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GLAZING SYSTEM BASED ON OPTIMIZATION GLAZING MODEL: DESIGN APPROACH

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Abstract :- *Laser glazing technology was used to strengthen the surface layer of concrete. This model characterizes the depth pool of glazing of a steady running cross velocity and laser power, and subsequently an upgraded the depth of glazing measurement for a predefined contribution of the power supply of laser and traverse speed is gained. The laser source is continuous wave CO_2 of 10.6 µm wavelength, 1 mm laser spot diameter and (20-70) W power are used for 1, 2 and 3 mm/sec traverse speed.*

Keywords: *laser glazing, stepper motor, GUI, CO_2 laser.*

1. Introduction

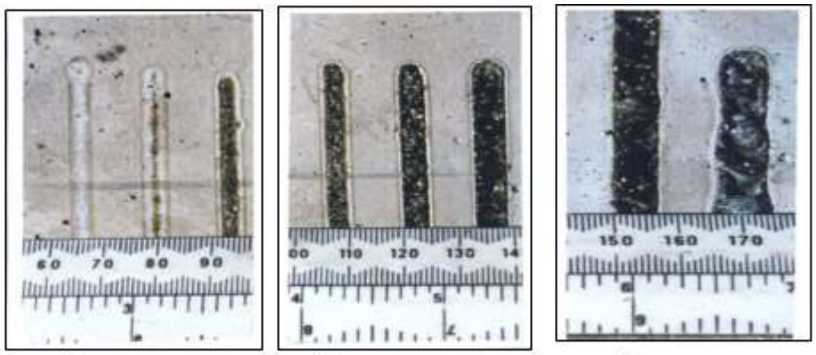
The applications of the expanding laser in the manipulation of materials can attribute to some new points of interest of the laser in particular, automation worthiness, high productivity, elimination of finishing operations, contactless machining, reduced processing cost, improved product quality , greater use of the material and the area affected by the minimum heat. In general, the application of the laser to the processing of the material can be grouped into two main classes [1]:
(a) Applications require energy, limited energy and do not cause significant phase or state changes.
(b) Applications require a significant amount of energy to induce phase transformations.

2. Literature Review

The detailed survey on research papers recently published in the leading journals has been studied extensively to gain the best knowledge and understand the limits of the study.
Selected architectural materials or non-homogeneous materials are clay quarry tiles, ceramic tiles and ordinary Portland cement (OPC) [2]. Many studies have been conducted to study laser glazing of non-homogeneous materials.
The accuracy of existing models for measuring the depth of glazing of the concrete surface treated by the CO_2 laser is influenced by many factors, such as sideways conduction and the inhomogeneous substrate of the concrete; in addition to the environment and measurement approach used and therefore the error factor is placed.

Blair K.J has demonstrated the possibility of investigating the laser glass technique for the concrete surface to form an impermeable layer. et al. (1996) [6]. The goal of generating impermeable layers is to avoid leaching water from said material to other sites by "binding" the particle contamination of the layer. The effect of a laser is to provide a source of heat that melts the surface of the material and thus obtains the case of "mooring". Several experiments were conducted using the CO_2 and Nd: YAG lasers to process the concrete surface in which different results are presented:

- Limitation of the movement of radioactive particles produced by the coating layer that was generated by the laser glazing technique.
- A continuous glassy coating was obtained with a relatively low power density (200 W /cm^2) and a low displacement speed (3 mm / sec).
- No glaze layer (surface dehydration only) is present during the use of lower powers or higher running speeds.
- While the use of higher powers or lower speeds of movement involved the cracking of the surface, with the expulsion of pieces of material.
- Color of affected area, the color will change from dark to light grey, with some brown charring around the edge of the affected area as shown in figure 1-2.



(a) (b) (c)

Figure (1.2): The laser beam influence on surface of concrete at different power levels (spot diameter (5mm), traverse speed (2mm/ sec), and laser power (above to below): a) (20, 35,50W), b) (75,110, 210W), c) (460, 840 W) [5].

- The depth and width to which the concrete is heat affected. The glazing width and depth are proportional to the laser power and inversely proportional to the traverse speed.

Prolonging the life and applications base of the concrete are ultimate aim of **J. Lawrence** and **L. Li (1999)** [7]. They produced novel surface glaze generation on the OPC surface layer of concrete based on high power diode laser (HPDL). The mechanical, physical and chemical properties of generated surface were investigated and analyzed. With power densities of high power diode laser (HPDL) as low as 750W/cm^2 and at rates up to 480mm/min the glazing of the ordinary Portland cement (OPC) surface of concrete was successfully demonstrated. The common features of the laser glaze are the porosities and cracks [7].

Determination of laser beam absorption lengths of CO_2 and high-power laser radiation diode (HPDL) to the ordinary Portland cement concrete surface (OPC) is provided by J. Lawrence (2000) [9], using Beer-Lambert's Law . The absorption lengths of the concrete of an HPDL and CO_2 radiation were 177 ± 15 μm and 470 ± 22 μm, respectively. The absorbance measurements performed at room temperature using spectrometers suitable for each wavelength of the laser showed that the surface of the OPC concrete absorbed about 75% of the CO_2 laser radiation and about 69% of the HPDL radiation [8].

J. Lawrence and L. Li (2000) show that the generation of a surface glaze has produced a noticeable improvement in wear characteristics on an OPC untreated concrete surface [9]. The glazing wear rate generated by HPDL was 3.5 mg / cm ^ 2 h under normal and corrosive environmental conditions (NaOH, detergent and HNO_3). In contrast, raw OPC concrete surface exhibited a wear rate of 9.8mg / cm 2 h under ambient conditions and 114.8, 73.8 and 18.5mg / cm 2 h when exposed to HNO_3, NaOH and detergent, respectively. Life assessment tests have shown that the HPDL-generated glaze has increased the useful life of 1.3 to 14.8 times on an untreated OPC surface.

The surface glazing characteristics of concrete treated with CO_2 laser and high power diode laser (HPDL) are presented in a comparative study by **J. Lawrence and L. Li** (2000) [10]. The researchers described that the resulting melting depth of the HPDL laser glazing, along with the depth of the HAZ, was lower than that obtained with the CO_2 laser. Furthermore, the glazing turned after the HPDL interaction was found totally amorphous in nature, while the glass was after interaction with CO_2 laser outside a semi-amorphous structure, with substantial areas, randomly located within the undercoat and showing a columnar structure quite regular.

Dotcheva and Milward (2005) reported a theoretical and experimental methodology for the efficient planning of finishing end-milling operation for machining a pocket-type contour. The focus was to overcome human error in the system, thus generating better cutting conditions for given tool path. With the development of geometric relationship among the cutting tool, corner– milling operation and machine surface, a mathematical model that described the cutting phases during the corner cutting was developed, optimized and experimentally verified. It was concluded that the optimized model was efficient, exhibiting “in-tolerance” accuracy and surface roughness [11].

The empirical glazing surface of concrete samples using a CO2 laser working station with a power of 25-100 watts shows the coincidence in the coincidence of the results in the results of the existing calculated model that cannot be ignored even at low power laser supplied. **M.S. Salim et al** (2017), team of researchers present a new model of empirical glazing (IDGM) for measuring the glazing depth that is derived and verified. The validation process of the proposed model for the translation speed (1, 2 and 3 mm / sec) shows that the values measured in real time agree with those of the proposed models in about 96%. [3-5]

3. Problem statement

Research motivation is the design and implementation of concrete glazing machine based on optimizing of glazing depth model derived by Salim et al research team. [4] [5]

4. Objectives

The main goal of this research is to design and implement of Concrete Glazing Model based on optimization of the melting pool depth measurement of the concrete surface laser treatment which can be achieved through verifying several steps.

5. Methodology

CGM is a control system that receives a set of programmed directives, processes it and generates corresponding output control signals that control the motion of machine tool. It also process the feedback signals generated by various sensors and feedback devices. Major components of CGM includes part program, program input device, machine control unit, drive system, machine tool, and feedback system.

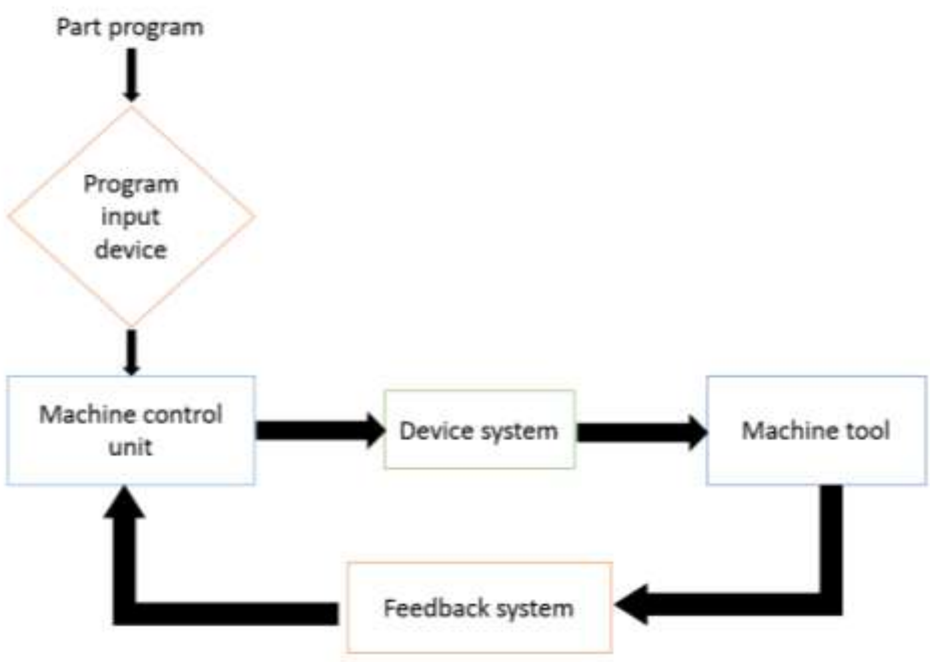


Figure (1.3): schematics diagram of a typical CGM machine.

I. Part Program

A part program is a set of instructions coded in terms of numbers, alphabets and symbols which are required to move the laser beam head and workpiece in desired motion so that the required produce a part.

The part program is entered in the machine tool via internal or external memory and build-in keyboard with the help of computers using USB cable interface.

The machine control unit can be referred as brain of a CGM. As functionality of our body is controlled by our brain in similar way it is machine control unit that controls the CGM.

II. Feedback and Drive System

The feedback system comprises of measuring devices and sensors that can estimate the state and condition of the CGM at any instant.

A stepper motor driver circuits, and ball lead-screws together constitutes drive system. The function of drive system is to execute motion commands as instructed by MCU. The MCU feeds the motion commands (i.e. position and speed) of every axis to the amplifier circuits. The command signals are amplified and are then fed to drive motors which in turn rotate the ball lead-screws to position the tool at the desired position.

Some of manufactures and researchers will design their machine for speed, others for a maximum work envelop. But these choices are directly related to the intended purpose and material worked. [12]

6. Design and analysis of concrete glazing machine

The first purpose of this research was to create an GUI that met the demands of CGM. The machine response was great for the GMI through which the machine movement is controlled on three axes, laser power and the speed required for the predefined value of the glazing depth.

Conclusions

The accuracy of the measurements of glazing depth for concrete surface CO_2 laser processing affects by different factors, therefore, the used models of mathematics neglected sideways conduction and the non-homogeneous concrete substrate; they also depend on the technique of measurement that used and environment.

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