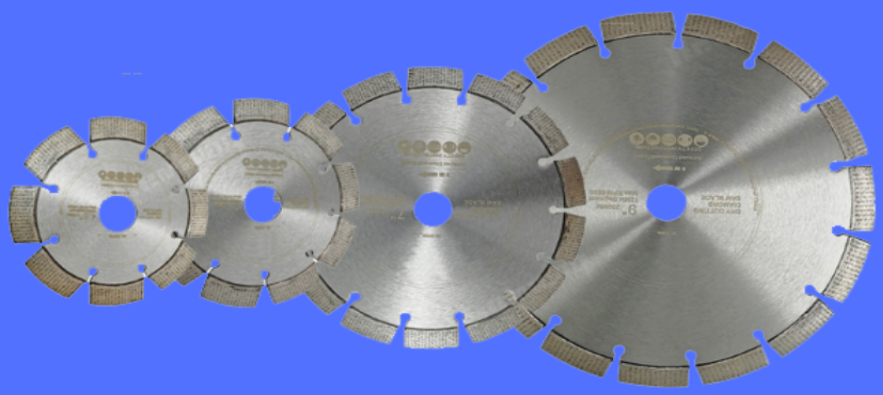
DIAMOND SAW BLADES

INTERNSHIP REPORT

Huzaifa Pardawala | 2021



SUBJECT TO MUMBAI JURISDICTION

GHASIRAM VNM INDUSTRIES PVT. LTD.

(Formerly Known as GHASIRAM STEEL INDUSTRIES PRIVATE LIMITED)
Manufactures of : Industries Blades, Tools Bits and other metals in all forms

Works .Gut No. 420/1 to 420/7, Village - Khanivali, Taluka- Wada, Dist. - Palghar - 421303.

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Letter of recommendation

To whom it may concern

It is with immense pleasure that I write this letter of recommendation for Huzaifa Pardawala, a student of the batch of 2022 of Jai Hind College, Mumbai, India.

Huzaifa has successfully completed his two month internship at Ghasiram VNM from 1st July, 2021 to 31st August, 2021.

During his internship, Huzaifa studied and analysed the manufacturing process and the rotational dynamics of the diamond saw blades. He suggested methods of improving quality checks and safety protocols for the workers at the factory.

Overall, Huzaifa is well disciplined, focused and has a stellar work ethic. He got all the reports for the products done in due time and finished the tasks assigned to him at the very earliest. He was extremely amicable with the worker and it did not take him much time to build a rapport with the production manager and the head accountant at the firm. The diamond saw blades and its various types form the major bulk of the products we sell.

Huzaifa was extremely quick to pick up on the concepts involved in the production of these blades such as powder metallurgy, cold press and sintering.

At a personal level, Huzaifa has a very warm and pleasant personality. He went beyond his requirements and researched deeper into his topic because of his genuine interest in learning about the machines.

Huzaifa is unquestionably an exceptional candidate. He is a great asset to any team that he is a part of.

I wish him the very best in all his future endeavours.

GHASIRAM VNM INDUSTRIES LIMITED MUMBAI INDIA

Acknowledgement

I would like to thank Mr. Shiv and Mr. Anil for guiding and assisting me during my internship at Ghasiram VNM. Their expertise in the field of power tools and abrasives in the capacity of a production manager and chief accountant respectively helped put the whole project into perspective.

I would also like to thank Mr. Meet Gupta for his supervision and assigning me my tasks during the internship. His insight on powder metallurgy and the various machines at the factory were extremely helpful in my research on diamond saw blades and its dynamics.

Lastly, my heartfelt gratitude goes out to Mr. Manoj Gupta, the director of Ghasiram VNM who selected me for this internship and provided a helping hand on every step of my internship.

Introduction

Ghasiram VNM is a leading importer and manufacturer of power tools and accessories in the Indian market. The quality and reliability of its products is unsurpassed and continues to attract new customers everyday. Established in 2017, the firm has over 70 employees including labourers, production managers, and accountants.

The firm's goal is to be trusted by and remain successful long term partners of their stakeholders, clients, associates, and most importantly, employees.
The firm aspires to be the largest producer of Tungsten Carbide Tip and Diamond saw blades across India as well as across the globe. It assures its clients reliable and efficient products and is accountable to everyone associated with the firm.

Fig.1 Ghasiram VNM's factory

Project Objectives

Ghasiram VNM produces different types of diamond saw blades such as sintered segmented rim blades, Tungsten Carbide Tip blades, Turbo teeth rim blades, continuous rim blades, as well as abrasive flap discs and chisels. These blades, discs, and chisels are manufactured at the factory and are sold pan India and exported to the United States of America. They are used for cutting marble, granite, aluminium, wood, bricks, concrete, steel sheets, ceramic tiles, porcelain,etc. They are used with equipment such as miter saws, circular saws, and chop saws.

My task was to analyse the manufacturing process of the diamond saw blades, study the rotational dynamics of these blades, and suggest methods to improve quality checks. I was also given the task to

come up with methods to induce a safer working environment for the staff handling the machinery whilst increasing productivity.

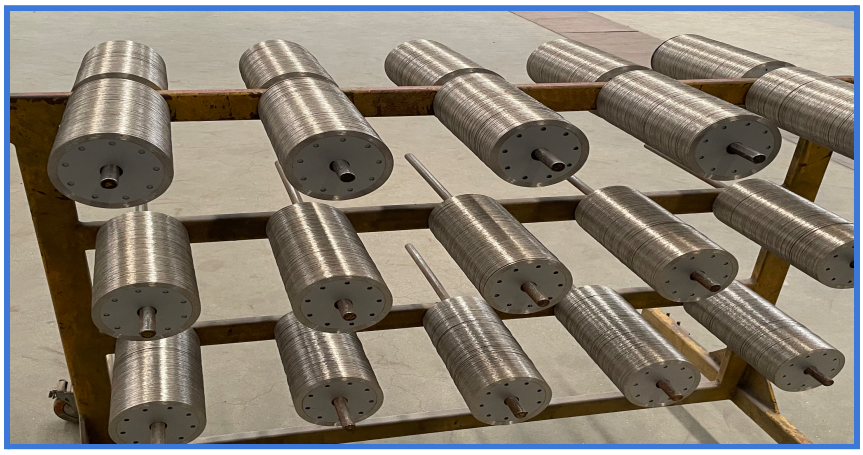

Fig.2 Diamond saw blades after being sintered in the sintering furnace.

Key Terms

Abrasives	Materials used for cleaning and polishing surfaces via rubbing and grinding.
Sintering	Process of fusing different materials together into one solid mass at a high temperature and pressure without melting the constituent materials.
Vickers Hardness test	A quality test which involves indenting the diamond saw blade with a diamond indenter, in the form of a right pyramid with a square base and an angle of 136 degrees between opposite faces subjected to a load of 1 to 100 kgf.
Sintering furnace	Furnaces involved in the sintering process, which increase the blades' mechanical strength, density and translucency and are able to maintain temperatures below the blades' melting point. They are used to shape the blades into the final product.
Brazing	A process used to combine metal items by flowing the filler metal into the joint by capillary action. The filler metals are brazing alloys with a melting point above 450℃.
Arbor hole	It is the central hole of the blade where the blade is connected to the arbor.

Raw Materials

A diamond saw blade is a metallic blade which has commercial diamonds on its edges and grinds abrasive materials. There are many different types of diamond saw blades depending on how their edges are shaped, what materials are used, and are used for different applications. This report deals with metal-bonded segmented diamond blades.

The procedure to manufacture the diamond saw blades begins with the mixing powder made from the raw materials. The mixing powder includes metals like Nickel,Cobalt, Copper, Iron(II), and commercial diamonds. With the variation of these components in different proportions, we can obtain a very wide range of diamond saw blades for various applications such as grinding ceramic, aluminium, marble, granite ,concrete, etc.

Fig.3 The mixing powder

Manufacturing Process

The mixing powder is then put through the cold press to give the circular discs which form the main body of the diamond saw blades. These diamonds can be either natural or synthetic. The diamonds used at Ghasiram VNM were synthetic so that they could be tailor made to suit the particular applications they are being used for. The blades had a Nickel base to make them tough after putting them through the blast furnace which will be discussed later in the manufacturing process. In the nickel grades, the impurities in the mixing powder are uniformly distributed which gives them their tensile strength. A proper coating of a strong of a carbide former suchs as the carbides of Chromium or vanadium are used which ensures a strong diffusion type bond of the diamonds with the mixing powder.

The process of mixing takes place in a turbula type mixer where a gold lustrous powder is obtained as the mixing powder. The mixing powder is then placed in the cold press. The cold press machine has a power of 4kW.
During the cold press, the diamond segment gets its shape after superimposing the mixing powder on the steel core. The exposed diamonds in the matrix in these segments are the components of the blade that do the real cutting and grinding and hence the name diamond saw blades.

The segment is then removed from the hydraulic cold press and placed in the hydrogen shield sintering resistance furnace. It is made of $1Cr_{18}Ni_9Ti$ alloy steel. The heating element is made of $Cr_{20}Ni_{80}$ nickel-chromium alloy wire. The furnace has an inlet for hydrogen gas produced by decomposition of ammonia gas and has an outlet at the bottom. The sintering furnace has three parts: the upper part, the middle part and the lower part. The sintering temperature of the furnace reaches a sintering temperature of about 870 degrees celsius and remains constant for about 8 minutes where the batch of blades get hardened and the blades take their final shape. It has a maximum temperature of 1050 degrees celsius. The upper part is at a lower temperature than the middle and the lower part for even distribution of heat. The furnace has a capacity of 400 pieces per hour.

Thus, the powder is then molded into its circular shape and then heated in the sintering furnace under pressure to form a solid called the matrix. The segment/rim is wider than the steel core and this side clearance allows the edge of the blade to penetrate the material that is to be cut. The methods of attaching the segments to the steel core include brazing and laser welding.

The segment or rim is slightly wider than the blade core. This side clearance allows the cutting edge to penetrate the material being cut without the steel dragging against the sides of the cut. There are several methods of attaching the segments to the steel core.

A quality check is then done to ensure that the blades are strong enough and are durable. This is commonly done at Ghasiram VNM by using the Vickers hardness test. The Vickers hardness test consists of indenting the diamond saw blade with a diamond indenter, in the form of a right pyramid with a square base and an angle of 136 degrees between opposite faces subjected to a load of 1 to 100 kgf. The two

diagonals of the indentation left in the surface of the material after removal of the load are measured using a microscope and their average calculated. The area of the sloping surface of the indentation is calculated. The Vickers hardness is the quotient obtained by dividing the kgf load by the square mm area of indentation. This is done to ensure that the blade retains an edge, and that the blade is hardened excessively to the point where it becomes brittle.

Another type of common quality test is known as the cutting test whereby the blades are tested on the materials that they are supposed to grind. Many different types of blocks of materials such as concrete, granite, marble, etc are kept at the workplace to test the diamond blades according to their types and applications. They are mostly used in either an angle grinder or a circular saw.

After the blades have been tested using the hardness test or the cutting test ,they are put through the process of painting and packaging. The paint ensures that the blades don't get rusted due to moisture. The paints used are primarily acrylic. They are then packaged according to the various types of blades such as continuous rimmed, segmented, or turbo blades.

Fig.4 Cold press machine.

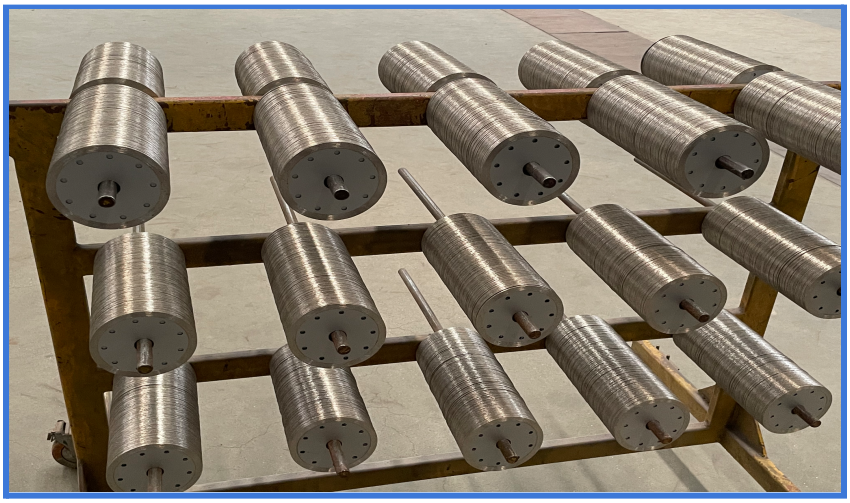

Fig.5 Unsegmented diamond blades' cores.

Fig.6 Sintering furnace.

Fig.7 The baked blades after being put through the sintering process.

Fig.8 The brazing process.

Fig.9 The painting process

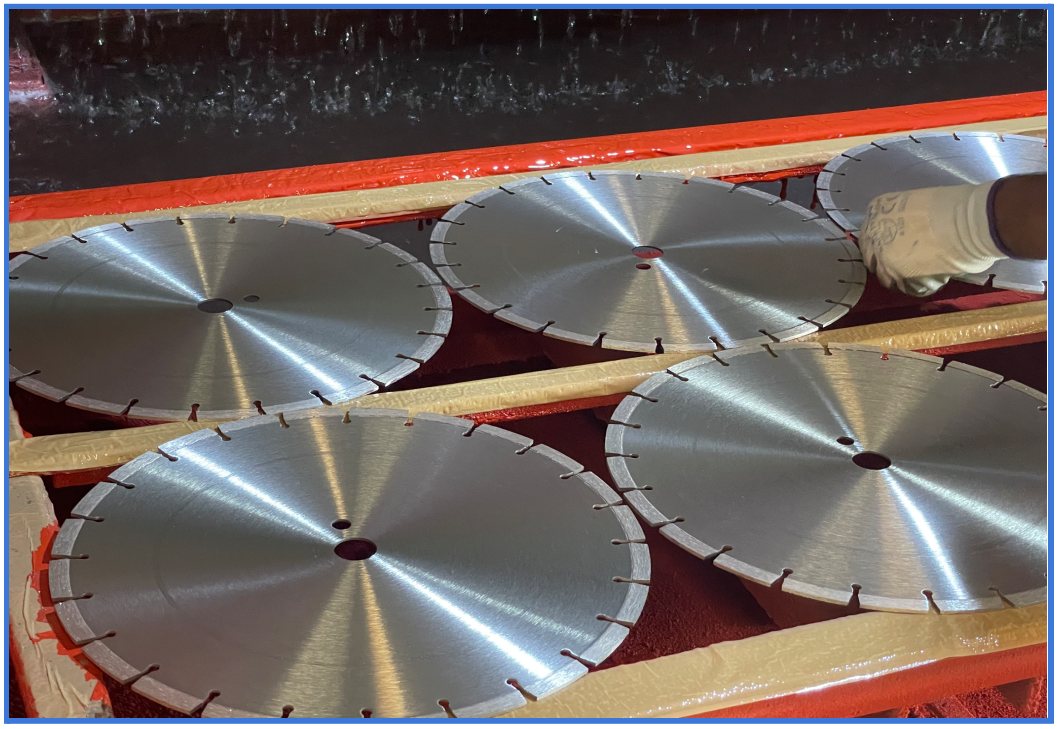

Fig.10 Finished blades ready to be packaged

Structure of the diamond saw blades

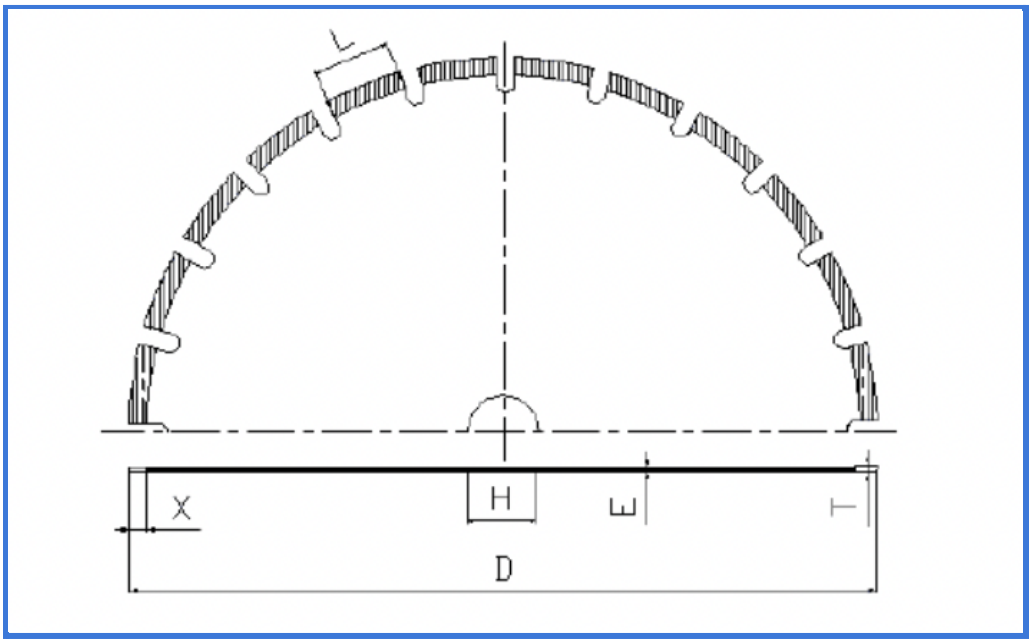

Fig.11 General outline of a diamond saw blade.

X= Width of the segment
D= Outer diameter of the diamond saw blade

H= Inner diameter of the the diamond saw blade
E= Depth of saw blade
T= Depth of the segment
The hole at the centre of the blade is known as the arbor hole. It is essential to know the arbor hole measurements while choosing a diamond saw blade for maximum efficiency in cutting and spinning. The diamond segment is superimposed on the steel core during the brazing process and these blades are then hardened in the sintering oven.

Analysis of the rotational dynamics of the diamond saw blades

As the blades' diameter keeps increasing, the rotations per minute keep decreasing. By doubling the blades' diameter the rotations per minute become nearly half.This means that the blades' diameter is inversely proportional to the blades' rotational speed.
Moreover, the blade's speed differs based on the application of the blade. For a blade made of the same diameter, the descending order of the rotations per minute is for a blade used for grinding sandstone, then marble, then soft granite and finally hard granite.

The formula used for calculating the recommended speed of rotation per minute for a blade:

$$n=(V_p \div 2\pi R) \times 60{,}000$$

Where,
n= Rotations per minute of the blade
V_p= Peripheral speed of the blade
R= Radius of the blade

Suggested safety measures and quality check methods

1)Nominal tensioning should be done for each and every diamond blade. Each blade should be tensioned according to its dimensions to run at a specific rotational speed. Blades that function at either a higher or lower speed may wobble or flutter which causes cracks in the core.

2) Blades should ideally function between 9,000 to 13,000 surface feet per minute. Each blade should work within the recommended range of RPM. Smaller blades have a higher recommended RPM.

3)While testing the diamond saw blades, strong vibrations during the cutting test can lead to a decrease in the accuracy of the diamond saw blade's cutting. The high level of noise produced by these blades is also

harmful for the workers. A lot of heat generated by friction during cutting also leads to deformation of the blades.

Thus it is suggested that the following step should be followed:
There should be a previously defined criteria to measure the performance of the blades and the tool wear should be measured and kept in check by using parameters such as diameter variation and the blades' weight loss. These blades should be adapted to test several cutting conditions.

To ensure safety of the workers I explained the reaction of the decomposition of ammonia which takes place in the sintering oven and how inflammable the hydrogen gas is so they should keep any inflammable substance as far as they can from the furnaces and the wires connecting them.

The workers were to wear masks at all times in the cold press and mixing room so that they don't inhale any of the powder dust of the metals such as cobalt and nickel.

The recommended RPM ranges for the blades of different diameters sold at Ghariram VNM are given below. I suggested this range of rotational speeds during testing to the production manager after reviewing an article on the same and testing it with the workers at the factory. I repeatedly told the workers that as diameter increases, the rotational speed should decrease while carrying out quality checks. The following table summarises my research and observation:

SIZE	MINIMUM RPM	MAXIMUM RPM
4" (101.6 mm)	9,000	15,000
4.5" (114.3 mm)	8,000	13,500
5" (127 mm)	7,200	12,200
6" (152.4 mm)	6,500	11,000
7" (177.8 mm)	5,100	10,000
8" (203.2 mm)	4,500	8,700
9" (228.6 mm)	4,000	7,600
10" (254 mm)	3,600	6,700
12" (304.8 mm)	3,000	6,100
14" (355.6 mm)	2,500	4,300

Detailed overview of the products at Ghasiram VNM

1.Sintered segmented Diamond Saw blades

SR. NO.	SIZE	SEGMENT WIDTH	SEGMENT HEIGHT
1	4” (101.6mm)	0.9” (22.86 mm)	10mm
2	4.5” (114.3mm)	0.9” (22.86 mm)	10mm
3	5” (127mm)	0.9” (22.86 mm)	10mm
4	6” (152.4mm)	0.9” (22.86 mm)	10mm
5	7” (177.8mm)	0.9” (22.86 mm)	10mm
6	8” (203.2mm)	0.9” (22.86 mm)	10mm
7	10” (254mm)	0.9” (22.86 mm)	10mm
8	12” (304.8 mm)	0.9” (22.86 mm)	10mm
9	14” (355.6 mm)	0.9” (22.86 mm)	10mm

Applications:
1. Concrete, Brick, Light weight Block, Pavers,and Field Stone.
2. Blade intended for Concrete, Brick, Block, Stone & Masonry Materials.
3. For High Speed Saw and upto 20 HP Walk behind saw.

2. Continuous Rim Narrow Teeth Blades

SR. NO.	SIZE	SEGMENT WIDTH	SEGMENT HEIGHT
1	4” (101.6 mm)	0.9” (22.86 mm)	10mm
2	4.5” (114.3 mm)	0.9” (22.86 mm)	10mm
3	5” (127 mm)	0.9” (22.86 mm)	10mm

4	6” (152.4 mm)	0.9” (22.86 mm)	10mm
5	7” (177.8 mm)	0.9” (22.86 mm)	10mm

Application:
1. Used for grinding Granite, Marble, Concrete, Brick, Block, Stone, Tile and Masonry Materials.

3. Continuous Rim Tile Blades

SR. NO.	SIZE	SEGMENT WIDTH	SEGMENT HEIGHT
1	4” (101.6 mm)	0.67” (17.018 mm)	10 mm
2	4.5” (114.3 mm)	0.67” (17.018 mm)	10 mm
3	5” (127 mm)	0.67” (17.018 mm)	10 mm
4	7” (177.8 mm)	0.67” (17.018 mm)	10 mm
5	8” (203.2 mm)	0.70” (17.018 mm)	10 mm
6	9” (228.6 mm)	0.70” (17.018 mm)	10 mm
7	10” (254 mm)	0.70” (17.018 mm)	10 mm

Application:
1. Blade used for all types of Ceramic Tiles, Quarry Tiles, Porcelain, Stone, Marble and Granite.

4. Turbo Blades

SR. NO.	SIZE	SEGMENT WIDTH	SEGMENT HEIGHT
1	4” (101.6 mm)	0.9” (22.86 mm)	10 mm
2	4.5” (114.3 mm)	0.9” (22.86 mm)	10 mm
3	5” (127 mm)	0.9” (22.86 mm)	10 mm
4	6” (152.4 mm)	0.95” (24.13 mm)	10 mm
5	7” (177.8 mm)	0.98” (24.89 mm)	10 mm

6	8” (203.2 mm)	0.98” (24.89 mm)	10 mm
7	9” (228.6 mm)	1.00” (25.40 mm)	10 mm
8	10” (254 mm)	1.00” (25.40 mm)	10 mm
9	12” (304.8 mm)	1.25” (31.75 mm)	10 mm
10	14” (355.6 mm)	1.25” (31.75 mm)	10 mm

Applications:

1. Blade intended for Concrete, Brick, Block Sandstone, Tile and Masonry Materials.

Fig.12 Collection of the diamond saw blades sold at Ghariam VNM.

Resources:

http://www.spomcn.com/product/show.php?itemid=70

https://www.researchgate.net/publication/287195293_The_Mechanical_Property_Analysis_of_Circular_Saw_Blades_under_Different_Rotational_Speeds

https://www.mkdiamond.com/pdf/prop65/MK_blade_manual.pdf

https://amastone.com/guide/bridge-saw-blades-parameters-when-cutting-marble-granite-and-ceramic/

https://www.gordonengland.co.uk/hardness/vickers.htm