribs extending from one end to another end along a spanning direction on one

surface, at an interval between the ribs; end closed portions where both end portions of the ribs are crushed in a direction at a right angle to the one surface; and an uneven part formed on a flat portion between the adjacent ribs.

[0009] It is preferable that the uneven part extend in a direction intersecting an extending direction of the ribs.

[0010] It is preferable that the uneven part is formed in plurality at intervals along the extending direction of the ribs.

[0011] It is preferable that the uneven parts formed in a region interposed between the adjacent ribs and the uneven parts formed in a region adjacent to the region is arranged in a staggered pattern.

[0012] It is preferable that a length L of the uneven part is $L = 43 \text{ mm to } 260 \text{ mm}$.

[0013] It is preferable that the uneven parts formed in one of the adjacent regions are displaced in the extending direction of the ribs by a length equal to half of the interval between the adjacent uneven parts formed in the other region.

[0014] It is preferable that an interval G between the adjacent uneven parts is $G = 50 \text{ mm to } 100 \text{ mm}$.

[0015] It is preferable that a friction coefficient μ of a single one of the uneven parts is $\mu \geq 0.05$.

[0016] It is preferable that a coefficient of slip resistance C. S. R of a surface of the flat portion is $0.4 \leq \text{C. S. R} \leq 0.9$.

[0017] It is preferable that a length L of a single one of the uneven part is $L = mA/nt$ where A is a cross-sectional area of the uneven part as viewed from a short side, m is the number of the uneven parts arranged along a short-side direction of the uneven part, n is the number of the uneven parts arranged

along a longitudinal direction of the uneven part, and t is an unevenness amount of the uneven part from a surface of the flat portion.

[0018] It is preferable that a width B of the uneven part is $B = 10 \text{ mm}$ to 30 mm .

[0019] It is preferable that an unevenness amount t of the uneven part from a surface of the flat portion is $t = 1.0 \text{ mm}$ to 3.5 mm .

[0020] The present invention is a concrete structure characterized by comprising: the deck plate; and a concrete layer formed integrally with the deck plate by pouring and solidifying of the concrete layer on an upper surface of the deck plate.

Effects of Invention

[0021] According to the present invention, it is possible to compensate for the decreased friction coefficient, enhance the quality and rigidity, and reduce the lowering of the working efficiency.

Brief Description of Drawings

[0022]

[Fig. 1] A view showing a deck plate installed between beams.

[Fig. 2] A perspective view of the deck plate.

[Fig. 3] A plan view of the deck plate.

[Fig. 4] A front view of the deck plate.

[Fig. 5] A partial cross-sectional view of a floor structure (or a ceiling structure).

[Fig. 6] A view for explaining a theory for finding the friction coefficient of a ridge part.

[Fig. 7] A view for explaining a specific method for finding the friction coefficient of the ridge part.

Description of Embodiments

[0023] Hereinafter, a preferred embodiment of the present invention will be described with reference to the drawings. It should be note that the following embodiment is merely an example, and various embodiments can be made within the scope of the present invention.

[0024] Fig. 1 is a view showing a deck plate installed between beams. Fig. 2 is a perspective view of the deck plate. Fig. 3 is a plan view of the deck plate. Fig. 4 is a front view of the deck plate. Fig. 5 is a partial cross-sectional view of a floor structure (or a ceiling structure).

As shown in Fig. 1 to Fig. 4, the deck plate 10 is a formwork for concrete which is poured when constructing a floor structure or a ceiling structure of a building structure. As shown in Fig. 5, the deck plate 10 is for enhancing the rigidity of a floor structure (or ceiling structure) 100 by being integrated with the concrete after the concrete solidifies. That is to say, as shown in Fig. 5, in the present embodiment, the floor structure (or ceiling structure) 100 includes the deck plate 10, and a concrete layer 30 formed integrally with the deck plate 10 by pouring and solidifying the concrete layer 30 on an upper surface of the deck plate 10.

[0025] <Structure of Deck Plate>

As shown in Fig. 1, the deck plate 10 spans between opposing beams 20. One end of the deck plate 10 is placed on one of the beams 20 and fixed to the beam 20 by welding or the like, and the other end is placed on the other beam 20 and fixed to the beam 20 by welding or the like. Specifically, each of the beams 20 is made of, for example, H-shaped steel, and each end portion of the deck plate 10 is placed and fixed on a flange portion of the H-shaped steel that constitutes each beam 20.

[0026] As shown in Fig. 2 to Fig. 4, the deck plate 10 is formed from a steel plate (metal plate) in the form of a thin plate on which plating such as galvanizing has been performed. The deck plate 10 is produced by roll-forming one piece of flat steel plate with a roll forming machine. For the deck plate 10, bending processing is performed at a plurality of positions by the roll forming machine.

The deck plate 10 includes ribs 1, flat portions 2, end closed portions 3, and ridge parts 4 (uneven parts).

[0027] The ribs 1 are formed by bending the steel plate. Each rib 1 is formed such that the steel plate is bent to one surface side of the steel plate at a predetermined interval and bent a plurality of times on the way to the first bending position, and thereafter bent, at the first bending position, to be along a surface direction of the steel plate. The ribs 1 are joined together by joining folded parts of the steel plates by caulking or the like. This makes the ribs 1 not to open. A plurality of the ribs 1 are formed along a width direction (short-side direction) of the deck plate 10 at predetermined intervals. The ribs 1 are formed to extend along a length direction (longitudinal direction) of the deck plate 10. That is to say, the ribs 1 are continuously formed from one end to the other end along the spanning direction to the beams 20.

[0028] The flat portion 2 is a portion of the deck plate 10, where bending processing has not been performed. That is to say, the flat portion 2 is a portion interposed between adjacent ribs 1. In the deck plate 10, each of the flat portions 2 is formed on the same plane.

[0029] The end closed portions 3 are formed at both end portions in the length direction (longitudinal direction) of the deck plate 10. The end closed portions 3 are formed by crushing both end portions of the ribs 1, in a direction at a right angle to the surface of the deck plate 10. Thus, in the ribs 1, the end

closed portions 3 at both ends are formed to have a crushed cross section, and other portion interposed between the end closed portions 3 is formed to have a substantially triangular cross section. As a result, since both end portions of the ribs 1 have a lower height than the other portion, the both end portions can be placed on the upper surface of the flange portions of the beams 20. Each end closed portion 3 is formed so that a length thereof along the extending direction of the rib 1 is longer than a length to be placed on the upper surface of the flange portion of the beam 20.

[0030] The ridge parts 4 are formed in each of the flat portions 2. The ridge parts 4 are formed by, for example, embossing so that the ridge parts 4 protrude to the opposite side to the ribs 1 on the deck plate 10. The ridge parts 4 extend in a direction orthogonal to the extending direction of the ribs 1, that is, along the width direction (short-side direction) of the deck plate 10. After pouring and solidifying concrete on the upper surface of the deck plate 10, the ridge parts 4 are engaged with the concrete, and thereby capable of enhancing the resistance against a horizontal load. For example, for the ridge parts 4, it is preferable that a length L be $L = 43 \text{ mm to } 260 \text{ mm}$, a width B be $B = 10 \text{ mm to } 30 \text{ mm}$, and a protruding amount t from the surface of the flat portion 2 be $t = 1.0 \text{ mm to } 3.5 \text{ mm}$. Further, in the case where the ridge parts 4 are formed in a staggered pattern on the deck plate 10, the length L of each ridge part 4 is preferably twice longer than a length Ls of the ridge part 4 when the ridge parts 4 are not formed in a staggered pattern.

A plurality of the ridge parts 4 are formed at predetermined intervals along the extending direction of the ribs 1, that is, along the length direction (longitudinal direction) of the deck plate 10. Here, an interval G between adjacent ridge parts 4 is preferably, for example, $G = 50 \text{ mm to } 100 \text{ mm}$.

[0031] Here, the length and width of the ridge part 4 and the protruding amount from the surface of the flat portion 2 are determined by the following theory.

First, consider the width B of the ridge part 4 and the protruding amount t from the surface of the flat portion 2.

As shown in Fig. 6, in the case where two objects (concrete and deck plate) having unevenness are engaged together, consider a friction coefficient μ when a horizontal load acts on one of the objects (concrete) and then the one object tries to ride over the other object (deck plate). In this case, according to Coulomb-Amonton's laws, if a vertical load to the one object (concrete) is W, a force by which the one object (concrete) is caused to ride over the other object (deck plate) is F and an inclination angle of the protruding part (ridge part) is θ , the friction coefficient μ can be obtained by the following formula (1):

$$\mu = \tan \theta \dots (1).$$

[0032] Next, as shown in Fig. 7, consider a case where one ridge part 4 on the deck plate 10 is viewed from the short side (X direction). Here, as an approximate value, a straight line is drawn from each of edge portions C, D of the ridge part 4 to a position E at the center on the short side (the center of the width), and suppose that the inclination angle of the straight line with respect to the flat portion 2 is θ and consider the friction coefficient μ of the ridge part 4. In this case, the relationship of the following formula (2) is established:

$$1/2 \times B = t / \tan \theta \dots (2)$$

where B is the width (length on the short side) of the ridge part 4, and t is the protruding amount (depth) of the ridge part 4 from the surface of the flat portion 2.

Here, the formula (1) is substituted into the formula (2), and then the friction coefficient μ can be obtained by the following formula (3):

$$\mu = 2t/B \dots (3).$$

[0033] That is to say, if oil of the rollers of the roll forming machine adheres to the surface of the deck plate 10 or rainwater, etc. adheres during construction, the friction coefficient (0.6 to 0.75) that the contact surfaces of the concrete and the deck plate 10 should originally have is decreased, but the decrease can be compensated by the ridge part 4 having the friction coefficient μ calculated by the formula (3). Additionally, in order to adjust the magnitude of the friction coefficient μ , the ratio between the width B and the protruding amount t of the ridge part 4 can be adjusted. Specifically, the friction coefficient μ can be increased by increasing the protruding amount t and decreasing the width B.

For example, in the case where the ridge part 4 is formed with the protruding amount t = 1.0 mm and the width B = 10 mm, the friction coefficient μ of the ridge part 4 is $\mu = 0.2$. In the case where the ridge part 4 is formed with the protruding amount t = 1.0 mm and the width B = 30 mm, the friction coefficient μ of the ridge part 4 is $\mu \approx 0.067$. Moreover, in the case where the ridge part 4 is formed with the protruding amount t = 3.5 mm and the width B = 10 mm, the friction coefficient μ of the ridge part 4 is $\mu = 0.7$. Further, in the case where the ridge part 4 is formed with the protruding amount t = 3.5 mm and the width B = 30 mm, the friction coefficient μ of the ridge part 4 is $\mu \approx 0.233$.

It is preferable that the friction coefficient μ be within the range of $0.05 \leq \mu \leq 1.65$.

[0034] Here, the reason why the friction coefficient μ is $0.05 \leq \mu \leq 1.65$ is that, when the friction coefficient μ is within this range, a coefficient of slip resistance C. S. R falls within the range of 0.4 to 0.9 in the "testing with the slip tester OY-PSM of Tokyo Institute of Technology (specified in JIS A 1454 "Test Methods - Resilient Floorcoverings")", and the surface of the deck plate 10 is not slippery for the workers, and excels in safety.

[0035] After spraying water and dust on the surfaces of four types of deck plates, the above-mentioned slip tests were performed, and Table 1 shows the measured results of the coefficient of slip resistance C. S. R. A test sample 1 is a flat plate material having no ridge parts formed thereon, and the plate thickness is 1.2 mm. In a test sample 2, the length of the ridge part is 120 mm, the width is 15 mm, the protruding amount is 1.5 mm, the interval between adjacent ridge parts in the longitudinal direction is 80 mm, and the plate thickness is 0.8 mm. In a test sample 3, the length of the ridge part is 120 mm, the width is 15 mm, the protruding amount is 3 mm, the interval between adjacent ridge parts in the longitudinal direction is 50 mm, and the plate thickness is 1.6 mm. In a test sample 4, the length of the ridge part is 120 mm, the width is 15 mm, the protruding amount is 3 mm, the interval between adjacent ridge parts in the longitudinal direction is 50 mm, and the plate thickness is 1.2 mm. For each of the test samples 1 to 4, the slip tests were performed along the longitudinal direction and the short-side direction of the deck plate, and the coefficient of slip resistance C. S. R was measured for each case.

[0036] [Table 1]

	Coefficient of slip resistance C.S.R	
	Longitudinal direction	Short-side direction
Test sample 1	0.32	0.34
Test sample 2	0.42	0.4
Test sample 3	0.4	0.43
Test sample 4	0.44	0.4

[0037] Here, for example, in the case where the friction coefficient μ between the contact surfaces of the concrete and the deck plate is 0.6 and the friction coefficient μ is decreased by 0.2 due to adhesion of rainwater and oil, it is

possible to increase the friction coefficient μ by 0.2 by forming the ridge parts 4 having the protruding amount $t = 1.5$ mm and the width $B = 15$ mm like the deck plate 10 of the test sample 2 of Table 1, and thus the friction coefficient μ between the contact surfaces of the concrete and the deck plate 10 is $\mu = 0.6$ (the original friction coefficient between the original contact surfaces) - 0.2 (the decrease in the friction coefficient due to rainwater, etc.) + 0.2 (the increase in the friction coefficient by the formation of the ridge parts) = 0.6, and the decrease in the friction coefficient due to rainwater, etc. can be compensated by the formation of the ridge parts 4. Moreover, since the coefficient of slip resistance C. S. R is also between 0.4 and 0.42, it is possible to make the coefficient of slip resistance C. S. R within the range of 0.4 to 0.9.

[0038] Additionally, in the case where the friction coefficient μ between the contact surfaces of the concrete and the deck plate is 0.6 and the friction coefficient μ is decreased by 0.4 due to adhesion of rainwater and oil, it is possible to increase the friction coefficient μ by 0.4 by forming the ridge parts 4 having the protruding amount $t = 3$ mm and the width $B = 15$ mm like the deck plates 10 of the test samples 3, 4 of Table 1, and thus the friction coefficient μ between the contact surfaces of the concrete and the deck plate 10 is $\mu = 0.6$ (the original friction coefficient between the contact surfaces) - 0.4 (the decrease in the friction coefficient due to rainwater, etc.) + 0.4 (the increase in the friction coefficient by the formation of the ridge parts) = 0.6, and the decrease in the friction coefficient due to rainwater, etc. can be compensated by the formation of the ridge parts 4. Further, since the coefficient of slip resistance C. S. R is also between 0.4 and 0.44, it is possible to make the coefficient of slip resistance C. S. R within the range of 0.4 to 0.9.

[0039] Next, consider the length L of the ridge parts 4. It is possible to consider the length of the ridge parts 4 by viewing a single ridge part 4 on the

deck plate 10 from the longitudinal side (Y direction). Since an element that resists the horizontal load can be regarded as the cross-sectional projected area of the ridge part 4, it is necessary to approximate the projected cross-sectional projected areas of the X direction and the Y direction.

In this case, the length L in the longitudinal direction of the single ridge part 4 can be obtained by the following formula (4):

$$L = mA/nt \dots (4)$$

where A is the cross-sectional projected area of the ridge part 4 as viewed from the short side, m is the number (the number of rows) of the ridge parts 4 arranged along the short-side direction of the ridge part 4, n is the number (the number of columns) of the ridge parts 4 arranged along the longitudinal direction of the ridge part 4, and t is the protruding amount of the ridge part 4 from the surface of the flat portion 2.

For example, in the case where the ridge part 4 is formed with the protruding amount $t = 1.0 \text{ mm}$ and the width $B = 10 \text{ mm}$, the cross-sectional projected area A of the ridge part 4 is $A \approx 10 \text{ mm}^2$, and if the number (the number of rows) of the ridge parts 4 arranged in the short-side direction of the ridge part 4 is $m = 26$ and the number (the number of columns) of the ridge parts 4 arranged in the longitudinal direction of the ridge part 4 is $n = 3$, then the length L of the single ridge part 4 is $L \approx 86.7 \text{ mm}$.

By considering as described above, the length L, the width B and the protruding amount t of the ridge part 4 can be designed according to the friction coefficient μ required for the deck plate 10.

[0040] The ridge parts 4 formed on each of the flat portions 2 are arranged so that the ridge parts 4 formed on one flat portion 2 and the ridge parts 4 formed on the flat portion 2 adjacent to the one flat portion 2 are arranged in a staggered pattern in a plan view of the deck plate 10. More specifically, of the

adjacent flat portions 2, the ridge parts 4 formed on one of the flat portions 2 are formed at positions displaced in the extending direction of the rib 1 by half of the length of the interval G between the adjacent ridge parts 4 formed on the other flat portion 2.

[0041] As described above, since the ridge parts 4 are formed on the flat portions 2 of the deck plate 10, even when the friction coefficient that the surface should originally have is decreased due to adhesion of oil of the rollers of the roll forming machine, or adhesion of rainwater, etc., to the surface of the deck plate 10, it is possible to increase the friction coefficient of the deck plate 10, in the amount of the decrease of the friction coefficient, by the friction coefficient of the ridge parts 4. Consequently, the friction force between the concrete and the deck plate 10 can be increased, and the concrete and the deck plate 10 can be more integrated as a floor structure or a ceiling structure, thereby enhancing the function of resisting the horizontal load acting due to earthquakes, etc. In particular, by forming the ridge parts 4 having the above-described configuration on the flat portions 3, it is possible to effectively increase the friction force between the concrete and the deck plate 10 while minimizing the increase in man-hours and weight.

[0042] In addition, by forming the ridge parts 4 as described above, the coefficient of slip resistance C. S. R can be made within the range of 0.4 to 0.9 in the "testing with the slip tester OY-PSM of Tokyo Institute of Technology (specified in JIS A 1454 "Test Methods - Resilient Floorcoverings")", and not only the slip resistant feature during work is improved, but also the slip resistance can significantly improve the friction coefficient of the deck plate 10. Thus, the improvement of the friction coefficient can compensate for the decrease in the friction coefficient due to oil and rainwater, increase the friction force between the concrete and the deck plate 10, and more integrate the

concrete and the deck plate 10 as a floor structure or a ceiling structure, thereby enhancing the function of resisting the horizontal load acting due to earthquakes, etc.

[0043] Moreover, by forming the ridge parts 4, it is possible to reduce occurrence of wrinkles due to the stress difference between the periphery of the largely bent rib 1 and the flat portion 2 which is not bent, and it is possible to improve the quality of the deck plate 10 to be manufactured. Further, since the occurrence of wrinkles of the deck plate 10 can be reduced by forming the ridge parts 4, the roll forming process can be simplified compared to before.

In addition, by forming the ridge parts 4, the rigidity of the flat portions 2 between the ribs 1 can be increased, and deformation of the flat portions 2 due to the weight of the poured concrete and the workers walking during construction can be reduced.

[0044] Furthermore, by forming the ridge parts 4, the ridge parts 4 protruding from the flat portions 2 function as an anti-slip member that prevents the workers walking on the deck plate 10 from slipping, thereby reducing the lowering of the working efficiency. In particular, by making the coefficient of slip resistance C. S. R of the surface of the flat portions 3 of the deck plate 10 within the range of 0.4 to 0.9 which is regarded safe in the slip rating scale, the deck plate 10 has an excellent slip resistant feature when the deck plate 10 is considered as a working floor.

In addition, by forming the ridge parts 4, since the ridge parts 4 protruding from the flat portions 2 irregularly reflect light, the anti-glare effect for the workers can be enhanced. Moreover, since the reflection of sunlight in summer can be reduced, it is possible to decrease a burden on the workers and reduce the lowering of the working efficiency.

[0045] Further, by forming the ridge parts 4 so that the ridge parts 4 are arranged in a staggered pattern, the ridge parts 4 can be formed over the entire surface of the flat portions 2, and the above-mentioned effect can be further enhanced. In particular, by displacing the ridge parts 4 which are adjacent to each other in the width direction of the deck plate 10 by a length equal to half of the interval between the adjacent ridge parts 4 in the length direction of the deck plate 10, the distance between the surrounding ridge parts 4 can be maintained substantially equal, and the above-mentioned effect can be further enhanced.

Furthermore, as shown in the above formula (4), in order to resist horizontal loads from all directions, the ridge parts 4 are designed so that the cross-sectional projected areas of the ridge part 4 are equal in the X direction and in the Y direction of the deck plate 10, but the arrangement of the ridge parts 4 in a staggered pattern can reduce overlapping of the ridge parts 4 when viewed from the X direction. Accordingly, the cross-sectional projected area can be increased by a smaller number of the ridge parts 4, and the number of the ridge parts 4 to be formed on the deck plate 10 can be reduced, and therefore it is possible to reduce the amount of metal plate required for the production of the deck plate 10 and achieve a weight reduction.

In addition, the ridge parts 4 can be made suitable for further enhancement of the above-mentioned effect by forming the ridge parts 4 so that the interval G between adjacent ridge parts 4 is within the range of $G = 50 \text{ mm}$ to 100 mm , the length L of the ridge part 4 is within the range of $L = 43 \text{ mm}$ to 260 mm , the width B of the ridge part 4 is within the range of $B = 10 \text{ mm}$ to 30 mm , and the protruding amount t of the ridge part 4 from the flat portion 2 is within the range of $t = 1.0 \text{ mm}$ to 3.5 mm .

[0046] Moreover, since the deck plate 10 is formed from a metal plate, it is unnecessary to support the deck plate 10 from below, and the under space can be effectively used. Further, since the deck plate 10 has the end closed portions 3 at both end portions, the deck plate 10 can be installed on the upper surfaces of the beams 20. It is also unnecessary to provide a member for preventing leakage of concrete between the deck plate 10 and the formwork of the beams 20. In the case of RC building, since a part of the end closed portions 3 can bite into the beams 20, the effect of preventing dropping of the deck plate 10 can be enhanced.

Furthermore, when concrete is poured for the deck plate 10, the concrete solidifies in a state in which the ridge parts 4 bite into the concrete, and therefore the ridge parts 4 function as the engaged portions with the concrete and can enhance the rigidity of a floor structure or a ceiling structure.

In addition, since the ridge parts 4 are present in an extending manner in the longitudinal direction of the deck plate 10 and a plurality of the ridge parts 4 are formed along the short-side direction of the deck plate 10, the concrete is engaged with the ridge parts 4 in the length direction and the width direction of the deck plate 10, thereby enhancing the rigidity of the floor structure or the ceiling structure.

[0047] <Others>

It should be noted that the present invention is not limited to the above embodiment. For example, the ridge parts 4 as the uneven parts are not limited to protrude on the surface on the opposite side to the ribs 1, and may be formed to protrude in the same direction as the ribs 1. In this case, when seen from the surface on the opposite side to the ribs 1, grooves are formed in the flat portions 2. The formation of the ridge parts 4 is not limited to embossing, and other processing method may be used. Moreover, since the uneven parts are

not limited to the ridge parts 4 as long as unevenness is formed on the flat portions 2, a plurality of circular protruding or recessed parts may be formed. In this case, the unevenness may be formed by performing shot blasting after roll forming, or by embossing during roll forming. It is also possible to form both of these protruding or recessed parts and the ridge parts 4. Further, stripe-like scratches can be formed on the flat portions 2 to increase the surface roughness of the deck plate 10, and thereby reflecting light more irregularly and enhancing the anti-glare effect.

In the above embodiment, after the poured concrete has solidified, the deck plate is left and used as a reinforcing material for the floor structure or the ceiling structure, but it is not always necessary to leave the deck plate, and the deck plate may be removed after the concrete has solidified. That is to say, the deck plate may be used just as a mere formwork.

List of Reference Signs

[0048]

1 Rib

2 Flat portion

3 End closed portion

4 Ridge part (uneven part)

10 Deck plate

20 Beam

30 Concrete layer

100 Floor structure (ceiling structure)

Claims

1. A method of designing a deck plate formed from a metal plate, characterized by comprising:

the deck plate includes ribs extending from one end to another end on one surface, at an interval between the ribs,

end closed portions where both end portions of the ribs are crushed in a direction at a right angle to the one surface, and

an uneven part formed on a flat portion between adjacent ribs, wherein

calculating a friction coefficient μ which is compensated by the formation of the uneven part by a formula of $\mu = 2t/B$

where t is an unevenness amount of the uneven part from a surface of the flat portion and B is the width of the uneven part.

2. The method of designing a deck plate according to claim 1, characterized in that

calculating a length L of the uneven part by a formula of $L = mA/nt$

where A is a cross-sectional area of the uneven part as viewed from a short-side, m is the number of uneven parts arranged along a short-side direction of the uneven part, n is the number of uneven parts arranged along a longitudinal direction of the uneven part, and t is an unevenness amount of the uneven part from a surface of the flat portion.

3. The method of designing a deck plate according to claim 1 or 2, characterized in that the uneven part extends in a direction intersecting an

extending direction of the ribs.

4. The method of designing a deck plate according to any one of claims 1 to 3, characterized in that the uneven part is formed in plurality at intervals along an extending direction of the ribs.

5. The method of designing a deck plate according to claim 4, characterized in that uneven parts formed in a region interposed between the adjacent ribs and uneven parts formed in a region adjacent to the region are arranged in a staggered pattern.

6. The method of designing a deck plate according to claim 5, characterized in that a length L of the uneven parts is $L = 43 \text{ mm}$ to 260 mm .

7. The method of designing a deck plate according to claim 5 or 6, characterized in that uneven parts formed in one of the adjacent regions are displaced in the extending direction of the ribs by a length equal to half of the interval between the adjacent uneven parts formed in the other region.

8. The method of designing a deck plate according to any one of claims 5 to 7, characterized in that an interval G between the adjacent uneven parts is $G = 50 \text{ mm}$ to 100 mm .

9. The method of designing a deck plate according to any one of claims 1 to 8,

characterized in that a friction coefficient μ of a single one of uneven parts is $1.65 \geq \mu \geq 0.05$.

10. The method of designing a deck plate according to any one of claims 1 to 9, characterized in that a coefficient of slip resistance C. S. R of the surface of the flat portion is $0.4 \leq \text{C. S. R} \leq 0.9$.

11. The method of designing a deck plate according to any one of claims 1 to 10, characterized in that the width B of the uneven part is $B = 10 \text{ mm to } 30 \text{ mm}$.

12. The method of designing a deck plate according to any one of claims 1 to 11, characterized in that the unevenness amount t of the uneven part from a surface of the flat portion is $t = 1.0 \text{ mm to } 3.5 \text{ mm}$.