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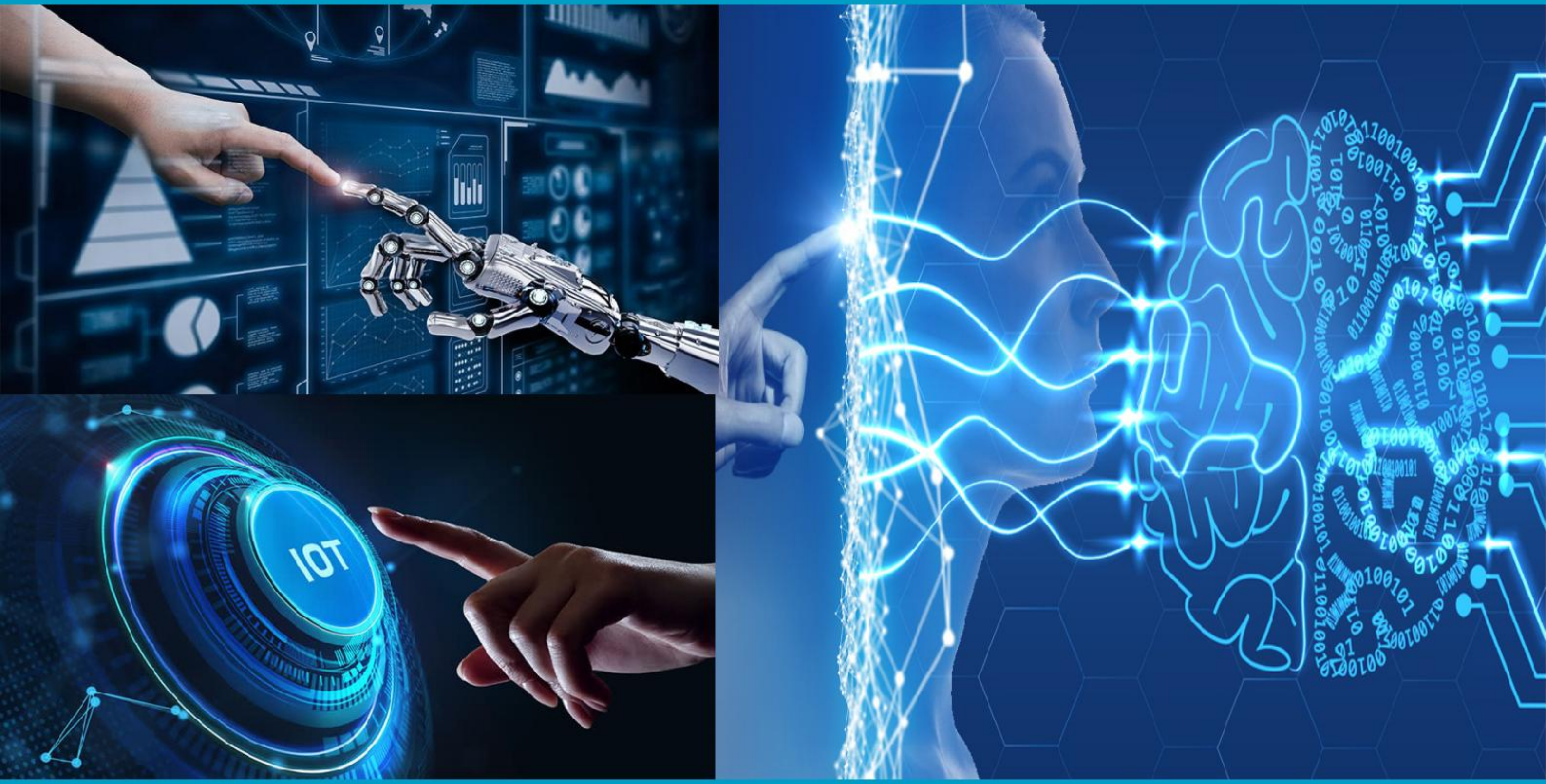

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Experimental Conduction and Analysis on the Conventional Spiral helix DNA-Helically Reinforced Columns with Mixing of Rubber

HARSH KUMAR, ABHISHEK SHARMA

Transportation Engineering, CBS Group of Institutions, Haryana, India

ABSTRACTS: The major responsibility of the columns is to provide the slabs structural support in some way. If a column is unable to hold beams, then those beams will not be able to sustain walls and slabs, which will ultimately result in the collapse of the whole structure. Because they are the primary components responsible for transporting loads from the superstructure to the foundation, columns are vulnerable to experiencing significant axial loads and moments. As a result, the design of these components should be prioritised. Those columns that have a greater degree of ductility tend to fail in a manner that is less catastrophic than others and to provide warning signs before they do. The ductility of reinforced concrete columns is a key component in determining their seismicity. This is due to the fact that a column with strong ductility is capable of absorbing and distributing the energy that is caused by earthquakes. It has been demonstrated that the ductility of circular reinforced concrete columns can significantly improve when spiral reinforcement is utilised to restrain the concrete in the compressive zone. In the DNA helix column that had rubber connections in the middle, the specimen that was inspected was 720 millimetres long, while in the other DNA samples, the specimen that was tested was only 600 millimetres long. The DNA helical reinforcement demonstrated better properties in terms of ultimate compressive strength, ductility, stiffness, and flexibility parameters, despite the fact that the DNA helix column with rubber in the centre was longer than the other specimen. We made the discovery that the use of DNA helical reinforcement, as opposed to the utilisation of spiral reinforcement, has the potential to greatly boost performance in longer columns.

KEYWORDS: Conventional Spiral Helix DNA, Rubber, DNA Helix Column, Longitudinal Reinforcement

I. INTRODUCTION

A column or pillar is a structural part in architecture and structural engineering that conveys the weight of the structure above to other structural members below through compression. Consequently, column serves as a compression device. There are many other types of columns, but the most common is the spherical support (the shaft of the column) with a capital and base (the pedestal) constructed of stone or any other material. Non-round supports with non-round components, such as square posts and rectangular piers, are the difference between them. When used in bridges, piers may take on a round shape. Wind and earthquake engineering may both benefit from the use of lateral force-resisting columns. Supporting beams or arches on top of ceilings or walls is a frequent use for columns. In architecture, the word "column" refers to a structural element having proportional and decorative features. Many columns are "engaged," meaning they form part of a wall, and they may be used as a decorative feature.There was some type of column usage by all major Iron Age civilizations in the Near East and the Mediterranean. Stone columns etched to mimic bundled reeds' organic structure were utilised by Egyptian builder Imhotep as early as 2600 BC, and subsequently faceted cylinders were prevalent in Egyptian architecture. Some of the most elaborate columns were discovered in the ancient world. Ancient Greece, followed by the Romans, preferred the use of columns on both the inside and outside of a building, whilst the Egyptians, Persians, and other civilizations preferred reliefs or paintings on the outer walls. Classical architecture is known for its widespread use of columns, which may be seen both inside and outside structures like the Parthenon. The classical architectural orders were developed by the Greeks, and they may be recognised by the column's form and the pieces that make up the column. The Romans added the Tuscan and Composite orders to the Doric, Ionic, and Corinthian orders.

A column is an essential part of any construction. The columns' primary job is to provide structural support for the slabs. If a column fails to support beams, those beams in turn fail to support walls and slabs, therefore the whole building falls apart. Because they are the principal load-transmitting components from the superstructure to the substructure, columns are susceptible to large axial loads and moments, making their design a priority. Due to the

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considerable axial loads and moments that columns are exposed to; the design of a column should be given particular consideration.Those columns that collapse less catastrophically and provide notice before failure is those that have a higher degree of ductility. Reinforced concrete columns' ductility is an important factor in determining their seismicity since a column with strong ductility is capable of absorbing and dispersing seismic energy. The ductility of circular reinforced concrete columns has been shown to increase greatly when spiral reinforcement is used to restrain the concrete in the compressive zone, and this has been observed in research programmes all over the globe.

R.C.C. columns may be made more flexible by substituting the typical spiral helix reinforcement with DNA double helix reinforcement, which is designed to work as both longitudinal and transverse reinforcement in the same column. Rubber is utilised to improve column flexibility in critical places such as beam column connections and the mid-portion in the form of transverse connections in order to boost the column's seismic performance. Furthermore, the impact of relocating rubber connections on the stiffness and flexibility of thin columns should be studied. Spiral-helix models will be compared to each other in terms of stress-strain variables, stiffness and flexibility, and buckling properties.

Importance And Feasibility

The column is an essential part of any building. The slabs are mostly supported by the columns. It is critical to realise that a column's failure leads in the building collapsing since columns support beams, which in turn support walls and slabs. This means that columns should be designed with care. It is possible to detect failures before they become catastrophic in columns with more ductile behaviour. A column's ductility is also important in defining its seismic behaviour since a column with strong ductility is able to absorb and disperse seismic energy. DNA helical reinforcement mixed with steel and rubber ties has been determined to be a preferable alternative for traditional spiral helical reinforcement in this project work because of the improvements in many column properties. There are several aspects of DNA helically reinforced columns that may be fully explored for future testing and improvisations, which adds to their relevance.

DNA helical reinforcement in columns has the potential to be a viable alternative to spirally reinforced circular columns, at least in the short term. There is just one practical stumbling point to this form of reinforcement: creating the cage for it, which may be easily solved by mechanical mechanisms.

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Structure of Project

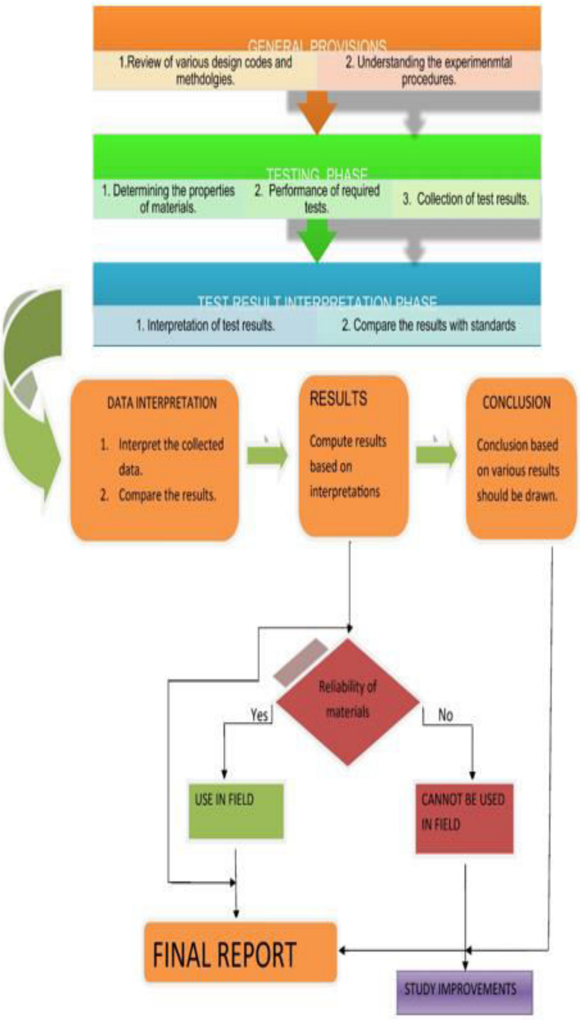

Fig. 1: Structure of Project

II. OBSERVATIONS AND RESULTS

DNA WITH RUBBER TIES AT END SPECIMEN 1

Table 1: DNA with rubber ties at end specimen 1

Load [KN]	Displacement [mm]	Stress [MPa]	Strain
0	0	0	0
10	0.1	0.699301	0.000167
20	0.21	1.398601	0.00035
30	0.32	2.097902	0.000533
40	0.44	2.797203	0.000733
50	0.57	3.496503	0.00095
60	0.71	4.195804	0.001183

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70	0.86	4.895105	0.001433
80	1.01	5.594406	0.001683
90	1.16	6.293706	0.001933
100	1.33	6.993007	0.002217
110	1.52	7.692308	0.002533
120	1.71	8.391608	0.00285
130	1.91	9.090909	0.003183
140	2.13	9.79021	0.00355
150	2.37	10.48951	0.00395
160	2.62	11.18881	0.004367
170	2.88	11.88811	0.0048
180	3.14	12.58741	0.005233
190	3.44	13.28671	0.005733
200	3.76	13.98601	0.006267
210	4.06	14.68531	0.006767
220	4.29	15.38462	0.00715
230	4.5	16.08392	0.0075
237	4.86	16.57343	0.0081
230	5.02	16.08392	0.008367
220	5.22	15.38462	0.0087
215	5.43	15.03497	0.00905
207	5.64	14.47552	0.0094
210	6.12	14.68531	0.0102
216	6.56	15.1049	0.010933
210	6.72	14.68531	0.0112
200	6.88	13.98601	0.011467
190	7.04	13.28671	0.011733
180	7.21	12.58741	0.012017
170	7.42	11.88811	0.012367
160	7.63	11.18881	0.012717
150	7.84	10.48951	0.013067
140	8.02	9.79021	0.013367
130	8.2	9.090909	0.013667
120	8.38	8.391608	0.013967

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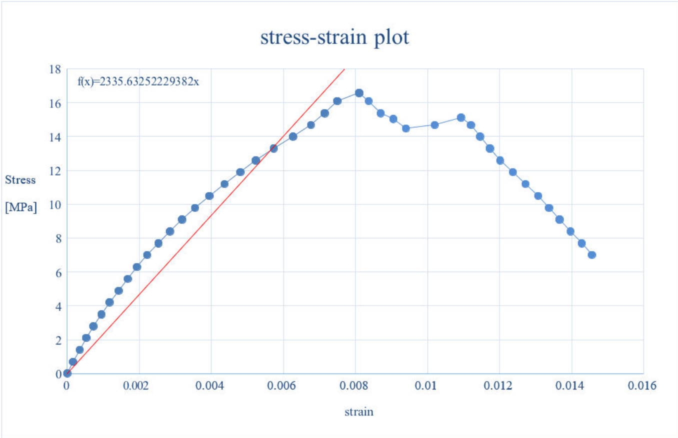

Fig. 2: Stress strain curve DNA with rubber at ends specimen 1

Observations and Results:

Length of specimen (l) = 600mm

Diameter of specimen (d) = 135mm

Area of specimen (A) = $\pi/4 \times 135^2 = 14313.88\ mm^2$

(1) Ultimate compressive strength

Ultimate compressive strength = 237kN

(2) Material properties in terms of elastic constants

(a) Young's Modulus (Secant modulus E)

$E = (\sigma_2-\sigma_1) / (\epsilon_2-\epsilon_1) = (13.28671-0) / (0.00573-0) = 2317.58$ Mpa

(b) Young's Modulus (from equation of best fitting trendline) y= 2335.6x

$E = dy/dx = 2335.6$ Mpa

(c) Poisson's ratio

μ = Lateral strain/Longitudinal strain = $(\delta d/d)/(\delta l/l)$

$= (0.16/135)/(3.44/600) = 0.206$

(d) Shear Modulus (G)

$G = E / 2(1+\mu) = 2335.6/ 2(1+0.206) = 968.3$ MPa

(e) Bulk Modulus (K)

$K = E / 3(1-2\mu) = 2335.6/ 3(1-2x0.206) = 1324$ MPa

(3) Axial stiffness and flexibility (from stress-strain plot)

(c) Axial stiffness = k = AE/l =14313.88 x 2335.6/600 = 55719.17 N/mm

(d) Axial flexibility = δ = l/AE = 600/(14313.88 x 2335.6) = 1.79x10^{-5} mm/N

(4) Ductility in terms of percentage strain

Ductility = (ϵfailure - ϵelastic limit) x100 / ϵelastic limit = (0.0109 - 0.0057)x100 / 0.0057
= 90.7%

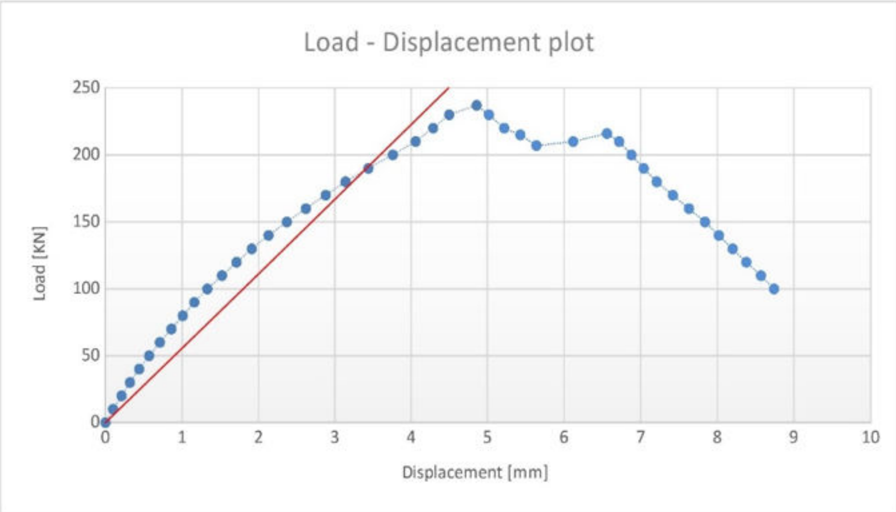

Fig. 3: Load displacement curve DNA with rubber at ends specimen 1

Stiffness and flexibility parameters (from load-displacement curve)

(1)Axial stiffness = k = $(P_2-P_1) / (L_2-L_1)$ = (200-0)x10^3/ (3.76-0) = 53191.49 N/mm

(2)Axial flexibility = δ = $(L_2-L_1) / (P_2-P_1)$ = (3.76-0) / (200-0)x10^3= 1.88x10^{-5} mm/N

5.3.2 DNA WITH RUBBER AT ENDS MEAN VALUES OF SPECIMEN 1 AND 2

(a) Mean Ultimate compressive strength= F_m= (F_1+F_2) /2 = (244+237) /2 = 240.5kN

(b) Mean Elastic Modulus=E_m= (E_1+E_2) /2 = (2316.9+2335.6) /2 = 2326.25 Mpa

(c) Mean Poisson's ratio=μ_m= $(\mu_1+\mu_2)$ /2 = (0.206+0.198)/2 = 0.202

(d) Mean shear modulus=G_m= (G_1+G_2) /2 = (966.9+968.3)/2 = 967.6 MPa

(e) Mean bulk modulus=K_m= (K_1+K_2) /2 = (1278.6+1324)/2 = 1301.3 MPa

(f) Mean axial stiffness from stress-strain plot=k_{m1} =
$(k_1+k_2)/2$ = (55273.05+55719.17)/2 = 55496.11N/mm

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(g) Mean axial flexibility from stress-strain plot $=\delta_{m1}= (\delta_1+\delta_2)/2 =$ $(1.81+1.79)\text{x}10^{-5}/2 = 1.80\text{x}10^{-5}$ mm/N

(h) Mean axial stiffness from load-displacement plot $= k_{m2}= (k_1+k_2)/2$
$= (55263.15+53191.49)/2 = 54227.32$ N/mm

(i)Mean axial flexibility from load-displacement plot$= \delta_{m2}= (\delta_1+\delta_2)/2$
$= (1.81+1.88)\text{x}10^{-5}/2 = 1.85\text{x}10^{-5}$ mm/N

(j)Mean axial stiffness considering both plots $= k_m = (k_{m1} + k_{m2})/2$
$=(55496.11+54227.32)/2 = 54861.72$ N/mm

(k)Mean axial flexibility considering both plots$= \delta_m= (\delta_{m1}+ \delta_{m2})/2$
$= (1.80+1.85)\text{x}10^{-5}/2 = 1.83\text{x}10^{-5}$ mm/N

(l)Mean percentage ductility = (61.06+90.70)/2 = 75.88%

III. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The following conclusions were drawn from the experimental results (as tabulated below) obtained from tests conducted on the conventional spiral helix and DNA helically reinforced columns:

Table 2: conclusions from the experimental results

Parameters	Spiral helix	DNAhelix(simple)	DNA helix(rubber at middle)	DNA helix(rubber at ends)
Ultimate compressive Strength(KN)	233.5	249.5	249	240.5
Young's modulus (E) MPa	2328.34	2666	2282.05	2326.25
Poisson's ratio(μ)	0.244	0.159	0.258	0.202
Shear modulus (G) MPa	933.09	1153.55	907.86	967.6
Bulk modulus (K) MPa	1615.80	1287.7	1573.14	1301.3
AxialStiffness (k)N/mm	55734.84	63731.65	45337.74	54861.72
Flexibility (δ) mm/N	$1.82\text{x}10^{-5}$	$1.60\ \text{x}10^{-5}$	$2.21\ \text{x}10^{-5}$	$1.83\ \text{x}10^{-5}$
Ductility (%)	53.55	29.04	88.57	75.88

Ultimate compressive strength

With the mean ultimate compressive strength of DNA-helically reinforced columns exceeding conventional spiral helix reinforced columns by 5.496 percentage points.

Modulus of elasticity

While DNA rubber columns had lower elastic modulus values, which were equivalent to the values found in basic spiral helix columns, the elastic modulus of DNA helical columns without rubber connections was greater, successfully resisting elastic deformations.

Axial stiffness and flexibility

Simple DNA helix columns without rubber showed maximum stiffness and hence least flexible behaviour. The increasing order of stiffness in columns was found as
Rubber at middle < Rubber at ends < Spiral helix < Simple DNA helix
The DNA helix with rubber at the ends was found to be more flexible than the DNA helix with rubber in the centre, which may be ascribed to the specimen's usage of the most rubber ties (4#). Spiral helix columns were discovered to have a rigidity somewhere between that of a basic DNA helix and that of a DNA helix tied together with rubber ties.

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Ductility

The increasing order of ductility is as

DNA helix < Spiral helix < Rubber at ends < Rubber at middle

This difference in the steel tie sizes was evident when it came to basic DNA-helical columns with rubber in the centre, where the rubber ties utilised were 6mm in diameter and there were only two, but in DNA-helical columns with rubber in the centre there were eight steel tie sizes. Steel tie diameter and rubber link number have an enormous influence on column ductility, with bigger steel ties and more rubber links resulting in greater ductility values for the columns. The ductility values of DNA helical columns with rubber at ends were found to be in the centre of simple DNA and DNA rubber at middle specimens, despite the usage of 8mm ties and just two rubber links.

Effect of length of DNA helix on column parameters

The specimen examined was 720mm long in the DNA helix column with rubber links in the centre, whereas the specimen tested was 600mm long in the other DNA samples. Even though the DNA helix column with rubber in the centre had a greater length than the other specimen, the DNA helical reinforcement displayed superior features in terms of ultimate compressive strength, ductility, stiffness, and flexibility parameters. We discovered that the use of DNA helical reinforcement may increase performance in longer columns significantly over the usage of spiral reinforcement.

IV. RECOMMENDATIONS AND FUTURE SCOPE

DNA helix columns exhibited a greater ultimate strength than spiral helix columns, showing that they may be employed as a convenient substitution and upgraded alternative to the standard kinds of reinforcement.

This finding suggests that there is still plenty of room for experimentation and research into how the length of the DNA helix reinforcement affects various parameters, so that they can be used in long columns as well, because the improved performance of the rubber-filled DNA helical columns was found despite the longer column length.

Dulcicity was affected by the quantity of rubber links and the diameter of the steel ties. Higher ductility values were achieved by using bigger steel links and more rubber links because of the increased confining pressure. Conversely, the ductility of ties with smaller diameters and fewer rubber links was lower. Because of these two factors, ductility may be obtained by altering them.

It is possible to apply this reinforcement at beam column connections that are vulnerable to plasticization during an earthquake or other lateral loads if rubber is inserted as alternative links in DNA helix columns, which have a stronger structure than spiral helix columns.

Thus, DNA helically reinforced columns may be completely tested for future improvisations, and their properties can be thoroughly studied for future testing.

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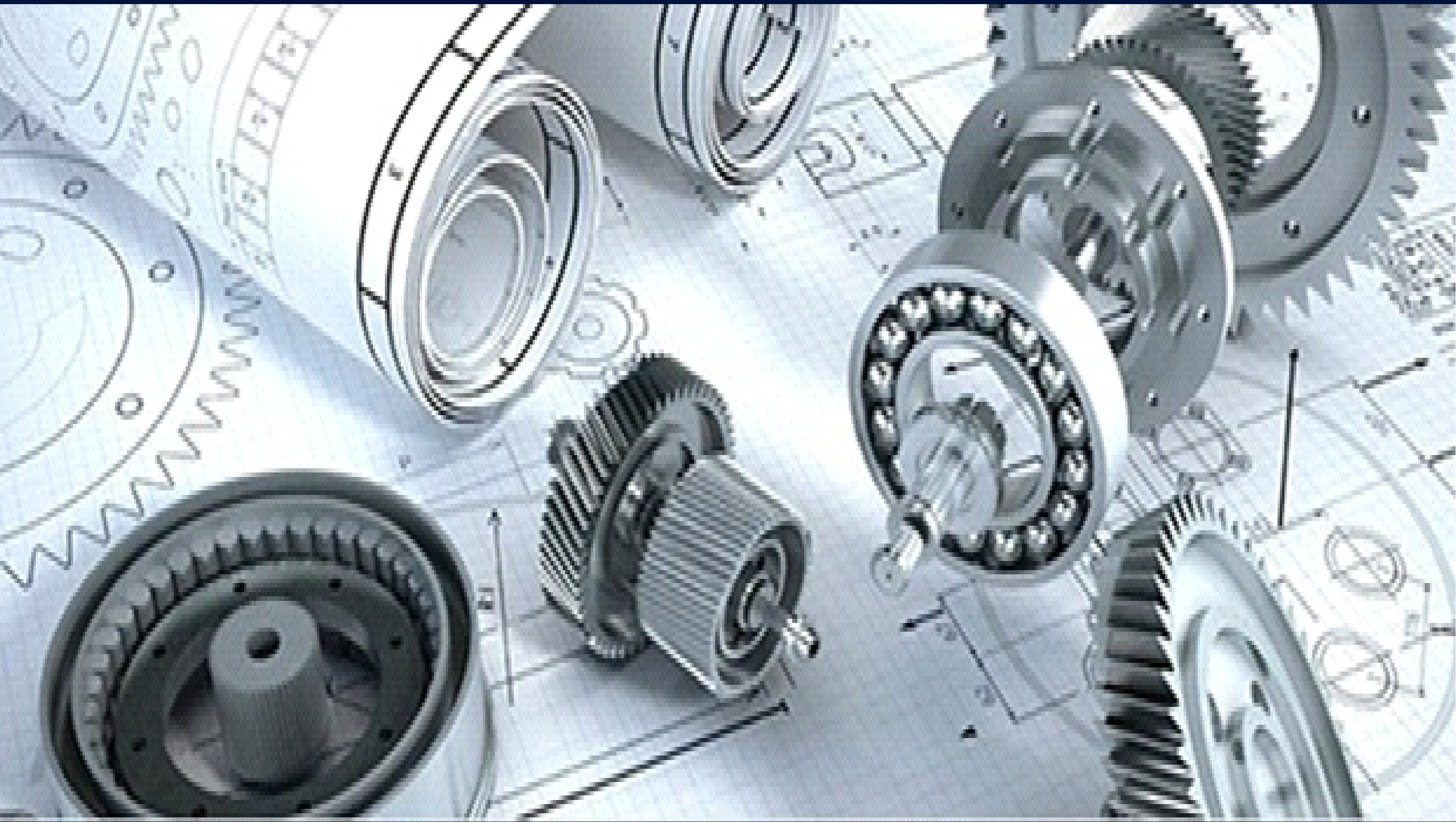

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