O. E. C. D. Report No.: 642

Report on test in accordance with

O. E. C. D. Test Code for Agricultural Tractors

MF 220-4

Manufactured by: TOYOSHA Co., Ltd.
Shiga Works
Shiga, Japan



Test No.: 54001/O. E. C. D.
Date of test: June till October 1979

This report has been approved by the O. E. C. D. Coordinating Center (C. N. E. E. M. A., France) as being in accordance with the O.E.C.D. Tractor Test Code.
Date of Approval: 7th March, 1980

INSTITUTE OF AGRICULTURAL MACHINERY

OMIYA SAITAMA JAPAN

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Tractor manufacturer:	TOYOSHA Co., Ltd. Shiga Works Shiga, Japan
Submitted for test by:	The manufacturer
Selected by:	The manufacturer with the agreement of the I. A. M.
Place of running-in:	TOYOSHA Co., Ltd, Shiga Works.
Duration of running-in:	55 hours

SPECIFICATION OF TRACTOR

Tractor

Make:	TOYOSHA Co., Ltd.
Model:	MF 220-4
Type:	Wheel tractor, unit construction, four wheel driven
Serial No. :	00294

Engine

Make:	Own make
Model:	HINOMOTO S148
Type:	Water cooled, 4-stroke, indirect injection diesel
Serial No. :	S148M 00559
Cylinders:	2 cylinders, vertical, in-line, 97mm bore x 100mm stroke, capacity 1477 cm^3, compression ratio 23:1, overhead valves, monobloc construction.
Fuel system:	Gravity feed, TOKYO ROKI replaceble paper filter, fuel tank capacity 27 ℓ, DIESEL KIKI NP-PES2K in-line injection pump, serial No. 2QF 146394, manufacturer's production setting; 0.049 cm^3/stroke at 2500 rev/min engine speed and full load, injection timing 22° before TDC, DIESEL KIKI throttle type NP-DNOSD 2110 injection nozzles, injection pressure 128 bar.
Governor:	DIESEL KIKI mechanical governor, governed range of engine speed 750—2700 rev/min, rated engine speed 2500 rev/min.
Air cleaner:	TOKYO ROKI oil bath, oil capacity 0.4 ℓ, pre-clener none
Exhaust-silencer:	Own make, 3-chamber expansion type silencer, 87mm diameter, 1230mm long, on the left hand side of engine, mouth showing foreward
Lubrication system:	Forced feed from gear-type pump, replaceable cartrige-type paper element full flow filter, oil capacity 4 ℓ, oil changing period 100 hours, cartridge changing period 100 hours, recommended oil quality CB or CD, recommended oil viscosity SAE 10W/30
Cooling system:	Water cooled, centrifugal pump assisted with 340mm dia 5-

	blade belt driven fan, coolant capacity 5 ℓ, pressurized at 0.88 bar
Starting system:	Electrical, 12 V HITACHI S13 solenoid engaged starter motor 2.1 kW, operable only when clutch pedal is depressed, electrical glow plug and excess fuel injection for cold starting

Electrical system

Voltage:	12 V, negative earth
Alternator:	HITACHI three phase alternator LR 120, 20 A
Battery:	SHIN-KOBE ELECTRIC MACHINERY N70L, 1 lead acid battery 70 Ah at 20 hour rating

Transmission

Clutch:	DAIKIN single dry clutch, 215mm dia plate, pedal-operated
Gearbox:	Own make, mechanical, sliding gear with 4 forward and 1 reverse speeds, constant mesh gear with 3 groups, total 12 forward and 3 reverse speeds
Rear axle and final drive:	Own make, crown wheel and bevel pinion with spur gear final drives, pedal operated mechanical differential lock, self disengaging
Front axle and final drive:	Bevel gear type differential, spur gear final drive
Oil capacity:	Common transmission and final drives 27 ℓ front axle differential 2.7 ℓ final drives in the front axle each 1.8 ℓ oil changing period 500 hours recommended oil API Service GL-3, SAE 80

Gear ratios and speeds

Gear		Number of engine revolutions for one revolution of driving wheel	*Nominal travelling speed for rated speed of engine km/h
Forward			
Low	1	1039.42	0.50
	2	737.04	0.71
	3	563.62	0.92
	4	379.69	1.37
Medium	1	321.27	1.62
	2	227.81	2.28
	3	174.21	2.98
	4	117.36	4.43
High	1	76.63	6.79
	2	54.34	9.57
	3	41.55	12.51
	4	27.99	18.58
Reverse			
Low	R	534.72	0.97
Medium	R	165.28	3.15
High	R	39.42	13.19

* Calculated with a tyre rolling radius of 552 mm

Power take-off

Non independent p. t. o., at rear of tractor, height above ground 596 mm, 5 mm on the left hand side of tractor's median plane, 35 mm dia, 6-spline, not totally in accordance to JIS Standard (equal I. S. O. Standard) refer to p. 28, proportional to engine speed, 2 speeds selected by hand lever:

High ratio: 817 rev/min at 2500 rev/min engine rated speed
540 rev/min (standard p. t. o. speed) at 1652 rev/min engine speed

Low ratio: 580 rev/min at 2500 rev/min engine rated speed
540 rev /min (standard p. t. o. speed) at 2327 rev/min engine speed

direction of rotation clockwise viewed from driving end

Power lift

Own make, hydraulic, gear type pump directly driven from engine, supplies oil to a single acting ram and 1 external tapping, maximum oil pressure 118 ± 5 bar, JIS 1 implement linkage (equal I. S. O. standard), position control, oil capacity and oil changing period in common with transmission box (see page 2)

Drawbar

Fixed drawbar height above ground 385 mm, thickness 20 mm, diameter of hole 23 mm, distance of centre of hole to rear axle centre 519, 594 mm, distance of centre of hole to p. t. o. 279, 354 mm to rear, maximum permissible vertical load on the bar 800 kg

Steering

Own make, spur gear type with double drag links

Brakes

DAIKIN, mechanically acting internal shoe type, acting on brake drums on differential half shafts, operated independently or together by pedals, fixed by ratchet both pedals of the foot brake for parking

Wheels

Steering wheels:

Two at front, BRIDGESTONE 7-16 tyres, 4 ply rating, diagonal type tyre casing, maximum permissible weight on each tyre 3970 N at 1.76 bar pressure, track width 1140 mm, rims W 6.00 F x 16

Driving wheels:

Two at rear, track width 1040 or 1495 mm changeable by reversing wheels;
BRIDGESTONE 12.4-24 tyres, 4 ply rating, diagonal type tyre casing, maximum permissible weight on each tyre 9270 N at 1.18 bar pressure, rims W 10 x 24, (normal type)
BRIDGESTONE 11.2-24 tyres, 4 ply rating, diagonal type tyre casing, maximum permissible weight on each tyre 8000 N at 1.18 bar pressure, rims W 9 x 24, (rice land type)

Wheelbase:

1590 mm

CONDITIONS DURING TEST

Masses:

Tractor without driver but with tanks full
Tyre size front: 7-16 4 ply rating rear: 12.4-24 4 ply rating

	Front kg	Rear kg	Total kg
Without ballast	615	687	1302
With ballast	615	1095	1710

Ballast:

	No. of weights	Total mass kg (excluding water)	Water kg
Front	—	—	—
Rear	6	196	212
Additional	—	—	—

Track setting: Front wheels track width 1140 mm
Rear wheels track width 1040 mm

Lighting: Electrical 12 V
Beam angle of headlight in plane view 34'

	Hight above ground of center mm	Dimensions mm	Distance from outside edge of tractor to centre *) mm
Head lights	827	94	560
Side lights	1338	90 **)	210
Reflectors	1207	53	180

*) at 1140 mm front wheels track width
**) in combination with direction indicator

Number of grease points: (whole tractor) 16

Overall dimensions:

	Length 1) m	Width m		Heights m	
		max. 2)	min.	with exhaust	without exhaust 5)
With ballast	2.88	1.82	1.68 3)	2.18	1.49
Without ballast	2.88	1.81	1.39 4)	2.18	1.49

Remarks: 1) Length with 3 point linkage
2) at 1495 mm rear wheels track width
3) at 1040 mm rear wheels track width
4) at 1140 mm front wheels track width
5) to top of air cleaner

Ground clearence: 354 mm in median plane of tractor below fixed drawbar bracket

Seat: Own make, coiled spring and rubber damper, pan seat with cushion, range of adjustment 60 mm fore and aft in 3 steps, no vertical adjustment

FUEL AND LUBRICANTS USED IN TESTS

Fuel: Diesel oil, specific gravity 0.8383 at 15°C, viscosity at 30°C 4.471 cSt, Cetane No. 59.4, to No. 2 JIS

Engine oil: NIPPON OIL HIGH SPURT SS, SAE 10W/30, viscosity at 37.8°C 74.7 cSt

Transmission oil: NIPPON OIL GEAR LUBE EP 80, SAE 80, viscosity at 37.8°C 107.3 cSt

COMPULSORY TESTS

(1) MAIN POWER TAKE-OFF PERFORMANCE

Date and locations of tests: 6th June, 1979 I. A. M., Omiya, Japan
Type of dynamometer: DC Electrical, MEIDENSHA EB-DH1

Power	Speed		Fuel consumption			Specific Energy
			hourly		specific	
kW	Engine rev/min	p. t. o. rev/min	ℓ/h	kg/h	kg/kWh	kWh/ℓ
MAXIMUM POWER-2 hour test						
20.2	2500	580	7.49	6.28	0.311	2.70
Part loads, the governor hand lever in the position corresponding to the maximum power at full load						
(Ⅰ) 85% of the torque obtained at maximum power						
17.7	2571	597	6.60	5.53	0.312	2.68
(Ⅱ) unloaded						
0	2683	622	2.40	2.01	—	—
(Ⅲ) half the load defined in (Ⅰ)						
9.0	2631	611	4.26	3.57	0.397	2.11
(Ⅳ) a load corresponding to maximum power						
20.2	2500	580	7.49	6.28	0.311	2.70
(Ⅴ) one quarter of the load defined in (Ⅰ)						
4.6	2662	617	3.29	2.76	0.600	1.40
(Ⅵ) three quarters of the load defined in (Ⅰ)						
13.4	2610	606	5.32	4.46	0.333	2.52

Power kW	Speed		Fuel consumption			Specific Energy
	Engine rev/min	p. t. o. rev/min	hourly ℓ/h	hourly kg/h	specific kg/kWh	kWh/ℓ
Part loads, the governor hand lever in the position corresponding to the standard p. t. o. speed at full load						
(Ⅰ) 85% of the torque obtained at maximum power						
16.6	2379	553	5.89	4.94	0.298	2.82
(Ⅱ) unloaded						
0	2509	582	2.09	1.75	—	—
(Ⅲ) half the load defined in (Ⅰ)						
8.6	2446	568	3.75	3.14	0.365	2.29
(Ⅳ) a load corresponding to maximum power						
19.1	2326	540	6.81	5.71	0.299	2.80
(Ⅴ) one quarter of the load defined in (Ⅰ)						
4.3	2472	574	2.90	2.43	0.565	1.48
(Ⅵ) three quarters of the load defined in (Ⅰ)						
12.6	2412	559	4.80	4.02	0.319	2.63

STANDARD SPECIFIC FUEL CONSUMPTION: 0.312/0.397/0.298/0.365 kg/kWh

Noload maximum engine speed: 2683 rev/min

Torque* at maximum power: 77.5 Nm

Maximum torque*: 87.3 Nm

at 1600 rev/min of the engine

Mean atmospheric conditions	temperature:	23 °C
	pressure:	1019 mbar
	relative humidity:	43 %
Maximum temperatures	coolant:	73 °C
	engine oil:	97 °C
	fuel:	38 °C
	engine air intake:	27 °C

*The torque is the equivalent crankshaft torque.

The recommended for drawbar work was not expressly specify by the manufacturer.

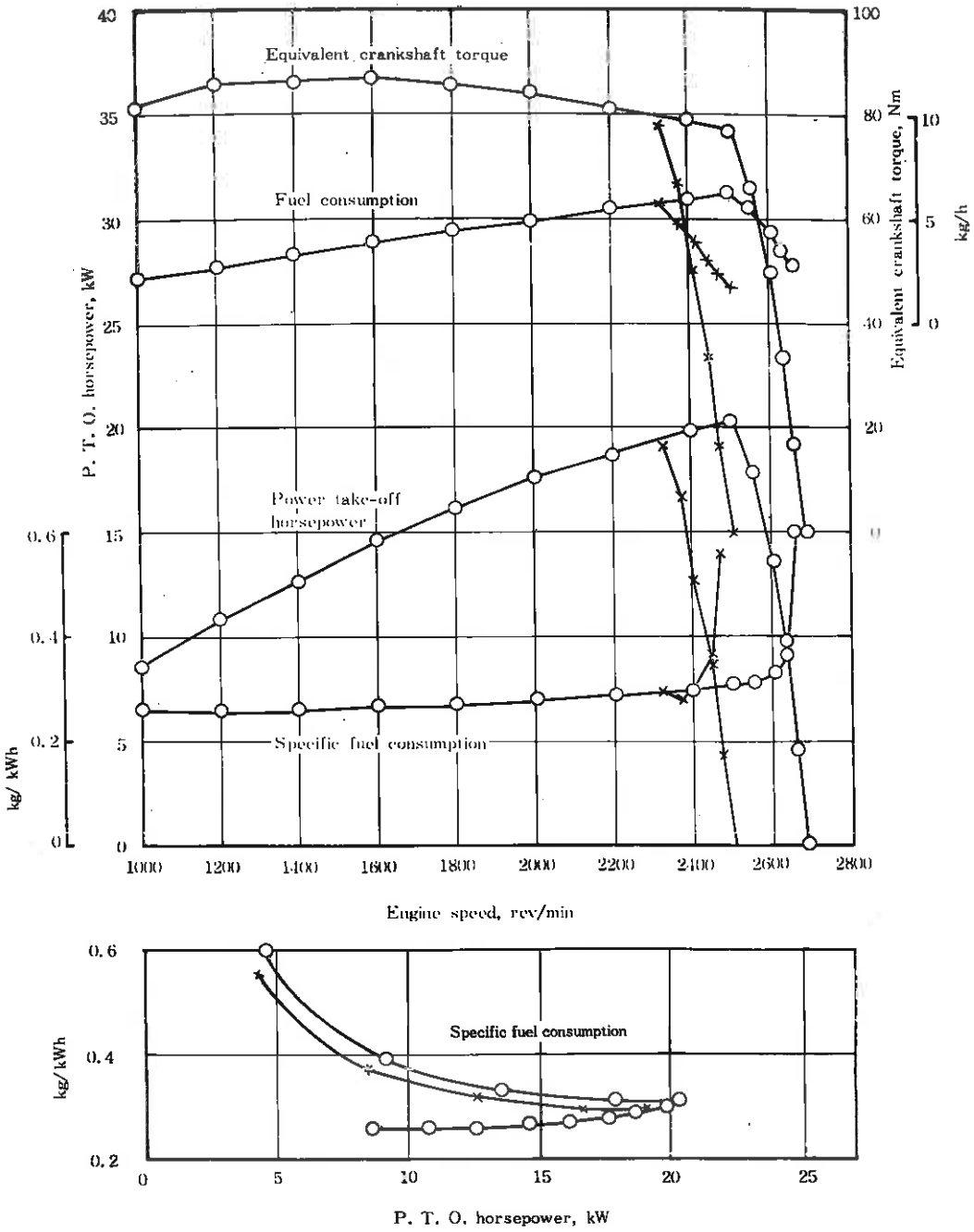


Fig. 1 Power take-off test

(2) DRAWBAR PERFORMANCE (I)

Date of tests: 20th September till 15th October 1979
Type of track: Concrete
Tyre size 12.4-24 at rear, 7-16 at front
Height of drawbar above ground: 369 mm
Tyre inflation pressure 1.18 bar at rear, 1.76 bar at front

Gear No.	Speed km/h	Power kW	Drawbar pull N	Engine speed rev/min	Slip of wheels %	Specific fuel consumption kg/kWh	Specific energy kWh/l	Temperature			Atmospheric Conditions		
								Fuel °C	Coolant °C	Engine Oil °C	Temperature °C	Relative humidity %	Pressure mbar
(I) MAXIMUM POWER (with ballast)													
M-1	1.40	5.3	13730	2603	14.8	0.507	1.65	34	46	75	21	56	1022
M-2	2.02	7.7	13730	2593	14.8	0.449	1.87	27	54	79	21	56	1022
M-3	2.59	9.9	13730	2579	15.1	0.406	2.06	29	49	72	21	56	1022
M-4	3.78	14.4	13730	2507	14.8	0.394	2.13	31	49	71	21	56	1022
H-1	6.05	15.7	9320	2490	10.2	0.359	2.34	30	44	75	21	56	1022
H-2	8.86	15.2	6180	2506	7.6	0.353	2.34	31	56	80	21	56	1022
H-3	11.48	14.7	4610	2477	7.2	0.375	2.24	31	58	77	21	56	1022
(II) FIVE HOUR TEST at 75% of pull at maximum power													
H-1	6.34	12.3	6990	2554	8.1	0.355	2.36	29	53	80	20	64	1026
(III) FIVE HOUR TEST at pull corresponding to 15% wheelslip in test (I)													
*M-4	3.82	—	13730	—	—	—	—	34	56	82	20	62	1025

*Those figures not quoted are irrelevant due to the additional ballast.

Height of drawbar above ground : 376 mm
Tyre inflation pressure 1.76 bar at front, 1.18 bar at rear

Gear No.	Speed km/h	Power kW	Drawbar pull N	Engine speed rev/min	Slip of wheels %	Specific fuel consumption kg/kWh	Specific energy kWh/ℓ	Temperature			Atmospheric Conditions		
								Fuel °C	Coolant °C	Engine oil °C	Temperature °C	Relative humidity %	Pressure mbar
(Ⅳ) MAXIMUM POWER (without ballast)													
M-1	1.44	4.0	10100	2635	15.0	0.718	1.17	34	52	78	26	60	1022
M-2	2.05	5.8	10100	2623	15.1	0.583	1.44	34	55	80	26	60	1022
M-3	2.66	7.5	10100	2614	14.8	0.502	1.67	30	58	80	26	60	1022
M-4	3.92	11.0	10100	2589	15.0	0.453	1.85	31	61	81	26	60	1022
H-1	6.01	15.6	9320	2496	11.5	0.406	2.06	37	62	87	22	50	1026
H-2	8.78	15.3	6280	2498	8.4	0.411	2.04	31	57	81	22	50	1026
H-3	11.70	15.0	4610	2506	7.2	0.410	2.04	30	55	83	22	50	1026

Total oil consumption during ten hours duration of tasts (Ⅱ) and (Ⅲ) 1.8 g/h

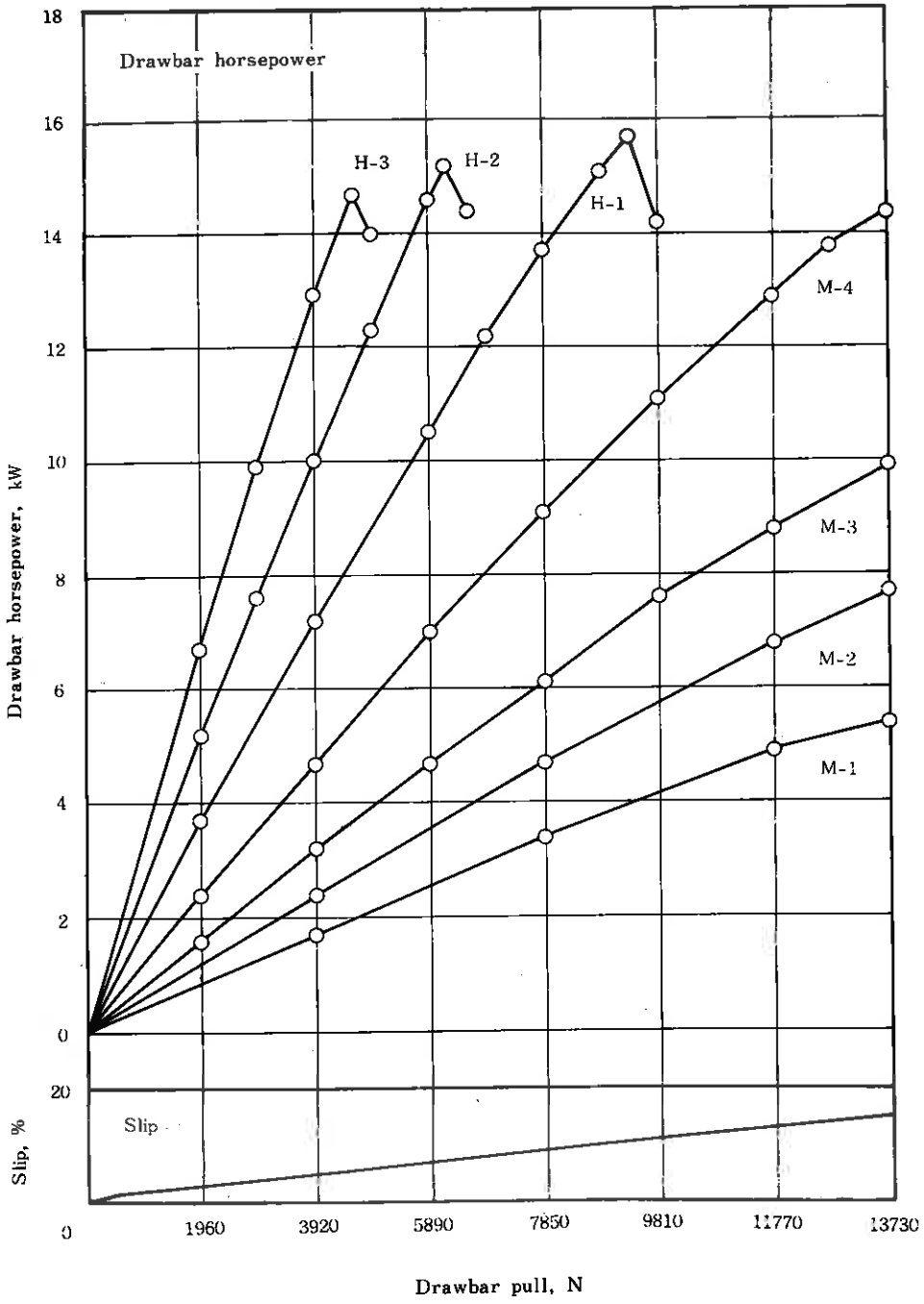


Fig. 2 Drawbar test on concrete, with ballast

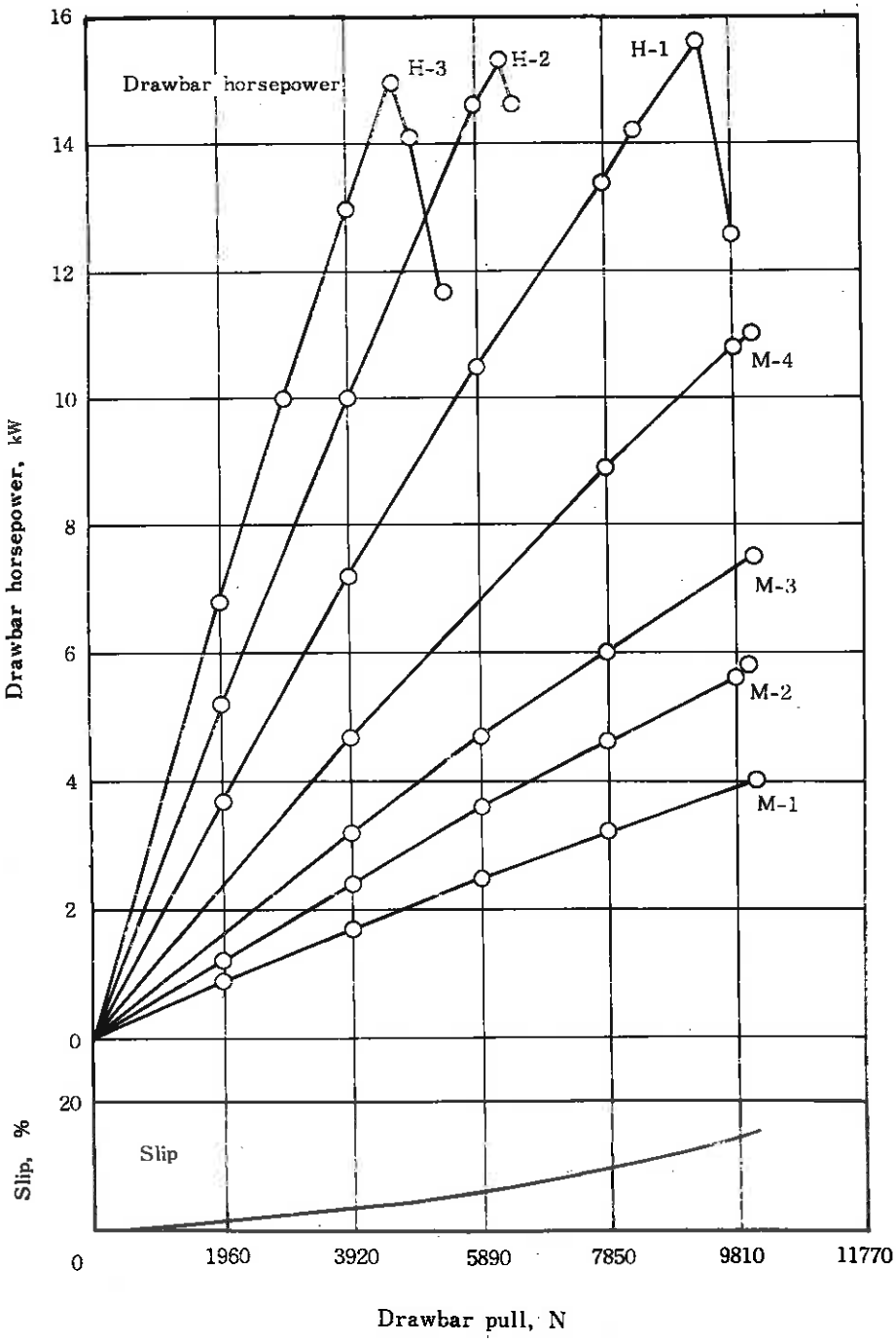


Fig. 3 Drawbar-test on concrete, without ballast

DRAWBAR PERFORMANCE (Ⅱ)

Date of tests: 8th-12th October 1979
Type of track: Concrete
Tyre size 11.2-24 at rear, 7-16 at front
Height of drawbar above ground: 370 mm
Tyre inflation pressure 1.18 bar at rear, 1.76 bar at front

Gear No.	Speed km/h	Power kW	Drawbar pull N	Engine speed rev/min	Slip of wheels %	Spacific fuel consumption kg/kWh	Spacific onergy kWh/ℓ	Temperature			Atmospheric Conditions		
								Fuel °C	Coolant °C	Engine oil °C	Temperature °C	Relative humidity %	Pressure mbar
(Ⅰ) MAXIMUM POWER (with ballast)													
M-1	1.37	3.2	8530	2625	14.7	0.686	1.22	28	44	76	22	58	1021
M-2	1.91	4.5	8530	2607	15.0	0.613	1.37	28	47	77	22	58	1021
M-3	2.52	6.0	8530	2599	15.0	0.516	1.62	28	44	76	22	58	1021
M-4	3.71	8.8	8530	2573	15.0	0.458	1.83	29	44	71	22	58	1021
H-1	5.47	13.0	8530	2484	14.9	0.387	2.17	31	61	83	22	58	1021
H-2	8.14	14.2	6280	2495	10.9	0.407	2.06	28	58	77	22	58	1021
H-3	10.91	13.4	4410	2485	8.6	0.427	1.96	27	48	68	22	58	1021
Height of drawbar above ground: 375 mm Tyre inflation pressure 1.76 bar at front, 1.18 bar at rear													
(Ⅱ) MAXIMUM POWER (without ballast)													
M-1	1.40	3.0	7650	2635	14.9	0.758	1.11	28	44	78	22	63	1016
M-2	1.94	4.1	7650	2617	15.0	0.634	1.32	26	47	79	22	63	1016
M-3	2.56	5.4	7650	2612	15.0	0.538	1.56	26	51	80	22	63	1016
M-4	3.74	7.9	7650	2595	15.3	0.446	1.88	28	47	79	22	63	1016
H-1	5.65	12.0	7650	2543	15.2	0.400	2.10	30	57	83	22	63	1016
H-2	8.03	14.0	6280	2508	13.7	0.359	2.12	31	55	81	22	63	1016
H-3	10.76	13.5	4510	2496	10.9	0.422	1.99	32	52	77	22	63	1016

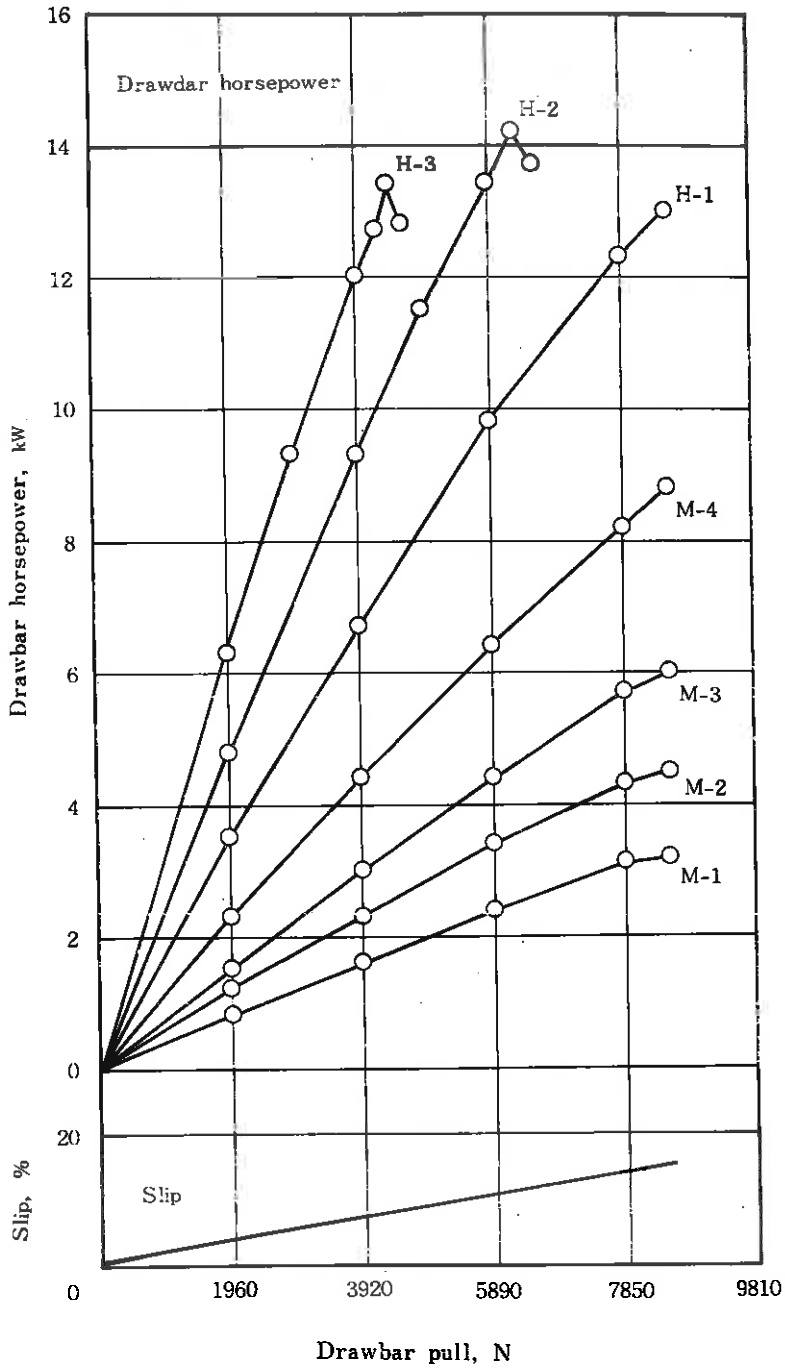


Fig. 4 Drawbar-test on concrete, with ballast

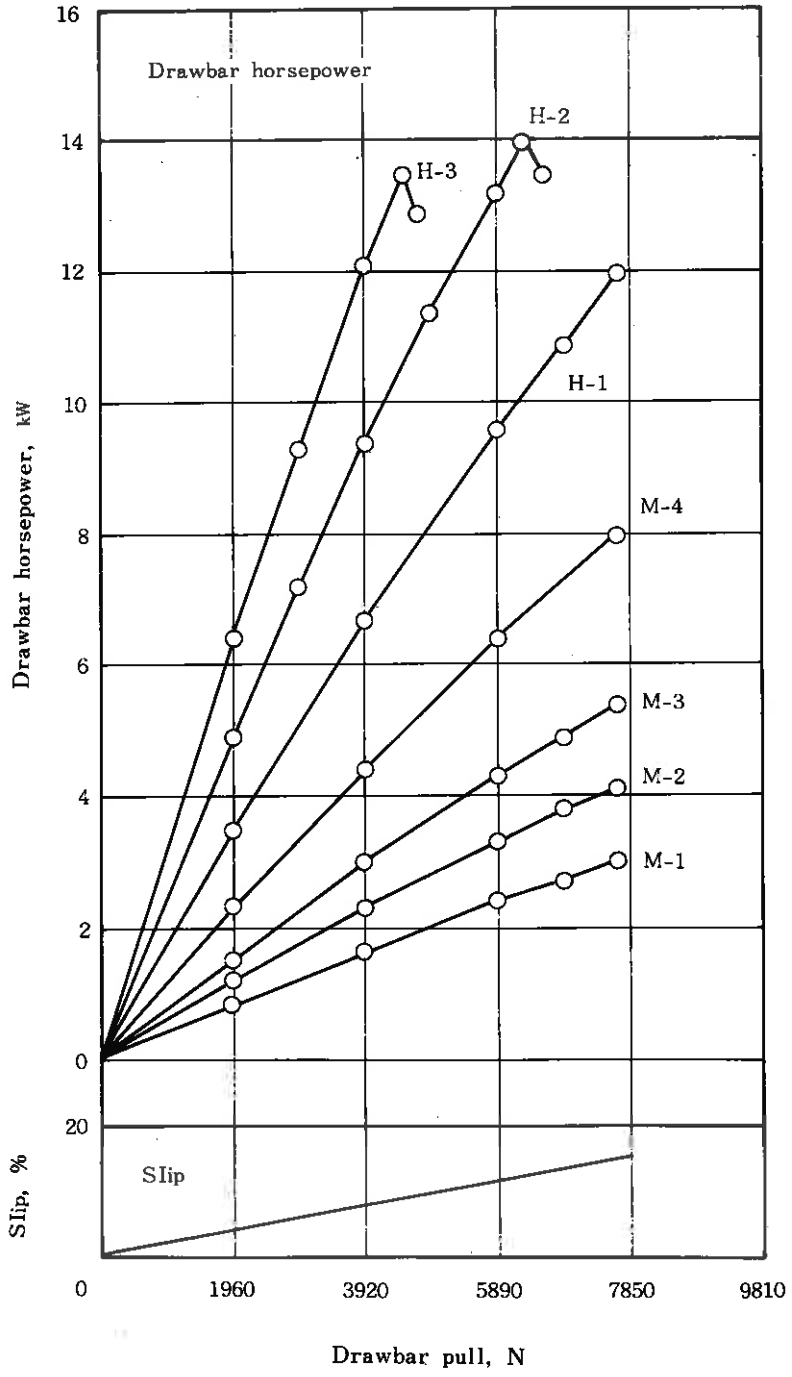


Fig. 5 Drawbar -test on concrete, without ballast

(3) TURNING SPACE AND TURNING CIRCLE

Details of wheel equipment: As in specification, without ballast front 1140 mm, rear 1040 mm

Results	With brakes		Without brakes	
	right-hand m	left-hand m	right-hand m	left-hand m
Radius of turning space	2.60	2.63	3.40	3.42
Radius of turning circle	2.40	2.43	3.20	3.22

(4) LOCATION OF CENTRE OF GRAVITY

mm

Height above ground	694
Distance forward from the vertical plane containing the the axis of the rear wheels	718
Distance from the median plane	0

(5) BRAKING

Date of tests: 18th-19th September 1979
Type of track: Concrete
Type of decelerometer: YOSHIDA SEIKI Co., Ltd., Type 106-2C
Weight of ballasted tractor: 1746 kg
Tyre sise: 12.4-24 at rear
7-16 at front

COLD BRAKES

	Ballasted	Without Ballast
Travelling speed of the tractor km/h	20.0	20.0
(1) Deceleration m/s^2	6.03	5.98
(2) Stoping distance m	3.57	4.26
(3) Force exerted on the brake pedal N	196	196
(4) Force exerted on the brake pedal to achive a deceleration of 2.5 m/s^2 N	118	98

BRAKE FADE CHARACTERISTICS (hot tests)

	Ballasted	Without Ballast
Deceleration, hot/deceleration, cold × 100	114	92
Stopping distance, cold/stopping distance, hot × 100	105	99
Force on pedal, cold/force on pedal, hot × 100	100	100

PARKING BRAKE

Efficiency of parking latch: Satisfactory facing up and down 16 % slope

Force on pedal: facing up 98 N
facing down 78 N

(6) MEASURENENT OF AMBIENT NOISE

Date of tests: 13th June, 1979

Type of sound level meter: Bruel and Kjaer 2203

Type of track: Concrete

Results of tests: Gear H-4
Travelling speed before acceleration 15.0 km/h
Sound level 80.5 dB (A)

(7) NOISE MEASUREMENT AT THE DRIVER'S EAR LEVEL

Date of tests: 12th June, 1979

Type of sound level meter: Bruel and Kjaer 2203

Type of track: Concrete

Results of tests:

Gear	Travelling speed km/h	dB (A)
H-1	6.37	95.5
H-2	9.00	96

(8) POWER LIFT AND HYDRAULIC PUMP PERFORMANCE

Date and location of tests: 13th June, 1979 I. A. M. Omiya, Japan

Hydraulic fluid

Make and type: NIPPON OIL Co., Ltd., GEAR LUBE EP 80

Viscosity: 107.3 cSt (37.8 °C)

Viscosity index: 88

Type of linkage lock for transport: Hydraulic

Cylinder over pressure relief valve: None

Pump characteristics

(Ⅰ)	Opening pressure of the relief valve: (manufacturer's figures)	88 bar
	Sustained pressure of the open relief valve:	115 bar
(Ⅱ)	Pump delivery rate at minimum pressure and rated engine speed:	20.4 ℓ/min
(Ⅲ)	Pump delivery rate at maximum hydraulic power:	21.7 ℓ/min
	Corresponding delivery pressure:	75 bar
	Power:	2.69 kW

Linkage geometry when connected to the standard frame

	Maximum mechanical advantage	Minimum mechanical advantage
Projected length in side view		
lower links, mm	700	700
lift arm, mm	270	270
lift rods, mm	537	537
top link, mm	584	598
Distance of lift rod connection point from pivot point of lower link, mm	390	390
The following dimenions are given relative to the rear wheel center line, situated 552 mm above the ground level		
Lower link pivot point	118 mm behind, 76 mm below	118 mm behind, 76 mm below
Top link pivot point	222.5 mm behind, 360 mm above	222.5 mm behind, 240 mm above
Lift arm pivot point	77.5 mm behind, 384 mm above	77.5 mm behind, 384 mm above
Maximum and minimum height of lower link hitch points	236 mm above, 388 mm below	236 mm above, 388 mm below
Height of lower link hitch points when locked in transport position	Any height within lift range	Any height within lift range

Lifting heights in relation to a horizontal line through the lower link pivoting point, cm

			−41.1	−40	−32.0	−31.2	−30	−20	−10	0	+10	+20	+30	+31.2	+33.6	+40	+42.7
Lifting force with the pressure at maximum hydraulic power 75 bar calculated from measurements made at the maximum pressure 115 bar kN	At the hitch points	Max. mech. advantage	—	—	—	3.44	3.52	4.45	4.88	5.17	5.32	5.33	5.25	5.17	—	—	—
		Min. mech. advantage															
		Maximum force exerted throughout whole range 3.44 kN Force at which front of tractor is calculated to lift with maximum allowable front ballast 11.70 kN															
	On the frame	Max. mech. advantage	—	—	3.47	—	3.76	4.35	4.67	4.73	4.67	4.56	4.25	—	4.04	—	—
		Min. mech. advantage	2.63	2.53	—	—	3.18	3.58	3.72	3.76	3.67	3.59	3.46	—	—	3.18	3.11
		Maximum force exerted throughout whole range 3.47 kN Force at which front of tractor is calculated to lift with maximum allowable front ballast 6.71 kN															

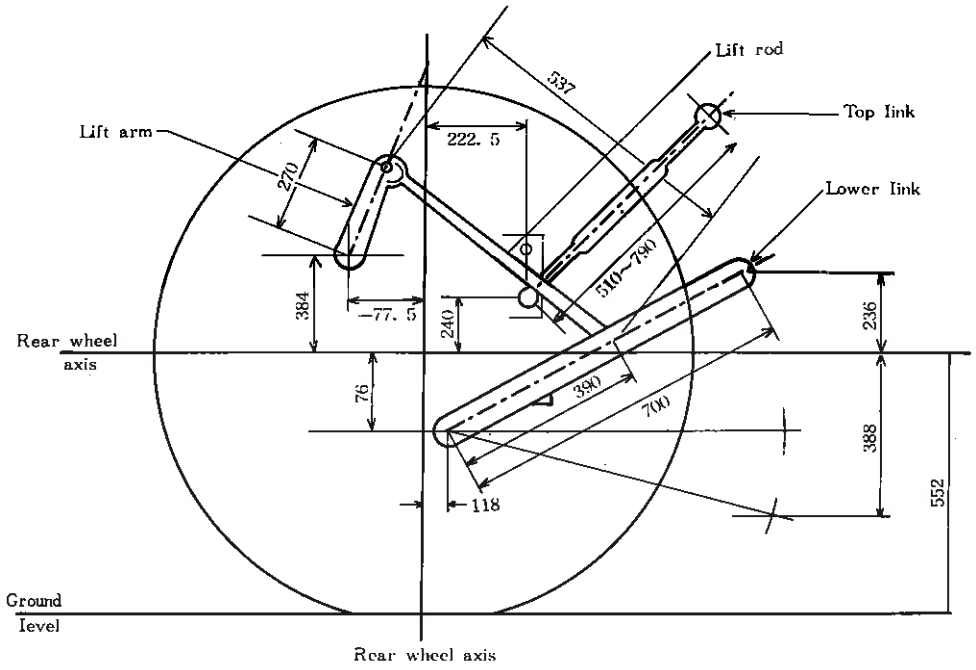


Fig. 6 Dimensions Required for Table of Linkage Geometry

REPAIRS AND ADJUSTMENTS DURING TESTS:	None
REMARKS:	After checking up the power take-off spline dimensions, the length of effective spline and the shape of spline bottom land was found not in conformity with JIS standard.

Officer in charge:	T. KANATSU
Head of Testing Division:	M. ARIYOSHI
Date:	20th October, 1979