TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

13th March 2015

1. SIMULATION MODEL FOR ASSESSING LOAD BEARING CAPACITY OF RIVETS USED IN AUTOMOTIVES

Materials, such as steel, aluminum, magnesium, and fiber-reinforced plastics are adopted on a large scale for manufacturing various parts used in automobiles. Welding is a manufacturing technology that is widely adopted by manufacturers to join parts that are entirely made of steel. Welding cannot be used for parts that are made using a combination of materials; instead, mechanical connections, such as rivets are employed. Rivets play a major role in holding the chassis of automobiles together reliably even in the case of a crash. Currently, it is difficult to predict the precision of load that a rivet would be able to withstand. In many cases, connections are the weak points. For instance, in the event of a crash, they are subjected to failure first; and since a car has about 3000 to 5000 joints, manufacturers around the globe look to minimize the risk. Simulations are one of the techniques that are widely used for verifying the various connection points that could sustain the stresses in a crash. The calculations obtained from the simulations predict the performance of individual joining points but not for every type of strain. If the components that are joined become bent, then the calculations will not be precise. For instance, the computations attribute to greater load capacity than the actual load bearing capacity of the rivet under real conditions. Automotive manufacturers are striving to eliminate the above-mentioned factor. There is a need to develop a novel advanced model that is capable of delivering more realistic projections.

A group of researchers from the Fraunhofer Institute for Mechanics of Materials (IWM) in collaboration with their colleagues from the Laboratory for Material and Joining Technology (LWF) and the Association for the Advancement of Applied Computer Science GFaI, Germany, have developed a novel simulation model for precisely assessing the load bearing capacity of rivets used in automobiles. With this new simulation model, the researchers believe that it would be possible for

manufacturers to forecast more reliably in terms of both slow and fast bending loads in addition to the pull and shear forces that emerge when the joined components are shifted relative to each other. For testing the newly developed simulation model, sample components were produced from a variety of materials and were connected by rivets to which stresses were then applied. The components were then bent in different directions and were also pulled and pushed at varying speeds. The performance of the rivets was then integrated into mathematical equations containing different parameters, such as material properties and densities. The researchers studied about 15 different combinations of materials; and based on the data obtained, the projections for other similar materials and density combinations were obtained. From all the data gathered from these tests, the new simulation model was found to be accurate and precise.
The advantage of this simulation model is that, it is precise and accurate when compared to the other simulations models that are currently available in the market. Also, it takes into account various stresses that would be acting on the parts that are joined by rivets, thereby making it possible for manufacturers to produce safer rivet joints for automotives.
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2. WEARABLE ROBOT FOR PERFORMING HOUSEHOLD TASKS

Robots have been witnessing increased adoption in a wide range of industrial sectors. They are finding opportunities for household functions and as wearable robots to help people with various disabilities.
A group of researchers at the Massachusetts Institute of Technology (MIT) have developed a novel robot that enhances the grasping motion of the human hand. This robotic device can be worn around one’s wrist and works essentially like two extra fingers adjacent to the little finger and thumb. The above-mentioned capability has been achieved using an innovative control algorithm that enables it to move in sync with the wearer's fingers to grasp objects of various shapes and sizes. By wearing the robot, a user could use one hand to perform different tasks, for instance, hold the base of a bottle while twisting off its cap. According to the researchers, the robotic fingers move in a completely natural manner. With a

little training, the users will begin to feel that the robotic fingers are a part of their body. The robot is expected to help people with limited agility to perform routine household tasks such as opening jars and lifting heavy objects. This novel robotic finger consists of actuators that are linked together for exerting forces that are as strong as those of human fingers during the grasping motion. While developing the algorithm for the robotic fingers, the researchers have assumed a biomechanical energy that could be achieved with seven human fingers. Their assumption was tested by wearing a glove outfitted with multiple position recording sensors and attached to the wrist. The researchers grasped each object with their hands and then manually positioned the robotic fingers to support the object. The researchers then recorded both hand and robotic joint angles multiple times with various objects and then analyzed the data. They found that every grasp could be explained by a combination of two or three general patterns among all seven fingers. The information obtained from the above-mentioned tests helped in developing a control algorithm to correlate the postures of the two robotic fingers with those of the five human fingers. The algorithm teaches the robot to assume a certain posture that the human expects the robot to take. The robotic finger mimics the grasping of the hand similar to the closing in and spreading apart action of a human finger. Further research is being conducted on the robotic finger to control the force in addition to the position. Apart from this, research is also being carried out to scale the robot down to a less bulky form.

Thel robotic finger helps people with disabilities, allowing them to carry out tasks in a more efficient manner. The robot wold have opportunities for adoption be adopted once it is commercially available.

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3. AERIAL ROBOT FOR INSPECTION OF INFRASTRUCTURE

Infrastructure such as buildings, industrial plants, and bridges are subjected to heavy loads and extreme weather conditions, which result in damages over time. Currently, most of the infrastructure inspections are carried out by humans; this is considered a huge safety risk. To address the above-mentioned problems and increase safety for humans, the inspection process is being automated using robots.

Researchers from the Fraunhofer Institute for Non-Destructive Testing IZFP in Saarbrücken, Germany, have developed micro-aircraft robots that could be used for building inspections. When compared to conventional methods, the inspection carried out by this aerial robot is more convenient and efficient in terms of reducing the total time taken for inspection. Conventional methods take two or three days for carrying out the inspection process, but this aerial robot can complete the same inspection process in two to three hours. The cracks and other flaws are digitally photographed in high resolution, which allows a quick conclusion on the state of the structure that is being inspected. The researchers have also said that this robot could be equipped with a thermal imaging camera if it is required for an application. The individual pictures that are captured by the robot are automatically transmitted to the computer of the user where it is combined to create an overall picture and the resulting 2D and 3D models are used for analyzing the structure. The aerial robots have undergone a variety of tests and the results have been positive. The device is equipped with eight electric motors, thereby allowing it to safely land even if one of the motors fails. The researchers are now working on developing a complete software suite for recognizing the damages, a database for the documentation of the images, and also for automating the entire analysis operation. In addition to creating a software suite, the researchers are also working on integrating navigation sensors into this robot for automatically controlling the navigation of the robot in the future. For instance, the sensors would allow the robots to carry on in a predetermined pattern.

Some of the advantages of this novel aerial robot are that it significantly reduces the risks caused to humans involved in the inspection of buildings and other infrastructure and also increases the efficiency of the process by reducing the time taken for inspection. This aerial robot is expected to have opportunities once it is commercialized due to its ease of use and high efficiency.

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4. PATENT ANALYSIS OF THERMIT WELDING PROCESS

Thermit welding is a welding process which is based on a chemical reaction. In this welding process, super-heated molten metal is poured around the joints of the materials that are to be welded. The chemical reaction that takes place between the metal oxides and the metal reducing agents usually generates the heat that is required for joining of the material. The most preferred metal oxide used in this welding process is iron oxide, and magnesium or aluminum is used as a metal reducing agent. The basis for the thermit process is the strong chemical attraction of aluminum for the oxygen.

Applications for thermit welding include finish welding of strengthening bars in concrete, welding necks to rolling mill rolls with pinions, welding large broken crankshafts or broken frames of machines, restoring broken teeth on large gears, and so on.

Disadvantages of this process include low deposition rate, high level of fume, slag inclusion, and so on.

From the patents that have been exhibited, research has been carried out to automate this process for various applications. For example, Patent CN 101347868 B, Aluminothermy welding method of aluminum alloy, pertains to thermit welding method suitable for fast welding of aluminum alloy armor plates, aluminum alloy parts for armored equipment in battlefields, and welding and repair aluminum alloy parts of civilian vehicles or other working machines in the field.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Thermite ignition and rusty iron regeneration by localized microwaves	March 1, 2012/ WO 2012120412 A1	Ramot At Tel-Aviv University Ltd.	Eli Jerby, Yehuda MEIR	A method and corresponding devices employ a mixture of at least a metal oxide and a metal which undergoes an exothermic chemical reaction. Microwave radiation is applied to the mixture so as to generate a localized hot spot in the mixture, thereby initiating the exothermic chemical reaction. The use of localized microwave radiation facilitates low power and portable implementations. Devices and techniques for cutting, drilling, welding, material synthesis, generating thrust, and mechanical power and motion are also disclosed.

Method of cooling welded rail section, device for cooling welded rail section, and welded rail joint	March 30, 2010/ EP 2415885 A1	Nippon Steel Corporation	Katsuya Iwano, Kenichi Karimine, Seiji Sugiyama, Masaharu Ueda	The invention provides a method of cooling a rail weld zone. The method includes a first rail web portion cooling process of cooling a rail web portion cooling region of the rail weld zone in a part of a temperature range until the completion of transformation from austenite to pearlite, a second rail web portion cooling process of cooling the rail web portion cooling region after the entire rail web portion of the rail weld zone is transformed to pearlite, a foot portion cooling process of cooling a foot portion of the rail weld zone, and a head portion cooling process of cooling a head portion of the rail weld zone. When cooling time of the first and second rail web portion cooling processes is t minute, a k value satisfies an expression represented as -0.1t+0.63≤k≤-0.1t+2.33.
Exothermic mixture for welding containing aluminium, calcium silicide casi2 and transition metal oxides.	October 23, 2009 / EP 2362816 A2	Tubefuse Applications V.O.F	Wayne Rudd, Hu Chun Yi	An exothermic reaction mixture for joining metallic components includes at least one transition metal oxide and, as fuel, a mixture of aluminium and calcium suicide, wherein the molar ratio of aluminium to calcium suicide is from 16:1 to 0.25:1. Methods of preparing the exothermic reaction mixtures and for using them in welding applications are also described.
Manual thermit welding electrode and preparation and using methods thereof	November 20, 2008/ CN 101444876A	Tsinghua University	Yuan Xuan one, Zhancheng Bin, Chen Kexin	The invention discloses a manual thermit welding electrode and preparation and using method thereof which belong to the technical field of welding. A welding compound of the welding electrode comprises a thermit, a slag forming constituent and an alloying agent. Raw materials are weighed according to the proportion and arranged in a ball mill, a grinding ball and a milling medium are added, and the welding compound is obtained by drying after wet grinding; the welding compound is filled in a cylinder which is made of paper, a lead wire is arranged at one end of the cylinder, and the other endis sealed by a plastic plug, thereby forming the thermit welding electrode; the welding electrode is arranged in a sleeve which is made of paper and sealed for preservation. When in use, the sleeve is fixed on the plug at the back end of the welding electrode, the sleeve is held by a hand, and the lead wire at the front end of the welding electrode is ignited, and then the manual welding or cutting operation can be carried out. The welding electrode is small, lightweight and portable, the welding and the

				cutting operations are simple, rapid and safe, the welding and the cutting operations canbe carried out anytime and anywhere, and the welding electrode can be applied in the welding and the cutting of steels, stainless steels or copper alloy materials.
Aluminothermy welding method of aluminium alloy	August 18, 2008/ CN 101347868 B	Jiangyin Tungda Institute	Li-Hua Liu, Zhang Lei, Zhu Zongguo, Li Jifeng, Tang Sau, Tan Dian-long, GUO Qiang, Chen Wei, Ma Xiangping	The invention relates to a thermit welding method of aluminium alloy, which comprises the following steps: preparing a thermit welding agent; placing the thermit welding agent in a crucible; embeddinga TiC igniter into the thermit welding agent; exposing a part; igniting the exposed part; igniting the thermit welding agent in the crucible for thermit reaction; placing the solid aluminium alloy into the surface of reactants in the crucible immediately after the reaction is finished; using the residual heat to melt the solid aluminium alloy and obtaining the liquid aluminium alloy melt; preheating fractures of the aluminium alloy parts to be welded to the temperature of 390-410 DEG C when the former step is carried out; directly casting the aluminium alloy melt to the position of the fracture of the processed aluminium alloy parts; carrying out the densification processing by striking and extruding the welding seam when the metal to be seamed is just solidified and realizing the welding; and clearing weld flash by hands when the temperature is high. The thermit welding method of the invention is applicable to emergent and fast welding and repairing of aluminium alloy armor plates and aluminium alloy parts of armored equipment in battlefields and is also applicable to emergent welding and repairing of aluminium alloy parts of civilian vehicles or other machines in field working.
Self-contained keyhole weld fitting and method of use	April 29, 2008/ CA 2680788 A1	Brian S. Shaw, Tdw Delaware, Inc.	Brian S. Shaw	The present invention is generally directed toward a method for attaching a self-contained keyhole weld fitting and apparatus. More specifically, the present invention provides an improved fitting and method of use providing a branch outlet which can be physically and sealably secured to an underground pipe while causing less disturbance to the earth above the pipe than using a traditional fitting and excavation.

Crucible for melting a thermit material having a glass or metal layer; thermit welding device with such crucible	December 21, 2007/ WO 2008077957 A1	Fci Connectors Singapore Pte L, Framatome Connectors Int, Funamizu Daisuke	Funamizu Daisuke	The thermit welding device (1) of the present invention comprises: a tubular thermit welding crucible (3) having a bottom portion provided with a through portion (6) to an exterior, and having a glass layer or metal layer formed on an inner tubular surface; and a body portion comprising a cavity portion (10) forming a welding portion, and a passageway (9, 11) communicating with said through portion (6) at one opening portion and communicating with said cavity portion (10) at another opening portion.
Thermite welding tool, crucible and thermite welding methods	July 31, 2007/ WO 2008014982 A1	Fci Connectors Sngapore Pte Lt	Daisuke Funamizu, Hideki Nishijima, Kazumi Wada	The present application relates to a thermite welding method comprising a step of inserting a welding lug into a through hole (9) of a thermite tool or crucible (2) and positioning at least a portion (10) of the welding lug inside a hollow portion (8) with a predetermined spacing from the base metal surface; a step of sealing the aperture portion of the hollow portion (8) by the surface of the base metal; a step of pouring melted thermite into the hollow portion (8) to form a welded portion; and a step of destroying at least the portion (6) between the welding lug and the surface of the base metal in the crucible (13) or the welding tool (1). The invention also provides a welding tool (1) and a crucible (2) for performing this method. The invention achieves an increase in the welding area between the surface of the base metal and the welding lug in thermite welding.
Mould for thermit welding of railway tracks in which at least one is worn, the mould presenting parts protected by compressible material and non protected machinable parts	May 22, 2007/ EP 1862250 B1	Railtech International	Frédéric DELCROIX	This present invention concerns a mold for the aluminothermic welding of railway rails. The compressible lining (58) used to seal the molding die in relation to leakages of the weld metal in the liquid state is limited to the parts of the contact surfaces (52) of the parts (19) of the mold on the rails to be welded, corresponding to the bottom, the sides and the top of the foot, to the sides of the web and below the head. The rigid refractory material of the parts (19) is exposed in the parts (67, 71) of the contact surfaces corresponding to the sides and the top of the head, and suitable to be removed selectively from the latter. This makes it easy to adapt the mold to rails with different degrees of wear.

Deposit metal welding method	May 10, 2002/ US 6805276 B2	Eci	Kazumi Wada	To prevent decreases in fatigue strength of a base material by relieving the residual stress of a weld. A method for welding a deposit metal to a base material with reduced residual stress, comprising a step of welding a deposit metal to a base material; and a step of plastically deforming into a recess, an area on the surface of the base material around a peripheral portion of the deposit metal. The invention is also directed to a welded block joint between a wire and a base material, characterized by comprising a deposit metal receiving an end portion of the wire and welded to the base material, wherein an area which is plastically deformed into a recess is formed on the base material surface at a peripheral portion of the deposit metal.

Exhibit 1 depicts patents related to the thermit welding process.

Picture Credit: Frost & Sullivan

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