Hybrid Ballast for Solar Panel Installation

BACKGROUND OF THE INVENTION

Concrete ballasts are conventional solution to installing solar panels on rooftops so that holes do not have to be drilled into the rooftop flooring. Precast or premanufactured concrete blocks are generally used and the transportation process (from manufacturer to rooftop mounting location) is very labour intensive. Existing solutions are not ideal for projects where crane mobilisation is not feasible, and workers have to manually lift the concrete ballasts to the rooftop.

In order to mitigate project delays and risks due to recent labour crunch, the need for reducing manpower becomes paramount and urgent. The proposed hybrid ballast is an alternative to concrete ballast for rooftop solar panel installation. The hybrid ballast is made up of minerals and mixture of polymer with an aqueous solution, shall be termed as liquified polymer throughout the writing, in a container that could be made of metal or polymer. The minerals are used to increase the density of the hybrid ballast and provide weight while the polymer provides weight through the absorption of the aqueous solution. This allowed the worker to only move the empty containers and other lightweight mineral and polymer to the rooftop. As the aqueous solution makes up the main portion of the weight of the hybrid ballast, the containers can be filled up at the rooftop, where the aqueous solution is readily accessible, to reduce heavy lifting as compared to using conventional concrete ballasts.

PROBLEM STATEMENT

Solar energy is clean, generates no emissions and is the most promising renewable energy source for tropical countries with high average annual solar irradiation. High density urban environment has limited available land for the large-scale deployment of solar panels, thus there are increasing efforts to tap solar photovoltaic from the building's rooftop.

Concrete ballasts are conventional components in the installation of solar panels on rooftops so that holes do not have to be drilled into the rooftop flooring. However, the transportation process (from manufacturer to rooftop mounting location) is labour intensive. Four workers are required to work together to move a single 80kg concrete ballast. This is a laborious and time-consuming work which eventually translates to higher labour cost. With the lack of available manpower in the labour market today, the component cost will be significantly greater.

In events such as construction demolition, renovation, etc, there are many waste stone, rocks, or gravels that need to be discarded and have potential to be reused for such purpose. These materials shall be considered for use in the hybrid ballast. The composition of the polymer and mineral shall be optimized such that the embodiment of the apparatus provides the highest density at the lowest cost.

DETAILED DESCRIPTION

The present invention shall be detailed in this section and will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

The disclosure seeks to enable the use of hybrid ballast in rooftop solar installations where there is no plausible area for the mobile crane to park and conduct material lifting to the rooftop, where the only way to lift the material up is through physical labour. The workers

deployed for the project shall also be termed as solar installers who will be in charge of transporting the materials and empty container from the warehouse to project site. At the project site, the solar installer shall transport the materials and the empty container from ground level to the rooftop. At the rooftop, the solar installers shall transport the materials and empty container to its designated position and after which the liquified polymer and mineral shall be added into the empty container to convert the container into a useful counterweight. Once the hybrid ballast has gained enough density from the materials that were added into it, solar mounting structures shall be deployed and attached to the hybrid ballast foundation by means of tightening with bolt and nut or by means of connecting to a metal base plate.

One of the crucial pieces of this invention is the utilisation of polymer - a super-absorbent polymer that can absorb up to 400 times its mass in water by a process called osmosis – as the embodiment of the apparatus and to enhance the density of the hybrid ballast whenever necessary to save on manpower cost for lifting heavier weights and vice versa. The polymer is used with an aqueous solution to create a solidified compound that can be used to fill up the empty spaces between the mineral. By utilising the empty space with liquified polymer mixture, the density of the hybrid ballast is enhanced. Based on the material safety data sheet (MSDS), the polymer is stable and suitable compound to use under rooftop conditions where direct sun exposure is highly probable.

The chemical properties of the polymer have been considered and concluded to be safe for rooftop solar applications. Firstly, the biodegradation of the polymer is slow and should not happen spontaneously if the conditions do not promote bacterial growth. Bioaccumulation is the process of accumulation of chemicals in or on an organism within the food chain. The polymer is unlikely to cause bioaccumulation due to its high molecular weight. It has low toxicity based on existing international controls and it is not listed under compounds that are endocrine disruptors or substances of concern. There is no environmental regulation control on the compound but while that being said, the disposal of the polymer shall be a systematic one where any discharge or leakage of the polymer into waterbodies are minimal.

The hybrid ballast is set to achieve a mass of 80 kg and through scientific experiments, the ideal ratio of the aqueous solution to polymer is found to be 150:1. The mass of the hybrid ballast is the total sum of the mass of the container, mineral and liquified polymer calculated based on the ratio of 150:1. Frank, J., Owens, III. (2009). System and method super absorbent polymer for ballasting a device having a ballast base. *U.S. Patent No. US20090291242A1.* United States. Patent Application Publication. proposed the usage of super absorbent polymer and water in containers to be used as ballast. While deriving the combination is an easy approach, the density is fixed and limited as no other components are added. This will reduce the suitability of using such ballast in space constrained applications where the need of a high-density counterweight is required.

Matusek., M. (2021). M² Polymer Technologies produces rapid response “sandless” sandbags that are filled with polymer and a small amount of sand to act as a ballast, instead of filled fully with sand. The sand is added so that the sandless sandbag will not be too light when they are in the dry mode. When water is added, the sandless sandbags are used as flood barrier.

Schmidt., H. (2005). Ballast counterweight for cranes consists of concrete mass containing a mixture of cement, magnetite and water. *German Patent No. DE202005006473U1.* Germany. German Patent and Trademark Office. Schmidt proposed a ballast counterweight for cranes consists of concrete mass containing a mixture of cement, magnetite and water. The outcome is a concrete ballast with different compositions from conventional concrete ballast counterweight for cranes.

Annex A shows more patents found but are different from the hybrid ballast stated in this disclosure. The design of the container must withstand the environmental condition on the rooftop and be able to last at least 20 years. The containers will be under the secondary slabs and the solar panels, hence resistance to UV need not be a great concern. Other considerations such as fire hazard and toxicity must also be considered. Two high potential material choices are PVC and HDPE. Both are recyclable and can last through the lifetime of the solar panel. HDPE containers and PVC are used for the prototype.

The physical properties of the apparatus in the invention disclosure is determined. Each hybrid ballast can weigh as light as 5 kg before adding the polymer, aqueous solution and mineral to as heavy as 80 kg when filled with its embodiments. In contrast, each concrete ballast has fixed weight of 80 kg and requires up to four men to move it at any point of time. Moving the concrete ballasts is labour intensive and time consuming, and the moving starts from the ballast factory all the way to the rooftop. The toughest journey is on the roof top because machinery and tools cannot be easily deployed on the rooftop because of the loading limit.

The advantages of the hybrid ballasts can be summarised as follows:

1) Lighten the workload of workers moving the ballast, from transporting to work site, to rooftop and then to exact location.
2) To reduce the duration and man-hour for solar panel installation.
3) Improve the work condition and safety for workers.

The moving of the concrete ballasts starts at the factory and all the way to the rooftop. For site that does not allow hoisting using heavy machinery, the moving of the concrete ballasts manually to the rooftop is a very challenging tasks as the lift and manhole to the roof are not designed to carry such weights.

For the hybrid ballast, only empty containers and the required mineral need to be moved up to the rooftop. The worker will fill up the empty containers with the aqueous solution after the containers are in position and filled with the mineral and polymer.

Additional advantage for using the hybrid ballasts is the ease of removal process, as shown in Fig 6 (A and B). During the end of life for the hybrid ballasts, the liquified polymer can be easily ‘dissolved’ and extracted from the rooftop. For concrete ballasts, they have to be manually removed again during the end of life of the solar panels.

BREIF DESCRIPTION OF DRAWINGS

Fig 1 (A and B) is a schematic diagram of a hybrid ballast design using commonly available containers. The mineral and liquified polymer are to be contained in commercially available containers. These containers will rest on a base plate with side guards. The solar mounting structure will then be attached to the base plate. The side guards are used to prevent the containers from sliding out of the base plate.

Fig 2 (A and B) is a schematic diagram of a hybrid ballast design using custom-made containers. The mineral and liquified polymer are to be contained in custom made containers. These containers will rest on a base plate with side guards. The solar mounting structure will then be attached to the base plate. The side guards are used to prevent the containers from sliding out of the base plate. These containers shall have design to interlock with each other.

Fig 3 (A and B) is a schematic diagram of a hybrid ballasts using custom-made containers attached to the solar mounting structure without the use of a base plate. The mineral and

liquified polymer mixture are to be contained in custom made containers. These containers are attached directly to the solar mounting structure. These containers shall have design to interlock with each other.

Fig 4 (A and B) is a schematic diagram of a hybrid ballasts using cylindrical containers and through an attachment to fix the solar mounting structure and containers together. The attachment also fixes the two cylindrical containers into position. The mineral and liquified polymer are to be contained in cylindrical or squarish containers. The solar mounting structure will then be attached to the containers.

Fig 5 (A and B) shows a flow chart for the installation process for concrete ballasts and hybrid ballasts.

Fig 6 (A and B) shows a flow chart for the removal process for concrete ballasts and hybrid ballasts.

REFERENCES

Frank J. Owens III, System and method super absorbent polymer for ballasting a device having a ballast base US20090291242A1, United States Patent Application Publication, 2009.

Martin Matushek, m2polymer.com, Blog - | M² Polymer Technologies Inc., 2021.

Holger Schmidt, Ballast counterweight for cranes consists of concrete mass containing a mixture of cement, magnetite and water, DE202005006473U1, German Patent and Trademark Office, 2005.

ANNEX A

Publication Number	Title	Assignee
DE202005006473U1	Ballast counterweight for cranes consists of concrete mass containing a mixture of cement, magnetite and water	Schmidt, Holger
CN112278191A	Floating state hoisting and rotating ballast counterweight method for offshore platform	CSSC Huangpu Wenchong Shipbuilding Co Ltd
RU2538809C2	Eccentric counterweight with concentrated dual density for conical stone crusher	METSO MINERALZ INDASTRIZ INK
DE202008017314U1	Counterweight or ballast weight for agricultural, forestry and / or construction machinery	Tenwinkel & Co KG GmbH
KR100835503B1	Counterweight for an elevator, ballast weights for this counterweight and elevator equipped therewith	OTIS ELEVATOR CO
US20150292770A1	Solar thermal collector system and method for pitched roof constructions	MBC Ventures, Inc.,

Publication no.	Claim 1	Key features of BIP/research	Differences
DE202005006473U1	The present invention relates to a concrete ballast counterweight for cranes. For the production of ballast weights usually used	The Counterweight consists of a concrete mass containing a mixture of cement, magnetite and water.	Different usage of mixture for counterweight consisting of water, sodium polyacrylate and

	concrete made of sand, gravel, cement, water and aggregates. To a high Concrete density is achieved when concreting steel scrap, z. B. Add steel scrap balls or cupola scrap to the concrete.	Presently used as a counterweight to cranes.	waste material such as gravel, stones and rocks.
CN112278191A	1. A floating state hoisting rotary ballast weight balancing method of an offshore platform is characterized by comprising the following steps: s1, injecting water into a left ballast tank of a fifth ballast tank, a left ballast tank of a sixth ballast tank and a left ballast tank of a seventh ballast tank to enable a platform to reach a hoisting state in a floating state;	The invention relates to the technical field of ships, in particular to a floating state hoisting rotary ballast weight balancing method for an offshore platform. Direct water injection into ballast tank to act as floating and rotating counterweight.	Process of counterweight installation differs. Water is added into storage tank consisting of waste material including gravel & rocks, thereafter process differs as the counterweight requires solidification through a super absorbent polymer and sealing after.
RU2538809C2	1. A counterbalance assembly for a cone crusher comprising a counterweight body made of a base material, a first ballast located on the counterweight body and made of a first material different from the main material and having a first density, and a second ballast located on the counterweight body and made of a second material different from the base material and having a second density lower than the first density.	The invention focuses on a multi-density counterweight body with different compartments to be filled separately. The first ballast is made of an alloy including tungsten and the second ballast is made of lead.	Different usage of materials used for counterweight application. Process of storage is not the same as existing patent design. The alternative counterweight invention aims to use water, gravel/stones and solidifying agent sodium polyacrylate to create a tight seal which is able to hold a specific amount of volume without leakage.
DE202008017314U1	Counterweight or ballast weight (100),in particular for agricultural, forestry, municipal and / or construction machinery, at least comprising a weight body (1) having a surface, wherein the weight body (1) consists of a magnetite-concrete mixture, characterized in that within the weight body a reinforcement (2) is provided of metal, at least partially from the weight body (1) and that the magnetite-concrete mixture with a grain size of 0-20 mm, a proportion of 0.5 to 5% of a concrete agent is added and that the surface of the weight body has an	The Counterweight consists of a concrete mass containing a mixture of magnetite and concrete. The invention provides a counter- or to provide ballast weight that on the one hand a surface which promotes little injury, little voids and also in their overall visual impression of an iron.	Different materials use for counterweight application. Process varies and is not similar to existing patent. The alternative counterweight invention aims to use water, gravel/stones and solidifying agent sodium polyacrylate to create a tight seal which is able to hold a specific amount of volume without leakage.

	average surface roughness R a of 1.5 microns to 4 microns.		
KR100835503B1	Elevator equilibrium with a frame 1 comprising two vertical U-shaped struts 3 opposite to one another and connected to each other by at least one upper horizontal beam 5 and a lower horizontal beam 7. Ballast weight for a counterweight according to claim 1, characterized in that the end of the ballast weight is cut off to cover the wings (9) of the support (3) of the counterweight in the lateral direction.	The invention focuses on two vertical struts acting as counterweight to elevators to provide a level of equilibrium.	Different application and usage of counterweight. Existing patent focuses on built U-Shape strut frame on horizontal beams.
US20150292770A1	A solar thermal collector system comprising: at least one solar thermal collector module comprising: a glazing sheet forming a top surface of said module; an absorber sheet on an interior of said module and positioned below and spaced apart from said glazing sheet, said absorber sheet being configured to absorb heat from the sun and to transfer heat to a working fluid in said absorber sheet; a first manifold connected to a first end of each of said glazing sheet and said absorber sheet; and a second manifold connected to a second end of each of said glazing sheet and said absorber sheet; and at least one thermal storage module in fluid communication with each of said first manifold and said second manifold and configured to transfer heat from said solar thermal collector module to said thermal storage module.	This invention is on a Solar Thermal collector system that comprises of modules, more specifically forming multiple vessels that is capable of holding liquid ballasts. The use of Super absorbent polymer sodium polyacrylate is meant to protect the vessel from leakage in a scenario where the vessel integrity is affected.	Application of invention differs from existing patent. The new invention process focuses on recycling waste materials to form part of the ballast weight, thereafter using water and a super absorbent polymer to maximise the space and weight within a specified volume.

CLAIMS

1. An apparatus that uses polymer, an aqueous solution and mineral mixture as counterweight for solar panel installation; wherein the mixture is stored in a container made either from metal or polymer; wherein the apparatus can enhance the density of the counterweight to match the weight of a conventional concrete ballast.

2. The apparatus set forth in claim 1 wherein: the polymer is capable of absorbing the aqueous solution when come into contact and retain the solution over an extended period of time, forming a liquified polymer, while being able to maintain its physical properties even if the liquified polymer is exposed to direct sunlight, maintaining its desired weight throughout the lifespan of the solar PV installation.

3. The apparatus set forth in claim 1 wherein: the liquified polymer and mineral composition is able to enhance the density of the hybrid ballast and attain the desired weight applicable for solar panel installation.

4. The apparatus set forth in claim 1 wherein: the liquified polymer and mineral composition can chemical react with a sodium compound to release the liquid contents that were absorbed by the polymer, in order to rapidly reduce the density of the hybrid ballast during the removal phase.

5. The apparatus set forth in claim 1 wherein: the counterweight shall be filled with contents on site to reduce manpower requirements compared to conventional methods of lifting high density concrete ballast manually.

6. The apparatus set forth in claim 1 wherein: the counterweight has the capabilities of rapidly discharging the weight before removing from site to reduce manpower requirements compared to conventional methods of carrying high density concrete ballast out from site.

7. The apparatus set forth in claim 1 wherein: the apparatus also consists of an attachment made of metal or polymer to firmly hold the counterweight to the solar mounting structure.