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(54) **CRUSHED BALLAST WITH IMPROVED DURABILITY AND RESISTANCE TO FRAGMENTATION AND METHOD FOR PRODUCING SAME**

(57) The invention is applicable to rail infrastructures consisting of aggregates with a particle size distribution selected from between 25 mm and 100 mm, individually coated with a first solidified polymer layer, said first pol-

ymmer layer (2) integrating a granular elastomer material (3) with granules having a size smaller than 4 mm, preferably smaller than 2 mm, and being optionally provided with a second coating polymer layer (4).

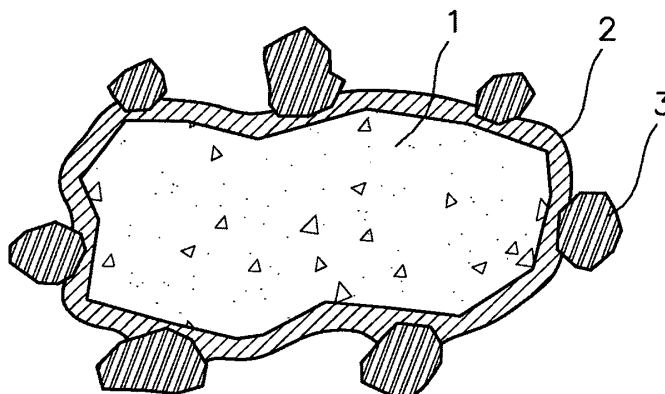


Fig. 1

Description

Field of the Art

[0001] The present invention relates to a ballast with improved characteristics in terms of durability and resistance to fragmentation with respect to other rail track bed materials.

[0002] The invention also relates to the method for producing said improved ballast.

State of the Art

[0003] The use of ballast as a rail track bed is widely known, but it has some drawbacks.

[0004] First, the aggregate suitable for this use must meet required characteristics which are more exacting the higher the speed of the trains is or the higher the load that said trains transport, the sharpness of the edges of the aggregate being one of the essential characteristics, because said sharpness is what provides stability and prevents the ballast from flowing and causing track deformations with train vibrations. The difficulty in finding aggregates that meet all the characteristics required by sets of technical specifications makes them more expensive and leads to the need to move them over great distances, making them even more expensive.

[0005] Another problem lies in the fact that vibrations to which the ballast is subjected due to the passage of trains cause the aggregates to become rounder over the years and to lose qualities, leading to the need of costly maintenance tasks or to the reduction in track performances.

[0006] Furthermore, vehicles circulating at high speed often cause the aggregates to be lifted off the ballast and pelted against the undersides of the train, being able to cause malfunctions.

[0007] Some products and methods for mitigating these drawbacks are known, such as for example, the invention described in patent document WO2011131621A1, where it anticipates the use of a ballast layer impregnated with a component which is subsequently sprayed with a second component producing a reaction, generating a protective polyurethane layer binding the ballast and prolonging its service life, but at the expense of complicating its maintenance or replacement, in addition to achieving an excessively monolithic result, greatly reducing the elasticity of the assembly. It must also be pointed out that the application of said chemical components *in-situ* can cause environmental contamination problems.

[0008] Another known alternative is the use of a polymer as an individual coating for each aggregate, as described in the document entitled "Characterization of polyurethane coated railroad ballast behavior", presented in the 90th Annual Meeting of the Transportation Research Board, Washington, DC in January 2011. This solution prevents the contamination problems of the *in-*

situ application of the ballast polymer coating, but the faces of the stones remain flat, without any relief that improves binding.

[0009] Finally, the use of granular particles of an elastomer material is also known, such as for example, through patent document DE102007053146A1, describing the mixture of small particles of an elastomer material between the ballast to provide it with certain elasticity and to improve the adherence between the aggregates. The problem with this embodiment is that vibrations tend to stratify the components of the ballast, and said granules of the elastomer material can come out of the ballast very easily and contaminate the track surroundings.

Brief Description of the Invention

[0010] The proposed invention relates to a crushed ballast with improved durability and resistance to fragmentation for rail infrastructures, consisting of aggregates with a particle size distribution selected from between 25 mm and 100 mm, individually coated with a first solidified polymer layer which integrates a granular elastomer material with granules having a size smaller than 4 mm, preferably having a size smaller than 2 mm.

[0011] These granules of the elastomer material are fixed on the surface of the aggregates by means of the solidification of the polymer material and allow increasing in a remarkable manner the roughness of the aggregate as they confer protuberances to said aggregate. Said protuberances provide an improved binding of the aggregates with one another as a result of their increased roughness, due to the simple geometric interference of said protuberances and to the higher coefficient of friction of these materials compared to the aggregate, whereby the total resistance and durability of the ballast is increased, in addition to its overall stability against vibrations.

[0012] Furthermore, by arranging elastomer granules between the aggregates, the vibrations can be absorbed by these granules, without causing the mentioned aggregates to wear out at all, such that the service life of the ballast is prolonged along with its elasticity, making it unnecessary to arrange elastomer parts between the ties and the ballast or between the tracks and the ties. A reduction in the noise level produced by the passage of trains as well as a reduction in the ballast-flying phenomenon as the train passes are also achieved. Furthermore, an aggregate treated accidentally pelted against the undersides of the train would cause less damage as it is coated with an elastomer material.

[0013] Optionally, it is proposed to arrange a second polymer layer over the aggregate provided with the elastomer material adhered with the first polymer layer, said second polymer layer providing a protective coating for protecting the elastomer material, and an increased fixing.

[0014] This arrangement allows using aggregates which, before receiving the proposed coating, do not

have the characteristics required for use thereof as a rail ballast, either because their edges are not sharp enough, or because of another reason. Old and worn-out ballasts, or aggregates discarded from a quarry, or recycled construction materials, or quarry ballasts that do not meet the strict requirements established by the standards for use thereof as a rail track ballast, for example by standard UNE EN 13450 2003, can therefore be used, for example. This and other similar standards greatly limit the type of aggregates that can be used, but the proposed coating increases the properties of the initial aggregate, whereby an aggregate which initially did not comply with said standard or another standard can be treated such that, after treatment, it indeed complies with said standard and can be used, thereby widening the range of stones which can be used as raw material, being able to use materials that are much more economical and easy to find than conventional aggregate. This also allows having closer supply sources and reducing logistics costs.

[0015] The granular elastomer material can originate from the shredding of recycled material, such as for example, tires, which increases the value of highly polluting waste, and allows giving it a new use, in addition to taking advantage of its properties with a competitive cost.

[0016] Optionally, the polymer material will be a material from the polyurethane family, since its elasticity and resistance properties, as well as its drying process and compatibility with other raw materials that are contemplated make it an optimal material, allowing it to be applied in liquid form and to solidify quickly. Furthermore, once the drying process is completed no pollutants are discharged to the environment.

[0017] The method applied for producing the ballast object of the present invention consists of applying in liquid form the first polymer layer on the aggregate. This method can be carried out, as a non-limiting example, by means of spraying or pouring a polymer product on an aggregate which is spread on and conveyed by a flush grid conveyor belt, or by means of immersing said aggregate into a tank containing said polymer material, and it is then extracted and dispersed so that it can be dried in the crushed form, by means of a vibrating conveyor, for example.

[0018] According to a first non-limiting embodiment, the granular elastomer material can be integrated to the aggregate by means of mixture thereof with the liquid polymer material before the application thereof on the aggregate, or according to a second embodiment, it can be adhered to the aggregate already impregnated with the polymer material but before drying same, for example by means of scattering or pouring the said elastomer material on the aggregate, this aggregate being spread on a flush grid conveyor belt or on a vibrating conveyor. Another possibility of application of the elastomer material is by means of immersion by means of vibration of the aggregate impregnated with the polymer material before drying same in a tank filled with said granular elastomer material.

[0019] In a non-limiting illustrative manner, the polymer material can be of the type which solidifies in contact with moisture, or by evaporation of volatile fractions, or by heat drying, or as it reacts upon applying a second component, in this case the method described up until now would be followed by the application of this second component to trigger solidification.

[0020] Optionally, the inclusion of a second coating polymer layer has been envisaged to assure the complete adhesion of the elastomer material to the aggregate. This second layer can be applied in a way similar to the way the first layer is applied.

[0021] This method of treating aggregate for producing the proposed ballast can be developed by means of a treatment plant having a small enough size so as to allow transport by road or by train to a location close to the location where the ballast must be installed. This possibility again reduces the production costs as transport of the raw materials is reduced.

Brief Description of the Drawings

[0022] The foregoing and other advantages and features will be better understood based on the following detailed description of an embodiment which must be interpreted in an illustrative and non-limiting manner in reference to the attached drawings in which the sizes of the granules of the elastomer material as well as the thickness of the coatings have been expressly emphasized, in which:

Figure 1 shows a section of an aggregate on which a first polymer layer has been applied, a plurality of granules of the elastomer material were adhered to said first polymer layer before the solidification thereof;

Figure 2 shows a section of the same aggregate shown in Figure 1 on which a second polymer layer has been applied to strengthen the fixing of the granules;

Figure 3 shows a section of an aggregate on which a first polymer layer consisting of a mixture of said polymer product with the granules of the elastomer material has been applied, these granules being embedded in said first layer;

Figure 4 shows a section of the same aggregate shown in Figure 3 on which a second polymer layer has been applied to strengthen the fixing of the granules; and

Figure 5 shows a schematic view of the ballast formed by a plurality of the aggregates shown in any one of the first four figures, showing how the geometric interference of the granules of the elastomer material confers greater stability to the assembly.

Detailed Description of an Embodiment

[0023] As can be seen in the attached Figures 1 to 4,

the proposed coating for aggregates 1 allows producing aggregates provided with protuberances. These protuberances, when putting a plurality of these aggregates 1 in a heap to form a ballast base for a railway track, generate a geometric interaction between these protuberances, greatly increasing the stability of the assembly (Figure 5).

[0024] Figure 1 shows an aggregate which has been coated with a first polymer layer 2 on which the granules of the elastomer material 3 have been adhered, Figure 2 shows this same configuration but provided with a second polymer layer 4 strengthening the fixing of the elastomer material 3.

[0025] Figure 3 shows an aggregate which has been coated with a first polymer layer 2 that had been previously mixed with the granules of the elastomer material 3 which have adhered to the aggregate 1 upon applying said first polymer layer 2. Figure 4 shows this same configuration but provided with a second polymer layer 4 strengthening the fixing of the elastomer material 3. These added protuberances thereby allow increasing the stability of the assembly, being able to use as raw material aggregates which would have been dismissed for use thereof as ballast, due to them not having sufficient binding properties and resistance, normally due to them not having sharp enough edges or being too rounded. This insufficiency is compensated for by the added protuberances. Furthermore, it allows greater irregularity of the particle size distribution of the ballast, since the cohesion of the assembly no longer depends on the correct interaction between the edges of the aggregates. This characteristic allows using as raw material for producing the proposed ballast more economical materials that are more easily accessible than the conventional materials, such as for example, old, worn-out recycled ballast, aggregates which have not passed the tests required for use thereof as ballast, construction rubbles, aggregates with a particle size distribution not acceptable for use thereof as conventional ballast, aggregates with rounded edges, etc.

[0026] The mentioned protuberances being of an elastomer material allows, in addition to a high stability, the ballast to have certain elastic properties and to be capable of absorbing vibrations without wearing out. This property results in greater durability, less frequent maintenance, a lower noise level as the train passes, and an increased safety.

[0027] Said elastomer material 3 can be formed completely or partially by rubber originating from shredded tires, an economical material which constitutes increasing the value of waste.

[0028] The production method used in the aggregates 1 shown in Figures 1 and 2 consists of, only by way of non-limiting example, conveying the aggregates 1 scattered on a conveyor belt on which there are arranged application means applying the first polymer layer 2 on the aggregates 1. Said impregnated aggregates 1 are then introduced in a tank containing said granular elas-

tomeric material 3. A plurality of granules is randomly adhered to the outer face of each aggregate 1 because the first polymer layer 2 has still not solidified. Said aggregates 1 are then extracted from said tank, and the first polymer layer 2 is then solidified. Said process will depend on the selected polymer, and may include steps of timed drying, heat drying, or application of a reactive component. This step can optionally be followed by the application and solidification of the second polymer layer 4.

[0029] In the case of the aggregates shown in Figures 3 and 4, the production process can consist of, by way of non-limiting example, a step of mixing the granular elastomer material 3 with the polymer material, for then pouring the mixture on a flush grid conveyor belt conveying the aggregates 1, the first polymer layer 2 and the elastomer material 3, thereby being applied simultaneously to proceed to the solidification thereof and to the optional application of the second polymer layer 4.

Claims

1. A crushed ballast with improved durability and resistance to fragmentation for rail infrastructures consisting of aggregates with a particle size distribution selected from between 25 mm and 100 mm, individually coated with a first solidified polymer layer, **characterized in that** said first polymer layer (2) integrates a granular elastomer material (3).
2. The ballast according to claim 1, **characterized in that** the size of the granules of the elastomer material (3) is smaller than 4 mm.
3. The ballast according to claim 1 or 2, **characterized in that** a second solidified polymer layer (4) is arranged individually coating each aggregate (1) and the corresponding first polymer layer (2) integrating the mentioned granular elastomer material (3).
4. The ballast according to claim 1, 2 or 3, **characterized in that** at least part of the aggregate (1) used is a recycled aggregate.
5. The ballast according to claim 4, **characterized in that** at least part of the aggregate (1) used is an aggregate selected from the following: recycled worn-out ballast, construction rubbles, low-quality quarry ballast, or ballast with a particle size distribution less than 40 mm.
6. The ballast according to any of claim 1 to 5, **characterized in that** at least one part of said granular elastomer material (3) is a recycled material originating from shredded tires.
7. The ballast according to any one of the preceding claims, **characterized in that** at least one of said

polymer layers (2, 4) is made from polyurethane.

8. A method for producing a crushed ballast with improved durability and resistance to fragmentation for rail infrastructures, **characterized in that** it comprises providing an individual coating to aggregates (1) with a particle size distribution selected from between 25 mm and 100 mm with at least a first polymer layer (2) integrating a granular elastomer material (3).

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9. The method according to claim 8, **characterized in that** it comprises in a first step adding to the aggregate (1) said first polymer layer (2) in a solidifiable liquid form and integrating said elastomer material, and a second step which comprises adding a second polymer layer (4) in a solidifiable liquid form onto said first polymer layer (2) and the granular elastomer material (3).

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10. The method according to claim 9, **characterized in that** said second polymer layer (4) is added after the solidification of the first polymer layer (2).

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11. The method according to any one of claims 8 to 10, **characterized in that** said granular elastomer material (3) is mixed with the liquid polymer material forming the first polymer layer (2) before application thereof on the aggregate (1).

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12. The method according to any one of claims 8 to 10, **characterized in that** said granular elastomer material (3) is added to said aggregate (1) after the application of the first liquid polymer layer (2) and before the solidification thereof.

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13. The method according to any one of claims 8 to 12, **characterized in that** an aggregate (1) at least partially recycled is used.

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14. The method according to any one of claims 8 to 13, **characterized in that** at least one part of said granular elastomer material (3) used is a recycled material originating from shredded tires.

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15. The method according to any one of claims 8 to 14, **characterized in that** the granules of the elastomer material (3) used have a size smaller than 4 mm.

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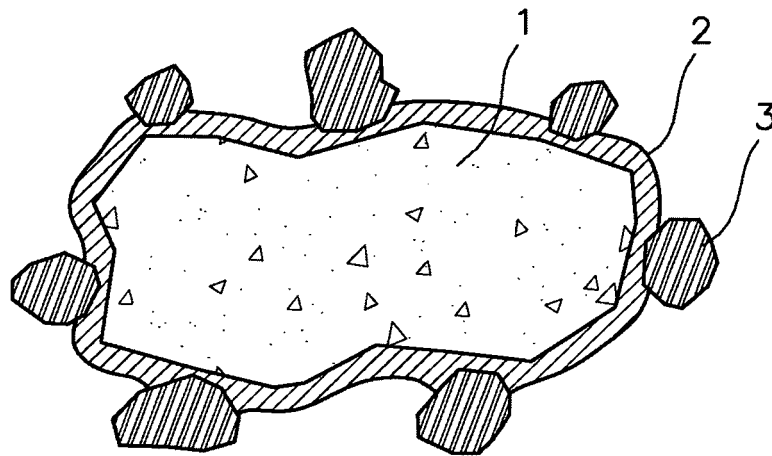


Fig. 1

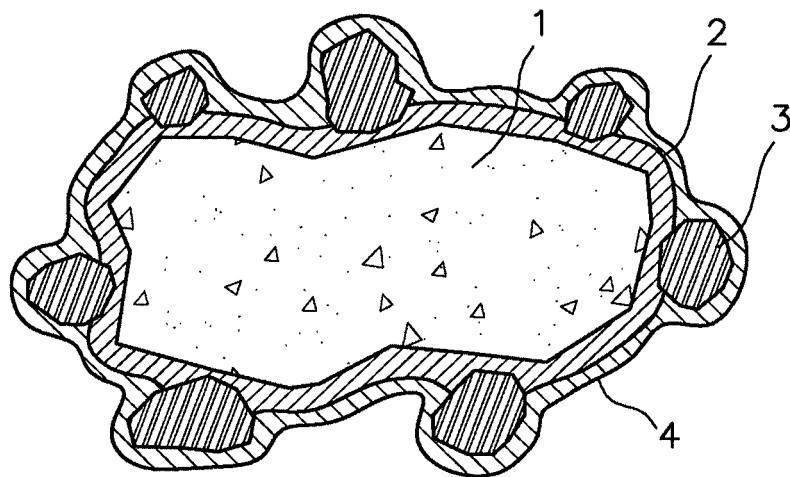


Fig. 2

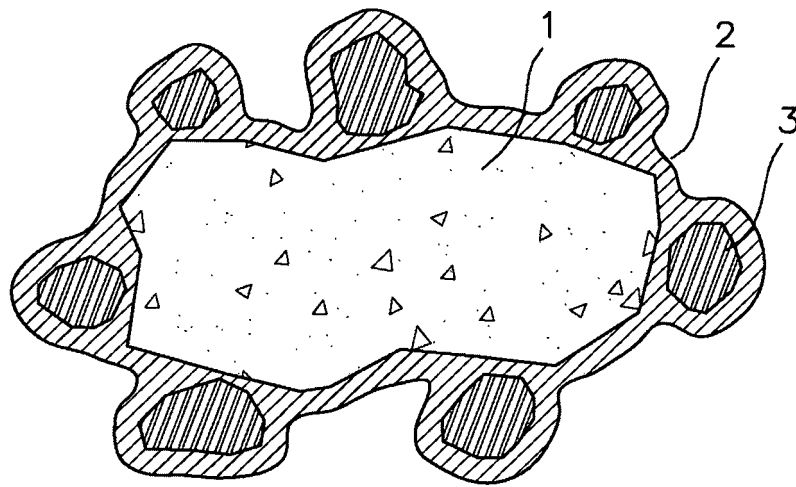


Fig.3

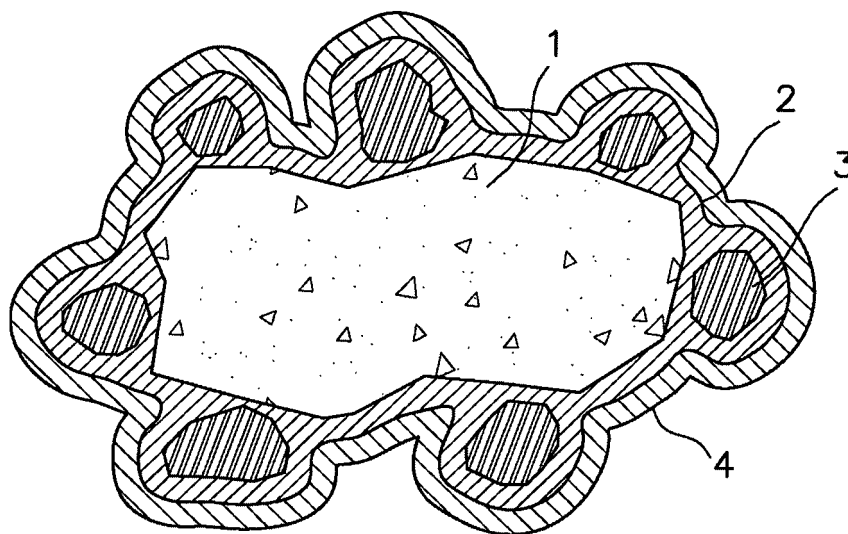


Fig.4

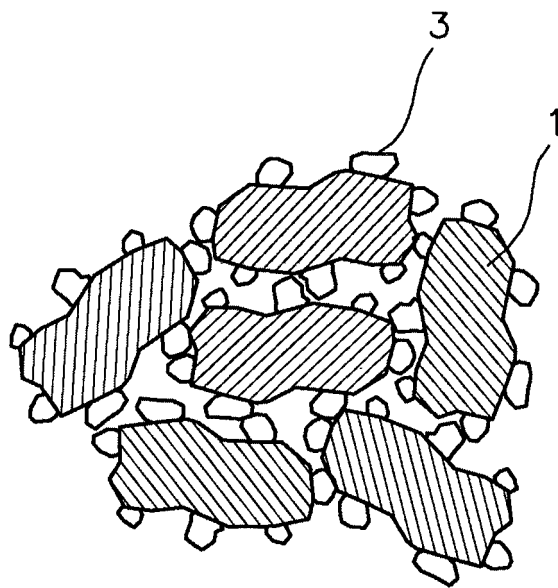


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070798

5	A. CLASSIFICATION OF SUBJECT MATTER		
	E01B1/00 (2006.01)		
	According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED		
	Minimum documentation searched (classification system followed by classification symbols) E01B		
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, INVENES, WPI		
	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	A	WO 2013120059 A1 (ROBINSON GLENN ET AL.) 15/08/2013, description; figures.	1-15
25	A	RU 2447220 C1 (ROSSIJSKIE ZHELEZNYE DOROGI AOOT) 10/04/2012, description; figures & abstract of EPODOC Database (Retrieved from EPOQUE; AN RU-2010153758-A).	1-15
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40	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance. "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure use, exhibition, or other means. "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
50	Date of the actual completion of the international search 27/03/2015		Date of mailing of the international search report (30/03/2015)
55	Name and mailing address of the ISA/ OFICINA ESPAÑOLA DE PATENTES Y MARCAS Paseo de la Castellana, 75 - 28071 Madrid (España) Facsimile No.: 91 349 53 04		Authorized officer I. Rodríguez Goñi Telephone No. 91 3493447

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