

AUTOMOTIVE INDUSTRY STANDARDS

**Specification for
Automotive Timing Belts**

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ON BEHALF OF
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLES RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

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Status chart of the standard to be used by the purchaser
for updating the record

Sr. No.	Corr- igenda.	Amend- ment	Revision	Date	Remark	Misc.

General Remarks :

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MoST) has constituted a permanent Automotive Industry Standard Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the secretariat of the AIS Committee, has published this standard. For better dissemination of this information ARAI may publish this document on their Website.

The present automotive standard is prepared to provide specification for Automotive Timing Belts for incorporating construction, quality control and performance requirements of timing belts. It is recommended for safety related components.

While preparing this standard considerable assistance is taken from following International Standards:

1. JASO E 105-92 Dimensions of Synchronous Belts for Automotive Engines
2. JASO E 110-92 Test Methods of Synchronous Belts for Automotive Engines
3. ISO 9010-1997 Synchronous Belt Drives - Automotive Belts
4. ISO 12046-1975 Synchronous Belt Drives - Automotive Belts - Determination of Physical Properties

The Automotive Industry Standards Committee (AISC) responsible for preparation of this standard is given in Annex : I

Specification for Automotive Timing Belts

1. SCOPE

This standard is applicable to the endless timing belts, which are also known as synchronous belts, used in driving the automotive engine parts such as camshafts, fuel injection pumps, balancing shafts etc.,

2. PURPOSE

This standard aims to specify the characteristics such as the nominal tooth dimensions, pitch spacing, width and width tolerance, pitch length and pitch length tolerances, and test methods for checking belt pitch length, breaking strength, fabric, and cord adhesion strengths of endless timing belts used in automotive engine drives.

3. TYPES OF BELTS

The automotive timing belts, based on their tooth profile, are classified into the following types:

- a) **Trapezoidal tooth** – There are two types of trapezoidal tooth profile belts:
 - Type ZA
 - Type ZB
- b) **Curvilinear Tooth** – There are two types of curvilinear tooth profile belts:
 - Type ZH
 - Type YH

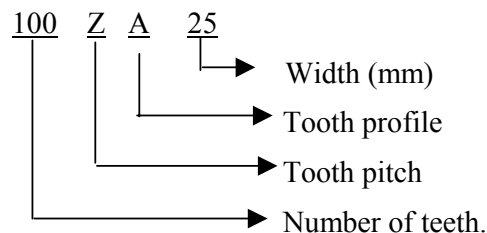
Compared to ZB and YH, the other two types ZA and ZH belts meant for light duty in their respective applications.

4. DESIGNATION

The automotive timing belt is designated by a combination of numerals and alphabets as given below:

- a) the first set of numerals indicates the number of teeth;
- b) the first alphabet indicates the tooth pitch;
- c) the second alphabet indicates the tooth profile;
- d) the second set of numerals indicates the belt width in millimeters;

For example



5. CONSTRUCTION

The automotive timing belt shall have construction as shown in Figure 1.

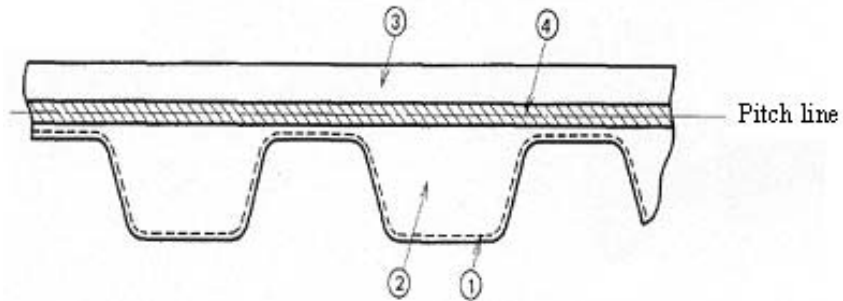


Figure 1

Cross Section of Typical Automotive Timing Belt.

No.	Components
1	Teeth cover fabric
2	Teeth rubber
3	Back rubber
4	Tension Member

- 5.1 Teeth and Back Rubber** - The teeth and back rubber compounds shall have uniform composition based on Polychloroprene or heat resistant hydrogenated nitrile rubber (HNBR) as designed by manufacturers and or users.
- 5.2 Teeth Cover Fabric** – The fabric shall be a specially woven expandable polyamide fabric free from flaws, distortions or any other foreign matter. The fabric shall be rubberised on both sides.
- 5.3 Tension Member** – The tension member shall be glass fibre or aramide fibre of Z and S twist placed evenly one after another and treated with bonding agent for better compatibility with rubber compound.

6. DIMENSIONS AND TOLERANCES

6.1 Trapezoidal tooth belts of types ZA and ZB

The nominal belt tooth profile dimensions for trapezoidal tooth belts of types ZA and ZB, as shown in Figure 2, are given in Table 1.

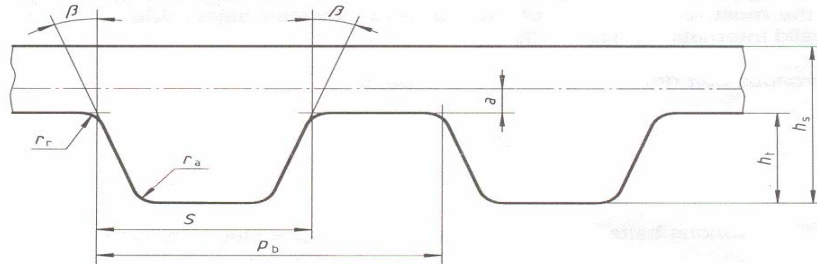


Figure 2

Tooth Profile Dimensions for Type ZA and ZB Belts

Table 1

Nominal Tooth Dimensions for Types ZA and ZB

Dimensions in millimeters, angles in degrees

Term	Symbol	Nominal profile	
		Type ZA	Type ZB
Tooth pitch	P_b	9.525	9.525
Tooth angle	2β	40	40
Height	h_s	4.1	4.5
Pitch line differential	a	0.686	0.686
Root radius	r_r	0.51	1.02
Tip radius	r_a	0.51	1.02
Tooth height	h_t	1.91	2.29
Tooth width	S	4.65	6.12

6.2 Belt tooth dimensions – Curvilinear tooth belts of types ZH and YH

The nominal belt tooth profile dimensions for curvilinear tooth belts of types ZH and YH, as shown in Figure 3, are given in Table 2.

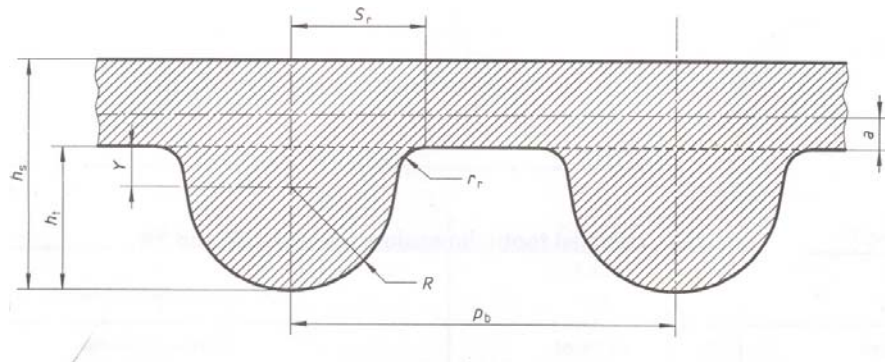


Figure 3

Nominal Tooth Dimensions (Profiles) for Types ZH and YH

Table 2

Nominal Tooth Dimensions for Types ZH and YH

Dimensions in millimeters, angles in degrees

Term	Symbol	Nominal profile	
		Type ZH	Type YH
Tooth pitch	P_b	9.525	8
Height	h_s	5.5	5.2
Pitch line differential	a	0.686	0.686
Root radius	r_r	0.76	0.64
Tooth height	h_t	3.5	3.04
Tooth radius	R	2.45	2.11
Vertical offset	Y	1.05	0.93
Root radius distance	S_r	3.27	2.84

Note: Tolerances for all the parameters given in Table 1 and 2 are to be decided by Manufacturers and or end users.

6.3 Belt pitch length and tolerances

Belt length shall be expressed as the length along the pitch line and is obtained by multiplying the number of teeth by tooth pitch, P_b . The tolerances for pitch length variation are given in Table 3.

Table 3
Pitch Length and Tolerances

Pitch length and tolerances in millimeters

Pitch length, L_p	
Range	Tolerances
$L_p \leq 381$	± 0.45
$382 \leq L_p \leq 505$	± 0.5
$506 \leq L_p \leq 762$	± 0.6
$763 \leq L_p \leq 991$	± 0.65
$992 \leq L_p \leq 1220$	± 0.75
$1221 \leq L_p \leq 1524$	± 0.8
$1525 \leq L_p \leq 1782$	± 0.85
$1783 \leq L_p \leq 2030$	± 0.9
$2031 \leq L_p \leq 2286$	± 0.95
$2287 \leq L_p \leq 2544$	± 1

6.4 Belt width and tolerances

The belt width ' b_s ' shall be measured at minimum three points using venires caliper and most commonly used belt width and tolerances for width variations within a belt are given in Table 4.

Table 4
Width and Tolerances

Unit: mm

Nominal belt width	Belt width tolerances
13	± 0.8
16	
19	
22	
25	± 1.0
28	
30	
32	
34	
38	

7. PITCH LENGTH MEASUREMENT

7.1 Measuring Fixture

The measuring fixture composed of (see Figure 4.) two pulleys of equal diameter of appropriate teeth profile, as specified in Table 5. One pulley is mounted on a fixed-position shaft, while the another on a movable shaft to permit the center distance to change on applying specified measuring force to movable pulley. The measuring pulleys should not have radial and axial run outs more than specifications given in Table 5.

There must be a vernier scale for measuring the center distance between the two pulleys.

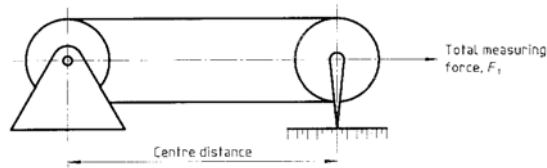


Figure 4
Pitch Length Measuring Fixture

Table 5
Belt Pitch Length Measuring Pulleys

Dimensions and tolerances in millimeters

Belt type	No. of teeth <i>z</i>	Outside diameter <i>D_o</i>	Run out		2 <i>a</i>
			Radial	Axial	
ZA, ZB, ZH,	20	59.266 ± 0.013	0.013	0.025	1.372
YH	22	54.651 ± 0.013	0.013	0.025	1.372

7.2 Total measuring force

The total measuring force, *F_t*, to be applied for measuring belts shall be calculated as follows:

- Types ZA, ZB, ZH and YH

$$F_t = (b_s \times 29) - 100$$

Where *b_s* is the width in millimeters;

F_t is the total force, in newtons.

7.3 Procedure

When measuring the pitch length of a timing belt, the belt should be rotated at least two revolutions to seat it properly and to divide the total force equally between the two strands of the belt. Then measure the distance (*C*) between the center of the pulleys using the vernier scale and calculate the pitch length from the following relationship.

$$\text{Pitch Length, } L_p = (D_o + 2a)\pi + 2C$$

The values of *D_o* and 2*a* are given in Table 5.

8. BREAKING STRENGTH TESTING

8.1 Specimen

The breaking strength of timing belt shall be tested using an endless belt or 2 test pieces of more than 250 mm each cut from an endless belt..

8.2 Testing method

When an endless belt is tested, it is attached on two rotatable flat pulleys having outside diameter of 114 mm. The belt should be turned inside-out, so that the teeth will be facing outside as shown in Figure 5. When two test pieces are used, they are attached with the grip length of more than 50 mm, at the distance of more than 150 mm between two grips. The test is carried out at a cross-head travel speed of 50 ± 5 mm/min. The maximum load at which the breakage occurs is noted for determining the breaking strength.



Figure 5

Testing Method on a Product

The breaking strength is determined as a half of the maximum breaking load when using an endless belt, and a smaller one of two measurements when using test pieces. However, the breaking load values are not considered when the specimen breaks at grip portion or on the flat pulleys. The test results are rounded off to the nearest 10 and reported along with the type of specimen, endless belt or test pieces used in the testing

9. DURABILITY TEST AT ELEVATED TEMPERATURE

9.1 Specimen

A timing with at least 80 teeth, or a maximum of 100 teeth, 9.525 mm in tooth pitch and 19 mm in width shall be used as a test specimen.

9.2 Test rig and testing procedure

The test rig having layout as shown in Figure 6 consisting of 3 pulleys shall be used for carrying out durability test at $100 \pm 2^\circ\text{C}$ and at 6000 ± 120 rpm of driving pulley. 3kg tension is applied to the belt using the idler pulley and 3.5 kW load is applied to the driven pulley. Under this condition the timing belt has to run minimum 200 hours. The breakage of belt teeth and the failure to transmit load is considered as belt failure.

Further, the coordinate dimensions of each pulley are shown in Table 6 and the specification and the dimensions are shown in Table 7.

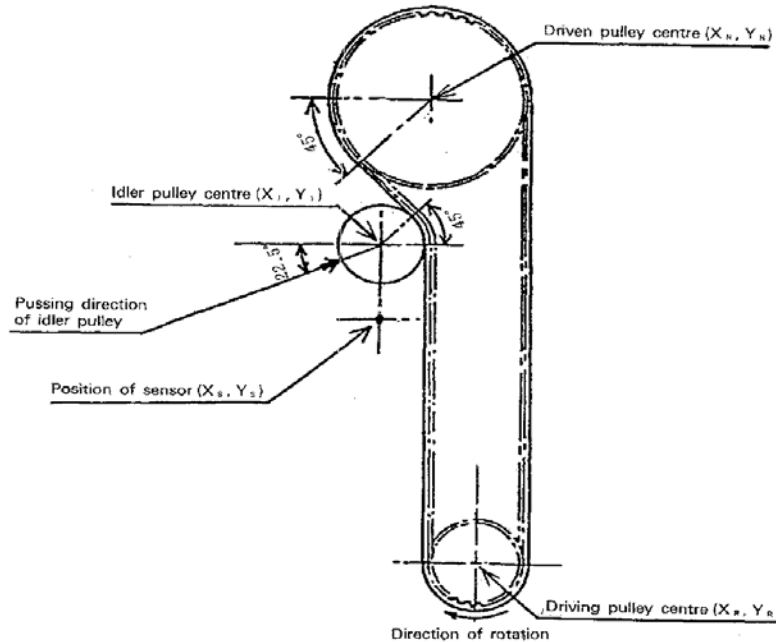


Figure 6:
Layout of Test Rig

Table 6
Coordinate Dimensions of Pulleys and Sensor

Unit: mm

		Coordinate dimension
Driven pulley	X_N	0
	Y_N	0
Driving pulley	X_R	28.8
	Y_R	$-(L_p^{(1)}/2 - 145.89)$
Idler pulley ⁽²⁾	X_I	-25.0
	Y_I	-91.8
Heat sensor	X_S	-25.0
	Y_S	$Y_I - 50$

Notes (1) L_p represents circumference pitch length of a specimen

(2) Coordinate dimensions are calculated values for providing a specimen with tension

Table 7
Specification and Dimensions of Pulleys

Unit: mm

Item		Driving pulley ⁽³⁾	Driven pulley ⁽⁴⁾	Idler pulley
Specification	Pitch	9.525	9.525	---
	Number of teeth	19	38	---
	Pitch circle diameter	57.61	115.21	50.0 (ref.)
Dimensions	Outside diameter	56.23 ^{+0.10}	113.84 ^{+0.13}	---
	Outside diameter (Idler pulley)	---	---	47.0 ± 0.1

Notes (3) Driving pulley shall be flanged on both sides.

(4) Driven pulley shall be flanged if necessary.

10. RECOMMENDED PRACTICES FOR STORAGE

All the timing belts made out of glass cord reinforcement should not be bent sharply. The belts could be placed in boxes or hung freely. Belts should always be stored in dry and cool conditions. Direct exposure to sunlight, ultraviolet rays, ozone etc. should be avoided.

ANNEX : I
(See Introduction)
COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

Chairman	
Shri B. Bhanot	Director The Automotive Research Association of India, Pune
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Member Secretary
Mrs. Rashmi Urdhwareshe
Deputy Director
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* At the time of approval of this Automotive Industry Standard (AIS)