ConSpare

Make it better.

Why sustainability is a concrete matter

Reducing carbon and cost from concrete batching plant operations

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Contents

Foreword

Apart from water, concrete is the most common material on the surface of the earth.

Humans have been using concrete in construction projects for millennia, with its basic ingredients – sand, aggregate, cement and water – being combined as a building material as far back as ancient Egyptian times.

Concrete is a key part of the fabric of our lives, but its environmental impact in terms of CO_2 emissions pose a significant problem.

It is so widely used that concrete production contributes an estimated eight per cent of all global CO_2 emissions caused by humans[1], and the year-on-year growth of global construction activity will only exacerbate this if action is not taken.

At a time when the UK government has made a legally binding commitment[2] to achieve carbon net zero by 2050, finding environmentally conscious ways to produce concrete is mission-critical.

There is good news on this front. We know from our work with virtually every concrete producer in the UK that the industry is pulling in the right direction to make this goal a reality, and there is a communal understanding that we are going to need to work together – not just as a concrete sector, but the wider construction community – to share the expertise needed to work towards achieving net zero.

With the clock ticking, there is no time better than now.

Clear action needs to be taken. Looking at our own business, we've prioritised getting our own house in order to reduce our carbon impact. Now, we want to help start different conversations and work with our customers in new ways to meet sustainability aims.

The key message that needs to be shared is that this is not an either/or between sustainability and profit. By identifying where efficiencies can be made within both concrete batch plants and the existing production process, carbon emissions can be reduced and the industry can become more profitable at the same time.

We hope that throughout this white paper, the need for a more sustainable concrete production process is made clear, as well as the route to getting there, and explore the significant impact that effective maintenance strategies have on keeping CO_2 emissions low for the long-term.

Together with the right technology and approach, we can all make savings – environmentally and financially.

It's time for solutions that don't cost the Earth.

James Bullock, CEO, ConSpare, and President of the Materials Handling Engineers' Association (MHEA)

1 The Climate Group, ConcreteZero: https://www.theclimategroup.org/concretezero#:~:text=ConcreteZero%20is%20a%20global%20initiative,with%20World%20GBC%20and%20WBCSD

2 GOV.UK: https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

Introduction

There are myriad reasons for concrete's ubiquity. It is indisputably the most versatile, durable and cost-effective building material on the planet, and its use on major infrastructure and building projects means that it will continue to be here for centuries to come.

The growth of construction will only increase concrete usage, especially as global construction output is expected to grow by 42% by 2030[1] according to the Institute of Civil Engineers. Our comprehensive database puts the number of batching plants in the UK at approximately 2,000. As a result of the carbon-intensive materials and process used to make concrete, these plants are currently contributing 1.5% of the nation's carbon footprint per year.[2]

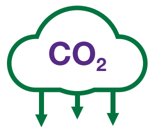
The industry is active in solving the problem and is undertaking a wide variety of measures to reduce the carbon footprint associated with concrete production, with cement replacements, carbon offsetting, electric vehicles and carbon capture amongst methods that are helping to improve the situation. However, there is still a long way to go.

In order to reduce this impact and ensure that both national and global carbon reduction targets can be met, there needs to be a sea-change in the way the concrete industry approaches its processes.

This white paper will identify the key areas where carbon emissions associated with concrete production can be reduced, particularly through improving the performance of concrete batch plants and smart maintenance solutions. We will analyse how this can be achieved through three key methods; reducing power, reducing raw material usage, and reducing maintenance interventions.

1 Building Magazine: https://www.building.co.uk/sponsored-content/taking-concrete-action-for-a-sustainable-future/5121543.article

2 Institution of Civil Engineers: https://www.ice.org.uk/news-insight/media-centre/press-releases-list/construction-sector-could-more-than-halve-emissions-from-concrete-by-2035/



There are approximately 2,000 batching plants in the UK contributing

1.5% of the nation's carbon footprint per year[2]

The problem

As with the vast majority of the construction industry, concrete production is in a state of flux as it tries to balance growing project demands with the need for a more sustainable approach to building.

1 https://cement.mineralproducts.org/Sustainability.aspx.

2 Eoin McQuone, Chief Carbon Coach, Founder and Managing Director.

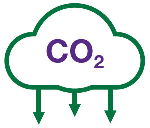
3 BSRIA Inventory of Carbon and Energy 2011 figure for ‘general’ virgin steel’

Producing concrete through concrete batch plants has always been a resource intensive process. It requires large volumes of raw materials, particularly high CO_2 cement (729kg of CO_2 emitted per tonne[1]), is powered by electricity (0.26kg of CO_2 per kWh[2]), and consumes large amounts of steel components such as wear parts and spare parts (2,700kg of CO_2 emitted per tonne[3]).

Cement usage – a key issue

One of the main reasons that the concrete industry is responsible for a high proportion of carbon emissions is its use of a key mix constituent – cement.

The process of calcining limestone to create cement is an intensive process, with an estimated 729kg of CO_2 emitted per tonne through power consumption and the chemical reaction involved. Although this figure has decreased since the 1990s, it remains a pervasive issue as the industry looks for solutions to reduce its overall footprint.



729kg of CO_2
emitted per tonne

This all plays out alongside a multitude of other factors that make industry-wide solutions all the more challenging.

It is a capital-intensive industry, with a large number of relatively small-in-scale concrete plants, which are widespread geographically to be local to both customers and raw material sources. This decentralised structure makes coordinated change difficult to implement.

Combine that with the changing nature and scale of large infrastructure and building projects – which have led to concrete mix designs becoming ever more complex – and a perfect storm begins to build.

Put simply, the problem is that currently, numerous concrete batch plants are not operating as efficiently as possible, resulting in wasted materials, unnecessary energy expenditure and increased maintenance interventions – which ultimately result in larger carbon emissions.

It is however understandable why there is room for improvement. The reality is that concrete production is an extremely precise process. Each part of the sequence is only as strong as the weakest link in the chain. When analysing the five key stages of concrete production – storage, conveying, batching, mixing and discharge – each faces its own individual challenges when it comes to the balance between productivity, cost-efficiency and sustainability.

However, one common factor that binds them all together is the potential for inefficiencies if equipment is not well specified and maintained.

This problem is far-reaching unfortunately, and many concrete plant operators know all-to-well that inefficiencies are part and parcel of the industry, but it doesn't have to be this way.

A well designed and operated plant is less energy intensive, produces less waste and is more reliable, which naturally has a positive environmental impact.

This approach is a way the concrete industry can be more sustainable through real action.

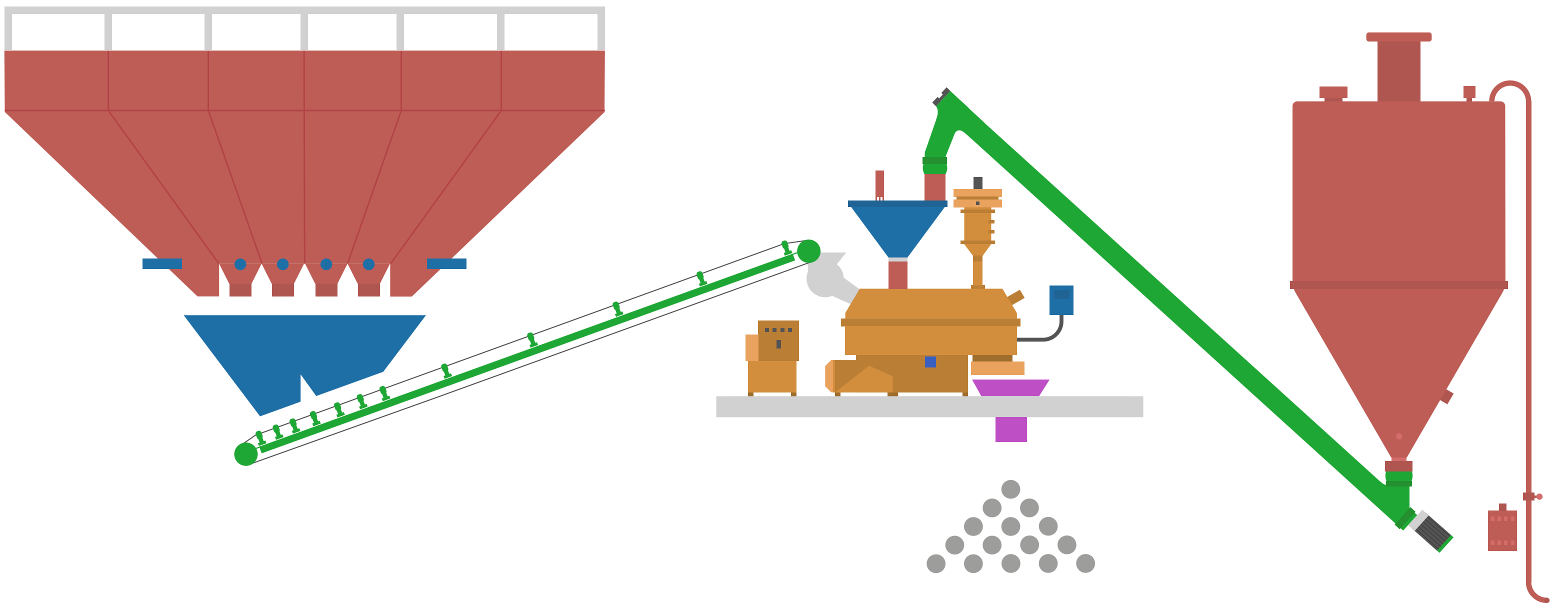
Challenges in the process

Concrete batching plants produce many types of concrete, in various output sizes, using different raw materials. Despite this, the production process itself is very similar throughout the UK.

The primary goal of any concrete batch plant is to ensure that mix constituents are combined in the correct proportions, at the right time, in the right sequence, to produce a batch that meets specification and is compliant with regulations, at the lowest cost and with the least waste.

At ConSpare, we break this process down into five distinct stages within a typical batch plant:

- **Storage** – of raw materials in silos, hoppers and vessels
- **Conveying** – of raw materials through a network of conveyors
- **Batching** – controlling and understanding required mix constituents per batch
- **Mixing** – mix constituents to produce an homogenous batch
- **Discharging** – to the next stage of process, be it a truckmixer or precast production line



Breaking down the activities of a typical concrete batch plant into these processes allows producers to find problems which are creating inefficiencies. These problems can then be assessed and their impact on production analysed.

Although the initial problem may seem small at batch level, for example, a little extra cement added to each batch to ensure strengths are met, or mixers taking a few extra seconds to homogenise the mix, the additional cost and carbon emissions start to add-up very quickly.

When you combine this with the linear process of concrete production, any problems start to have knock-on effects across other elements of the process and can create bottlenecks. This cumulative effect ensures great rewards can be found when tackling problems within the batch plant and production process.

Challenges in maintaining the process

A concrete batch plant often has an operational life of up to 30 years, so plant maintenance decisions have a long tail in terms of both carbon emissions and whole-life maintenance costs.

Even the highest performance concrete batching plant will reduce in efficiency over time, and proactive maintenance investments and maintenance interventions provide a perfect platform to implement further improvements.

For example, the performance of a concrete mixer can be restricted by elements including something as simple as its cleaning regime. Excessive concrete build-up in the mixing pan will affect the performance of mixing tools, which will extend mix times and affect the quality of the mixing action – potentially leading to reject batches.

As a highly abrasive process, replacement of components and wear parts is commonplace throughout the plant, often resulting in high usage of materials such as steel, rubber and polymers. Using maintenance as an opportunity to upgrade components to those which last longer, at a lower whole-life carbon footprint, provides those same cumulative benefits as experienced when improving the process.

Finding the solutions

Finding solutions is about making changes, but not necessarily giant ones. If the concrete industry can draw on the theory of marginal gains – making small, seemingly insignificant changes to processes that compound over time into wholesale improvements – this has the ability to make a big impact on improving Overall Equipment Effectiveness (OEE) and simultaneously on carbon reduction.

While the challenge is significant, we as an industry are on the cusp of a massive opportunity to modernise and reshape our path, just at the point where it is most needed. If you view the production process through the lens of reducing carbon, targeted investment decisions can be made to ensure that concrete plant operators achieve maximum benefit.

Across the concrete batch plant and the five stages of the production process, there are three key areas in which efficiencies can be made in terms of both carbon and cost.

Reducing raw material usage and waste

Reducing cement usage, whether that be Ordinary Portland Cement (OPC) or a green alternative. Minimising the number of rejected batches and maximising yield.

Reducing power usage

Identifying areas of the process where excess power is expended through poorly specified or maintained equipment, and adopting energy efficient technologies.

Reducing maintenance interventions

Ensuring that the concrete batch plant is running as efficiently as possible with minimal maintenance, investing in components and spares with the lowest whole-life carbon footprint.

By focusing efforts in these three areas, concrete batching plants can complement other carbon saving activities with operational efficiencies. By its very nature, the production process is full of bottlenecks, and it is these bottlenecks that are often hidden producers of carbon waste. Selecting the right batching plant equipment and components is vital in eradicating these pinch points, which is a win-win for all concerned – equipment upgrades are comparatively low cost, can be delivered quickly and provide an overwhelmingly cost-effective way to create benefits for both CO_2 reduction and lower operational expenses.

As the nature of concrete production is highly abrasive, plants need smart maintenance solutions to incorporate proactive servicing, preventative maintenance and high performance spare parts to ensure less unexpected downtime and maximise productivity.

When parts do need replacing, selecting options that will perform better and last longer will also reduce waste, both financial and environmental.

Alternative approaches in the industry

- Hanson has progressed the industry toward a more sustainable future with its plan to build the UK's first net-zero cement plant, while Renault and TVS have produced an electric truck mixer, the first of which was purchased by Tarmac last summer.
- Aggregate Industries offers ECOPact Zero concrete, a type that claims to offer a carbon neutral solution whereby the last mile of process-related emissions are compensated through offsets as a transition mechanism to full carbon neutrality.
- Carbon offsetting has become a huge trend for companies in all industries to improve their green credentials, and is a method of reducing their impact in areas of operations where they have already removed as much carbon as possible.
- Last summer, Climate Zero launched ConcreteZero, an initiative with the goal of sourcing 100% net zero concrete by 2050, with leading real estate and construction firms signing up.
- Marshalls are piloting carbon mineralisation techniques. This approach injects CO_2 directly into concrete as it is being mixed, which immediately reacts with cement in the mix and mineralises to create calcium carbonate. Once the CO_2 is mineralised, it is permanently locked into the concrete.
- Bio-sourced admixtures are another emerging technology, and have recently been introduced by Cemex. These admixtures use natural, renewable, and locally sourced raw materials and may achieve a carbon footprint up to 70% lower than traditional oil-based admixtures.

Make it better.

Constantly making small improvements across the whole process, which can then be scaled throughout the wider industry, will help accelerate our combined journey to net zero.

Throughout our 45 years' experience of supporting the concrete production industry, we have led the field in finding the products and processes that make it better, with results that speak for themselves.

1 Building Magazine: https://www.building.co.uk/sponsored-content/taking-concrete-action-for-a-sustainable-future/5121543.article

Reducing raw material use and wastage

One of the biggest contributors to high CO_2 raw material wastage in the concrete production process is the practice of over-cementing, which happens when the amount of water in a batch is incorrectly calculated meaning that additional cement needs to be added to ensure the concrete is of a suitable strength.

The financial and carbon cost of the extra cement is considerable, and the cause is often down to inaccurate measurement of the moisture content within a batch.

This is something ConSpare has seen first-hand when working with a leading readymix producer which was looking at ways to reduce over-cementing and the associated costs and emissions.

As part of its process, the producer was using an average moisture figure when weighing out sand, and the inaccuracy of this method combined with the natural variation of the moisture level within the raw material was causing an inconsistent amount of water to enter the mix.

This inconsistency led to the standard deviation of the concrete being 4.5, which is higher than it otherwise would be, as well as causing under-yielding and inaccurate raw material stocks.

The increased standard deviation, caused by the excess water, meant that ‘over-cementing’ was taking place in order to guarantee that the concrete would be of a suitable strength.

However, by switching from the ‘averaging’ method to Hydronix moisture measurement equipment, the plant was able to drastically reduce over-cementing.

Hydronix probes measure the moisture content of the sand accurately on a batch-by-batch basis, allowing the plant control system to automatically adjust the water input to compensate.

The result of this was an average reduction of 26kg of cement was achieved per cubic metre of concrete produced – equivalent to 1,413 tonnes of cement per year.

Hydronix

The reduction of cement and sand costs was equivalent to an annual return on investment of over 2,460%, meaning that the Hydronix equipment paid for itself within three weeks of operation.

At cement prices of £130 per tonne, the cement saving alone would be approximately £185,000 per year, while the annual saving of 1,413 tonnes of cement will reduce CO_2 emissions over a year by 1,030 tonnes.

£185,000 saved from cement reduction per year

2,460% annual ROI

1,030 tonnes of CO_2 emissions saved per year

What if

Another 500 readymix plants in UK adopted this technology, the savings could be

515,000 tonnes of CO_2 per year

What about

Reducing conveyor carryback and spillage:

Although sand and aggregates carry lower CO_2 content than cement, any inefficiencies in handling these materials lead to waste. Poorly cleaned and sealed belt conveyors suffer from material carryback and spillage. This lost material has to then be cleaned up, transported away from the plant and either reprocessed or scrapped, increasing operational costs and adding to hidden carbon emissions.

What about

Reducing rejects:

In addition to saving CO_2 through reducing cement usage, accurate moisture measurement can also provide significant reductions in product reject rates. Any reject concrete products or concrete batches result in the majority of materials, power, and resources used in production to be wasted.

Hydronix probes installed in sand bins

Reducing power usage

The efficiency of electrically powered equipment, such as mixing equipment, is another area where small changes can lead to impressive savings both in terms of operating cost and carbon emissions.

Concrete mixers regularly work for thousands of hours per year. Depending on the batch size and design of the machine, mixer drive motor systems can be rated from as little as 5kW all the way up 180kW. The generation of this power is responsible for significant CO_2 emissions and substantial financial cost, particularly in these unprecedented times.

In 2010, ConSpare replaced an energy intensive rotating pan mixer with a Teka TPZ1500 planetary mixer at a leading roof tile manufacturer. In this case, the firm's engineering manager primarily required the new mixer to achieve the same high quality of output but with fewer costs and less maintenance.

The $1m^3$ output TPZ mixer proved a success and consistently achieved the same mix quality and production volumes as the previous machine. It managed to achieve this through using only a 45kW drive motor, compared to the 82kW drive system fitted to the previous mixer.

The company operated both mixers for 2,500 hours per year at around 75% of maximum rated power, meaning that the Teka mixer has been saving over 68,000kWh of power per year. A total saving of 816,000kWh over the 12 years.

Over the period in question, the UK emitted an average of around 0.35kg of CO_2 per kWh generated. This, multiplied by the total power reduction, gives a total saving of 285 tonnes of CO_2.

68,000kWh
of power saved per year

285 tonnes
reduction of CO_2 in total

Teka

£40,800
power cost saving per year

70%
fewer spare parts used per year

Cost savings were also significant. Based on a rate of 60p per kWh this means the annual power cost saving is £40,800.

The client has also reported that the Teka mixer has used 70% fewer spare parts per year, which also has an environmental impact due to the amount of steel and tungsten these parts contain, as well as the financial and environmental savings that have been made by a reduced need to buy, transport and install spare parts.

Since the first installation, the company has invested in several additional Teka mixers, contributing significantly to producing more sustainable, lower carbon roof tiles at a lower cost.

Teka TPZ mixing action

What about

Reducing batch cycle times:

In addition to reducing power usage through more efficient mixing technology, optimising the batch cycle can also produce significant results. Minimising mix times, whilst maintaining mix quality, will reduce power consumed by the machine per batch. Making more concrete for less power.

Moisture measurement in the mixer can provide a window to analyse homogeneity of the batch and avoid unnecessary over mixing. As soon as homogeneity is reached the batch can be discharged immediately, and the batch cycle kept to a minimum.

More effective and efficient mixing actions can also reduce mixing times whilst using comparable motor sizes. For example, Teka's THT turbine mixer offers a radically different mixing action. In a recent case study, a major producer of paving slabs using THT reported a 30% reduction in mixing time compared to conventional planetary mixing technology with identically sized motors.

Reducing maintenance interventions

Maintenance interventions are a third critical area where efficiencies can be made, bringing about significant reductions in downtime and usage of carbon intensive spare parts.

The raw materials handled during production are tough on the equipment within a concrete batch plant, particularly in terms of impact, abrasion and material build-up. By finding solutions that last longer, and require less ongoing maintenance, batch plant operation can be streamlined to bring about financial and carbon savings.

ConSpare recently worked with a renowned manufacturer of building materials in Scotland and the north of England which was using two pan mixers to produce both concrete products and readymix concrete. The constituents of the concrete mix included both abrasive aggregate and coarse sand, which were having an impact on the service life of the pan mixers' wear parts.

In particular, the cast steel mixing blades required replacement after a period of only three months – equivalent to the replacement of 32 blades per year in the first mixer alone.

However, by replacing the cast steel blades with a Hawiflex® polyurethane alternative that lasted three times as long (nine months), the company significantly reduced the maintenance requirements of the mixer.

Because the mixing blades last longer, fewer will be required per year. Using current ConSpare prices, the total cost of buying and shipping a year's worth of Hawiflex® blades for this mixer with these wear rates is 52% lower than buying the cast steel, demonstrating that Hawiflex® blades have a lower whole-life cost.

Critically, in addition to the substantial cost savings, the move to Hawiflex® is also significantly more sustainable. By comparing the total weight of blades required per year for each option we calculated the total embodied carbon, which is 450kg of CO_2 for cast steel and just 108kg of CO_2 for Hawiflex®. This is an annual reduction of 342kg of CO_2 or 76%.

Hawiflex® polyurethane blade

In addition to the direct savings of CO_2, reductions in installation, maintenance and shipments of parts via haulier, will all result in additional carbon savings.

52% saved
using Hawiflex® blades

£

Annual reduction of
342kg of CO_2

CO_2

What about

Mixer wear plates

Reducing CO_2 associated with mixer blades is just the tip of the iceberg in terms of reducing usage of CO_2 intensive spare parts in a mixer. Steel wear plates in particular have a high cost in terms of carbon.

In a recent case study, a block producer was replacing its chill cast steel mixer floor tiles every two years due to premature failure as a result of impact damage. We calculated that the steel used to make each set of cast floor tiles equates to a carbon footprint of 2,300kg of CO_2. Given that the set was only lasting two years, the floor had a carbon cost of 1,150kg of CO_2 per year. Our wear plate solution which replaced this set is forecast to last for seven years, and after two years is showing minimal signs of wear and no impact damage.

What about

Components, big or small, cumulatively add up to make a big difference

- Extending component life through intelligent maintenance decisions can cumulatively and collectively make a big difference. For example, although material carryback on a conveyor may seem an isolated issue, it can result in accelerated wear of idlers, conveyor belts, and ultimately the conveyor structure. Although these items range in value and embodied CO_2, process level maintenance problems across the industry add up to a significant whole.
- Proactively maintaining equipment safeguards the efficiencies producers invest in. For example, there are significant benefits to maintaining equipment through scheduled maintenance and housekeeping. Daily cleaning of the concrete mixer will keep the mixing pan clean and ensure the operation is uninterrupted. Clean mixers mix better and, in our experience, use fewer spare parts.

Dr Miles Watkins

Industry expert and ConSpare's sustainability consultant

“Sustainability is changing society. Sea levels are rising, we have more droughts and heatwaves than in any time in human history, and Arctic ice is on course to disappear in our lifetimes.

This is having a massively impactful change and businesses need to understand how society is moving and move with it, or risk getting left behind.

There has been a considerable effort by our industry to tackle this problem, but we've only just begun – we're about to embark on a journey and everyone will need to throw their hat in the ring and take part.

ConSpare is instrumental in providing help to organisations who are struggling to find a solution, and is playing a critical role in helping its customers achieve their goal of reducing their carbon footprint.”

Conclusion

It is not often that an industry has the obvious choice. From a business standpoint, all too often compromises must be made to achieve a set of aims. In this instance, however, reducing carbon from the concrete production process can realistically be achieved at the same time as reducing cost. We know how to do it.

We are concrete industry experts with over 40 years' experience of upgrading batch plants and solving process problems. By providing the most effective equipment and smart maintenance solutions we can reduce material wastage, energy usage, and minimise spare part consumption at plant level.

Our approach is proven to 'Make it better', an ethos that ConSpare has held throughout the generations and will continue to promote as we move forward.

As ethical engineers, we recognise that long-term economic growth cannot come at the cost of the planet.

We exist to pave a sustainable way forward for the concrete production industry through evidence-based solutions that are proven to reduce environmental impact and preserve our planet for future generations.

Our pledge is to reduce carbon emissions associated with concrete production. We will always do more and help our customers to take advantage of the innovations we tirelessly continue to bring to the market.

We also want to provide the insight which allows our customers to make informed decisions through the lens of carbon.

We're proud of where we have come from but while we have the skills, expertise and experience to make a difference, our one voice isn't enough.

We hope the industry will work together as a coalition of change-makers to focus on the things that matter and drive as much carbon as possible out of the concrete production process as quickly as we can, however we can.

James Bullock, CEO, ConSpare, and President of the Materials Handling Engineers' Association (MHEA)

ConSpare

We urge you to join us on this journey and look forward to supporting the concrete production industry. For more information please contact us:

Call: 01773 860796
Email: sales@conspare.com

Our concrete commitment

We pride ourselves on our continuous improvement, and last year started focussing inwards on how we can become as sustainable as possible.

We have partnered with Go Climate Positive to accurately evaluate, monitor and improve the carbon footprint of our business, and we are on track to reduce our emissions by 70% since we moved to our new, purpose-built premises in May 2022.

We have also installed a 100kw solar array on the roof of our Castlewood headquarters, powering our entire operation and saving 23.5 tonnes of CO_2 per year – equivalent to 21.5% of our total Scope 1 and Scope 2 emissions.

We designed a thermally efficient building that no longer requires a gas or oil heating supply in favour of a lower carbon electric alternative, along with EV charging points, extensive planting and our new paperless process that saves 32,000 sheets of paper per year – a 40% reduction on the previous year.

We have completely overhauled our brand, in an effort to set the industry standard for sustainable concrete production, accelerating our collective journey to net zero.

23.5 tonnes of CO_2 per year
saved by solar power

40% paper reduction
saving 32,000
sheets of paper a year

ConSpare

Make it better.

For more information or to discuss your requirements please contact us:

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