GLOBUS

Globus An International Journal of Medical Science, Engineering and Technology
A Refereed Research Journal
Vol 11 / No 2 / Jul-Dec 2022 ISSN: 2319-8958

REHABILITATION ENGINEERING AND ITS TECHNOLOGICAL SOLUTIONS TO PROBLEMS CONFRONTED BY ENGINEERS

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Paper Received: 24.09.2022 / **Paper Accepted**: 25.10.2022 / **Paper Published**: 27.10.2022
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Abstract

The present paper discusses on how Rehabilitation engineers design and build devices and systems to meet a wide range of needs that can assist individuals with mobility, communication, hearing, vision and cognition. These tools help people with day-to-day activities related to employment, independent living and education. Technological problems and their solutions face by engineers is also discussed in the paper. For assistive technology, affordability and functionality are frequently the determining factors in design.

Keywords: Rehabilitation Engineering, Raw Material, Technological Aspects.

Introduction

In a linear economy, raw materials from both renewable and non-renewable sources are gathered, processed into products, and then thrown away as trash. For instance, the CFRP bicycle body is thrown as waste after being used in linear economics. Recently, various techniques, including mechanical, thermal, as well as chemical recycling procedures, have been used to recycle some carbon fibre composite material. In this study, the CFRP bicycle frame's resin is taken out and converted into recycled carbon fibre using convection pyrolysis (MAP) technology methods. The recycled carbon fibre is then employed in FRC structures, changing the linear economy into a circular one. By being used in civil engineering, recycled carbon fibre from CFRP wastes helps to reduce environmental pollution.

Continuous fibre composites, especially in particular Carbon Fibre Reinforced Plastics (CFRP), remain to see increased use in a variety of industries, including aviation, aerospace, and auto racing. They make it possible to build sturdy structures that are light and have an ideal rigidity. The measuring of compressive strength has been a subject of numerous studies since the 1980s. Unidirectional plies' (UD) compressive strength is typically acknowledged to be significantly less than overall tensile strength. The design for structures is frequently determined by this mechanical feature. This is especially true for thin structures that are loaded in compression during bending. A sailboat mast or an aeroplane wing are good examples. It is crucial to emphasise that the loads given to these structures typically fluctuate over time and can be equated to cyclic loadings, especially in the case of the instances that came before. Designers need to be able to use reliable information about the CFRP's compressive strength in these circumstances. In order to ensure the integrity of something like the structure during its full service life, they must consequently be aware of how the compressive strength changes following cyclic loading.

Due to the complexity of the microscopic simulation phase, the definition of such strength properties of CFRP has been the focus of heated

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discussion for many years. Moreover, the instability termed as micro-buckling is what leads to the compressive breakdown of CFRPs. It was discovered in the 1980s that strength measures acquired through only compression tests typically resulted in significant dispersion. Even though there have been numerous attempts over the past 30 decades to enhance experimental approaches, it appears that the outcomes depend greatly on a variety of variables, including specimen machining, experimental frame (stress density, buckling), load emergence (shear loading, final loading, mixed loading), and experimenter skills. Compression/ compression fatigue testing makes these problems worse and makes it more challenging to identify the root of degradation or failure. Pure compression experiments generate a stable compression state as a first approximation. Nevertheless, test setup-related singularities may significantly affect the fracture mechanisms. Depending on the setup accuracy and design, the compression stress is overburdened by high gradients closer to these peaks (grips, anti-buckling devices).

The daily concrete mix is created with an ultra-high compressive strength based on building demands. The tensile strength as well as flexural rigidity of concrete are not enhanced even as compressive strength is elevated. The disintegration that takes place inside the concrete matrix during tensile stress, which is mostly ascribed to bond losses seen between cement paste and aggregates, is one of the causes of this. In high ambient temperatures, this problem is more severe and results in significant damage. High tensile stress develops inside the concrete matrix as a result of internal water evaporation and shrinkage at high temperatures. Microcracks, bond losses, and gradual spalling are the results of this. Researchers have made an effort to resolve this problem. Short fiber-reinforced concrete is the most efficient technique for improving the microstructure & tensile strength of concrete. Concrete is currently made using a variety of fibres, comprising cotton, jute, sheep wool, steel, & textile fibres. The polymer fibre reinforcing system is one of numerous suggested approaches for strengthening concrete to handle high flexural and tensile strengths, even at high temperatures. Therefore, it is necessary to develop trustworthy rules and procedures for making ultra-high-performance polymer fiber-reinforced concrete.

Review of Literature

Anas (2022) [2] Due to its numerous uses in civil infrastructure projects, concrete is the construction material that is most frequently employed in the business. However, concrete's usage has been restricted because of a number of flaws, including brittleness, poor tensile strength, propensity for fracture initiation and propagation, and low durability. Researchers have improved concrete by adding various synthetic and natural fibres to it in order to improve these shortcomings.

Li (2021) [1] Waste carbon fibre reinforced plastic (CFRP) goods have not been effectively recycled and reused over the past ten years, and they occasionally have negative environmental effects. In this study, the CFRP bicycle frame's resin was extracted using microwave-assisted pyrolysis (MAP), which was then recycled into carbon fibre.

Rivera (2021) [3] It is commonly known that discrete fibres can be added to concrete to increase its tensile strength and toughness. Research have also demonstrated this fiber-reinforced concrete (FRC) could be advantageous for its improved compression behaviour. In comparison to plain concrete, this behaviour, which is related to the confinement act of the fibres, is generally stronger and more pliable.

Engineering Aspects of Rehabilitation Engineering

For rehabilitation engineers, there are five main employment opportunities: (1) research and training in academic or governmental settings; (2) product development by a manufacturer; (3) provision of rehabilitation engineering services in a clinical setting; (4) provision of rehabilitation engineering services for a state department of rehabilitation; and (5) private consulting services. According to Trachtman (1990, 1991), the majority of rehabilitation engineers work in healthcare facilities or academic institutions, and their main duties tend to be service provision or research and development. Many rehabilitation engineers either operate independently or in teams of no more than three other engineers. Although they are not exclusive, the duties of the rehabilitation engineer vary based on the job context.

Many of these roles may fall under the purview of rehabilitation engineers. A rehabilitation engineer engaged in research may create a device, deliver it in conjunction with patients, physicians, and therapists, and possibly help secure funding for the device. To find the appropriate device to satisfy the client's needs in a clinical context, a rehabilitation engineer may consult with the client, a physiatrist, a therapist, and a provider of durable medical equipment. The rehabilitation engineer may need to modify the device or integrate it with other tools the client uses.

To create the greatest product at the most affordable price, rehabilitation engineers who work with manufacturers in product development frequently collaborate closely with therapists, suppliers, and customers. The variety of needs of different clients makes this task more challenging and necessitates flexibility as uniformity is challenging (raising manufacturing costs). Additionally, rather of being paid for by the end user, most assistive technology is supported by outside vendors. Other marketing and design strategies are necessary. Furthermore, third-party providers typically view the financing of assistive technology from the standpoint of being essential for the client's rehabilitation and not for the client's comfort or convenience. Some people have understood this to suggest that the cheapest working technology should be bought rather than the best option available. This paradigm mandates that every assistive technology be backed by medical evidence. Finding funding for rehabilitative engineering services in a clinical context has occasionally been challenging because of this mentality. Regardless of the environment, the rehabilitation engineer's objective is to support the creation and use of the most appropriate and economical technology to achieve the (re)habilitation goals of the disabled person.

Technological Aspects

The expertise of suppliers of rehabilitation technology has been significantly depended upon by consumers and professionals in the field. NAMES, the National Association of Medical Equipment Suppliers, has acknowledged the need to create rules of conduct for suppliers of rehabilitation technology (NAMES 1992). Rules of conduct aid in ensuring the calibre of services provided by NAMES members. Manufacturers, dealers, doctors, and patients make up NAMES. Suppliers of rehabilitation technology offer disabled persons services and assistive technology. The specification process for rehabilitation equipment is different from that for other durable medical equipment in that it includes an assessment and evaluation of the technology to meet the needs of the client. The equipment and/or its components may then be modified to achieve the client's objectives. Suppliers of rehabilitation technology are frequently an important member of the rehabilitation team. The provider of rehabilitation technology is frequently in charge of communicating to the customer the methods and conditions of payment as well as offering servicing and upkeep for the equipment.

Conclusion

Both human performance design and engineering design are necessary for assistive technology. Assistive technology must also be evaluated using conventional engineering design quality metrics. A device's effectiveness must be assessed by rehabilitation engineers using a cost-benefit analysis over the course of the product. In order to predict the lifespan of an assistive equipment, one must look beyond financial viability and take client needs into account for a given period of time. The creation of useful assistive technology can be aided by the application of traditional engineering design principles while taking customer needs into account [4-6].

For assistive technology, affordability and functionality are frequently the determining factors in design. As was previously said, the income levels of people with disabilities are among the lowest ever. The majority of assistive equipment is bought by a third-party provider due to their lesser income. The least expensive assistive equipment that satisfies the user's demands is purchased by third parties. This strategy might not be the most economical one in the long run. But it's the system that's in place. The difficulty for the rehabilitation engineer is to produce high-quality equipment that is both affordable and meets the user's needs [7-8].

The cost of a product is amortised throughout its lifetime, thus more expensive technology needs to be justified by a longer lifespan and/or higher functionality. Funding decisions are frequently made primarily on providing for a person's absolute necessities, not on their comfort or convenience. This offers the engineer three fundamental directions:

(1) cutting-edge solutions that accomplish crucial tasks that other systems are unable to complete;

(2) goods that outlast rivals; and experts and customers. It is necessary to apply their expertise and knowledge to rehabilitation engineering jobs.

A foundation for achieving high-quality rehabilitation engineering support and designs is provided by total quality management. Tools for total quality management can help rehabilitation teams create the best answers to the problems that individuals with disabilities encounter. Customer and provider engagement is necessary for the delivery of rehabilitation engineering services.

Conflicts of Interest

The authors declare there are no significant competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

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