Calspan

A COMPARATIVE EVALUATION OF THE SCHWINN CONTINENTAL AND CONTINENTAL-BASED SPRINT BICYCLES

by

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Report Number ZN-5361-K

August, 1973

Prepared For:

Schwinn Bicycle Company
Chicago, Illinois

INTRODUCTION

For the past three years Calspan has been engaged in a research program in bicycle dynamics sponsored by the Schwinn Bicycle Company. Most of the work on this program has been devoted to the development of a realistic computer simulation of the bicycle and rider.

The purpose of this program was to utilize the computer simulation for evaluation of the Schwinn Sprint bicycle, a prototype model which is a shortened wheelbase version of the Schwinn Continental. To provide the input data for the computer simulation, the Sprint and Continental (both 24 inch frame size) were measured to determine their physical characteristics. The resultant data was used for the computer simulation runs as well as input for the simplified bicycle stability analysis.

In addition, several riders from the Vehicle Systems Department rode both bicycles through a slalom course and on the open road. Their subjective evaluations of the two bicycles are included in Appendix B.

CONCLUSIONS

The results of the computer simulation study, the simplified analysis, and the subjective evaluations all support the conclusion that the Sprint is a slightly more responsive bicycle than the standard Continental, due mainly to its shorter wheelbase. The Sprint does not exhibit any unstable tendencies and is considered an adequate design for production.

MEASUREMENTS OF THE PHYSICAL CHARACTERISTICS OF THE BICYCLES

In order to provide the necessary input data for the computer simulation program and the simplified analysis, the Continental and Sprint were measured to determine their physical characteristics (weights, dimensions, and moments of inertia). The methods of measurement used were identical to those used in Phase I of the Schwinn Contract work performed by Calspan. A complete description of the apparatus and methods is contained in Reference 1.

The characteristics of the two bicycles are shown in Figures 1 and 2. Since both bicycles had 24 inch frames and were similarly equipped, any differences in the measured moments of inertia between the two bicycles is attributable to the change in frame design alone. The one pound difference in weight between the two bicycles is probably due to the omission of a kickstand on the Sprint.

PHYSICAL CHARACTERISTICS OF THE 24 INCH SCHWINN CONTINENTAL 9AUG'73

WHEELBASE (IN)	41.88
TOTAL WEIGHT OF BICYCLE (LB)	36.50
PORTION OF TOTAL BICYCLE WEIGHT ON FRONT WHEEL (PERCENT)	44.47
LOCATION OF TOTAL BICYCLE C.G. ABOVE GROUND (IN)	19.00
ROLL MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	10.69
PITCH MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	29.99
YAW MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	23.43
ROLL-YAW PRODUCT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	-5.31

WEIGHT OF RIDER (LB)	102.00
PORTION OF RIDER WEIGHT ON FRONT WHEEL (PERCENT)	41.10
HEIGHT OF RIDER C.G. ABOVE GROUND (IN)	37.75
HEIGHT OF SADDLE ABOVE GROUND (IN)	38.75
ROLL MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	27.80
PITCH MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	39.90
YAW MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	18.40
ROLL-YAW PRODUCT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	0.0

WEIGHT OF FRONT FORK ASSEMBLY (FORK,WHEEL,AND HANDLE BARS),(LB)	9.88
PERPENDICULAR DISTANCE FROM C.G. OF FRONT FORK ASSEMBLY TO STEER AXIS (IN)	2.00
DISTANCE PARALLEL TO STEER AXIS FROM C.G. OF FRONT FORK ASSEMBLY TO FRONT WHEEL CENTER (IN)	8.25
ROLL MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS PERPENDICULAR TO THE STEER AXIS THROUGH C.G. OF ASSEMBLY (LB-IN-SEC SQ)	3.66
PITCH MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS THROUGH THE C.G. OF THE ASSEMBLY (LB-IN-SEC SQ)	4.25
YAW MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT THE STEER AXIS (LB-IN-SEC SQ)	1.27
ROLL-YAW PRODUCT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS THROUGH THE C.G. OF THE ASSEMBLY (LB-IN-SEC SQ)	-0.55

CASTER ANGLE OF THE STEER AXIS (DEG)	19.60
NOMINAL STEERING TRAIL (IN)	2.70
FRONT TIRE PNEUMATIC TRAIL (IN)	0.0
STEERING VISCOUS DAMPING COEFFICIENT (IN-LB/DEG/SEC)	0.0
STEERING HYDRAULIC DAMPING COEFFICIENT (IN-LB/(DEG/SEC)SQ)	0.0
SPIN MOMENT OF INERTIA OF THE FRONT WHEEL (LB-IN-SEC SQ)	1.76
SPIN MOMENT OF INERTIA OF THE REAR WHEEL (LB-IN-SEC SQ)	1.76

UNDEFLECTED FRONT WHEEL ROLLING RADIUS (IN)	13.50
FRONT TIRE SECTION WIDTH (IN)	1.25
RADIAL STIFFNESS OF FRONT TIRE (LB/IN)	1000.00
ROLLING RESISTANCE COEF. OF FRONT TIRE (LB/LB)	0.0
VERTICAL LOAD-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/LB)	-0.00235
SLIP ANGLE-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG)	0.233
SLIP ANGLE CUBED-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG CU)	-0.00242
INCLINATION ANGLE-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG)	0.00193

UNDEFLECTED REAR WHEEL ROLLING RADIUS (IN)	13.50
REAR TIRE SECTION WIDTH (IN)	1.25
RADIAL STIFFNESS OF REAR TIRE (LB/IN)	1000.00
ROLLING RESISTANCE COEF. OF REAR TIRE (LB/LB)	0.0
VERTICAL LOAD-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/LB)	-0.00235
SLIP ANGLE-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/DEG)	0.233
SLIP ANGLE CUBED-SIDE FORCE COEFFICENT OF REAR TIRE (LB/LB/DEG CU)	-0.00242
INCLINATION ANGLE-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/DEG)	0.00193

FIGURE 1: PHYSICAL CHARACTERISTICS OF THE SCHWINN CONTINENTAL

WHEELBASE (IN)	39.75	WEIGHT OF RIDER (LB)	102.00
TOTAL WEIGHT OF BICYCLE (LB)	35.50	PORTION OF RIDER WEIGHT ON FRONT WHEEL (PERCENT)	37.50
PORTION OF TOTAL BICYCLE WEIGHT ON FRONT WHEEL (PERCENT)	44.97	HEIGHT OF RIDER C.G. ABOVE GROUND (IN)	37.75
LOCATION OF TOTAL BICYCLE C.G. ABOVE GROUND (IN)	19.38	HEIGHT OF SADDLE ABOVE GROUND (IN)	38.75
ROLL MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	10.69	ROLL MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	27.80
PITCH MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	27.78	PITCH MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	39.90
YAW MOMENT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	21.47	YAW MOMENT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	18.40
ROLL-YAW PRODUCT OF INERTIA OF THE TOTAL BICYCLE ABOUT AXIS THROUGH TOTAL C.G. (LB-IN-SEC SQ)	-3.68	ROLL-YAW PRODUCT OF INERTIA OF RIDER ABOUT AN AXIS THROUGH HIS C.G. (LB-IN-SEC SQ)	0.0

WEIGHT OF FRONT FORK ASSEMBLY (FORK,WHEEL,AND HANDLE BARS),(LB)	9.88	CASTER ANGLE OF THE STEER AXIS (DEG)	19.10
PERPENDICULAR DISTANCE FROM C.G. OF FRONT FORK ASSEMBLY TO STEER AXIS (IN)	2.00	NOMINAL STEERING TRAIL (IN)	2.70
DISTANCE PARALLEL TO STEER AXIS FROM C.G. OF FRONT FORK ASSEMBLY TO FRONT WHEEL CENTER (IN)	8.25	FRONT TIRE PNEUMATIC TRAIL (IN)	0.0
ROLL MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS PERPENDICULAR TO THE STEER AXIS THROUGH C.G. OF ASSEMBLY (LB-IN-SEC SQ)	3.66	STEERING VISCOUS DAMPING COEFFICIENT (IN-LB/DEG/SEC)	0.0
PITCH MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS THROUGH THE C.G. OF THE ASSEMBLY (LB-IN-SEC SQ)	4.25	STEERING HYDRAULIC DAMPING COEFFICIENT (IN-LB/(DEG/SEC)SQ)	0.0
YAW MOMENT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT THE STEER AXIS (LB-IN-SEC SQ)	1.27	SPIN MOMENT OF INERTIA OF THE FRONT WHEEL (LB-IN-SEC SQ)	1.76
ROLL-YAW PRODUCT OF INERTIA OF FRONT FORK ASSEMBLY ABOUT AN AXIS THROUGH THE C.G. OF THE ASSEMBLY (LB-IN-SEC SQ)	-0.55	SPIN MOMENT OF INERTIA OF THE REAR WHEEL (LB-IN-SEC SQ)	1.76

UNDEFLECTED FRONT WHEEL ROLLING RADIUS (IN)	13.50	UNDEFLECTED REAR WHEEL ROLLING RADIUS (IN)	13.50
FRONT TIRE SECTION WIDTH (IN)	1.25	REAR TIRE SECTION WIDTH (IN)	1.25
RADIAL STIFFNESS OF FRONT TIRE (LB/IN)	1000.00	RADIAL STIFFNESS OF REAR TIRE (LB/IN)	1000.00
ROLLING RESISTANCE COEF. OF FRONT TIRE (LB/LB)	0.0	ROLLING RESISTANCE COEF. OF REAR TIRE (LB/LB)	0.0
VERTICAL LOAD-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/LB)	-0.00235	VERTICAL LOAD-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/LB)	-0.00235
SLIP ANGLE-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG)	0.233	SLIP ANGLE-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/DEG)	0.233
SLIP ANGLE CUBED-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG CU)	-0.00242	SLIP ANGLE CUBED-SIDE FORCE COEFFICENT OF REAR TIRE (LB/LB/DEG CU)	-0.00242
INCLINATION ANGLE-SIDE FORCE COEFFICIENT OF FRONT TIRE (LB/LB/DEG)	0.00193	INCLINATION ANGLE-SIDE FORCE COEFFICIENT OF REAR TIRE (LB/LB/DEG)	0.00193

FIGURE 2: PHYSICAL CHARACTERISTICS OF THE CONTINENTAL-BASED SCHWINN SPRINT

BICYCLE - RIDER DISTURBANCE RESPONSE SIMULATION STUDY

A brief computer simulation study was undertaken to compare the responses of the Sprint and Continental to an external disturbance while under rider control. The simulation program utilized was the same one as that used in Phase III of the Schwinn study performed by Calspan under Contract No. CC-182 (Reference 2). The side force disturbance consisted of an artificial side wind gust simulated by an 18 lb-sec impulse from a rocket motor rigidly attached to the bicycle frame.

The maneuver was performed under rider control and consisted of a straight path following task with the side force disturbance imposed on the bicycle. The disturbance response maneuver was performed at speeds of 6, 10 and 15 mph for both bicycles. Plots of the time histories of bicycle roll and steer angles and rider command roll angle are shown in Appendix A for all six runs of the study.

It is well known that the human rider is adaptive and that his characteristics change with the task, speed, etc. as well as with the dynamics of the bicycle. It should be kept in mind that these simulated responses were made with a set of rider model coefficients which remained constant throughout the study. Nevertheless, these data are a measure of bicycle stability since they indicate the degree of adaption which would be required to achieve an equivalent level of performance on both bicycles. The rider coefficients used in this study (Figure 3) were identical to those used in the Phase III study. This will allow direct comparison of the responses of the Sprint and Continental with the responses of the bicycles previously tested.

In analyzing the simulation results, it is difficult to detect any major differences in the performance of the two bicycles, particularly at the higher speeds (10 and 15 mph). Both bicycles exhibited stable responses at all speeds tested. The Sprint generally required smaller steering angles than the Continental for the same response. The results

INITIAL X LOCATION (FT)	0.0
INITIAL Y LOCATION (FT)	0.0
INITIAL YAW ANGLE (DEG)	0.0
INITIAL FORWARD VELOCITY (MPH)	10.00
MAXIMUM ROLL ANGLE (DEG)	60.00
MAXIMUM PATH DISTANCE (FT)	250.00
MAXIMUM SIMULATION TIME (SEC)	5.00
INTEGRATION TIME INCREMENT (SEC)	0.005

PATH GUIDANCE FUNCTION BEING USED (SUBROUTINE GUIDE)
WITH EXTERNAL DISTURBANCE INPUTS (SUBROUTINE DISTRB)

TIME INCREMENT BETWEEN RIDER PATH SAMPLES (SEC)	0.10
REACTION TIME DELAY (SEC)	0.0
COMPENSATION TIME LAG (SEC)	0.10
PREVIEW TIME INCREMENT (SEC)	1.00
PATH ERROR COEFFICIENT (DEG/IN)	0.2292
HEADING ANGLE ERROR COEFFICIENT (DEG/DEG)	-0.20
HEADING RATE ERROR COEFFICIENT (DEG/DEG/IN)	-0.20
ROLL ANGLE-STEER MOMENT COEF. (IN-LB/DEG)	6.98
ROLL VELOCITY-STEER MOMENT COEF. (IN-LB/DEG/SEC)	5.24
ROLL ACCELERATION-STEER MOMENT COEFFICIENT (IN-LB/DEG/SEC SQ)	0.87
ROLL ANGLE-RIDER ROLL MOMENT COEF. (IN-LB/DEG)	0.0
ROLL VELOCITY-RIDER ROLL MOMENT COEFFICIENT (IN-LB/DEG/SEC)	0.0
ROLL ACCELERATION-RIDER ROLL MOMENT COEFFICIENT (IN-LB/DEG/SEC SQ)	0.0
RIDER ROLL ANGLE-RIDER ROLL MOMENT COEFFICIENT (IN-LB/DEG)	-9.00
RIDER ROLL ANGLE CUBED-RIDER ROLL MOMENT COEFFICIENT (IN-LB/DEG CU)	-0.10
RIDER ROLL VELOCITY-RIDER ROLL MOMENT COEFFICIENT (IN-LB/DEG/SEC)	-3.50

NUMBER OF PATH SEGMENTS 1

X AND Y COORDINATES OF PATH SEGMENT JUNCTION POINTS

	X	Y
# 1	0.0	0.0
# 2	10000.00	0.0
# 3	0.0	0.0
# 4	0.0	0.0
# 5	0.0	0.0
# 6	0.0	0.0
# 7	0.0	0.0
# 8	0.0	0.0
# 9	0.0	0.0
#10	0.0	0.0
#11	0.0	0.0
#12	0.0	0.0

FIGURE 3: RIDER CONTROL MODEL COEFFICIENTS

of the six runs are summarized in Table 1. The following code, identical to that used in Reference 2, was used in abbreviating the results:

#A-B
(C/D)

where: A - simulation run number

B - S nonoscillatory stable
OS oscillatory stable
OU oscillatory unstable

C - amplitude (peak to peak) of steering correction in degrees

D - amplitude (peak to peak) of the first cycle of roll response.

BICYCLE	SPEED		
	6	10	15
Standard Continental	#1-S 23/8	#2-S 10/11	#3-S 5/14
Continental-Based Sprint	#4-S 22/8	#5-S 9/11	#6-S 5/13

TABLE 1 - BICYCLE STABILITY STUDY RESULTS

SIMPLIFIED ANALYSIS

The basic design difference between the two bicycles is the shorter wheelbase of the Sprint. This factor in turn has the following influences:

1. Difference in fore-aft weight distribution

2. Difference in the tire performance characteristics at both front and rear.

3. Reduced moment of inertia about the yaw axis for the Sprint.

A brief analysis of the two designs was made using the simplified control expressions for two wheel vehicles developed in the Phase III program. In particular, the steady state position control sensitivities ($\frac{r}{\delta}$ and $\frac{\varphi}{\delta}$) and the low speed position control dynamic stability characteristics were computed for the two bicycles. These computations show the Sprint to be mildly more responsive (i.e., to have higher position control sensitivity) at all speeds than the Continental. They also show no first order difference of any significance in the primary roll stability mode at low operating speed (the condition of most importance to the novice rider - that is, the rider who is unfamiliar with the operation of drop handlebar bicycles and riding in the "touring" position). The roll angle sensitivity term can be modified to give a lateral acceleration sensitivity parameter which has approximately the same relative values as the other parameters for the bicycles. A listing of these performance values is given for the two bicycles in Table 2, which is based on the same input data used in the simulation study.

In judging the meaning of these small differences in behavior it should be noted that certain operating variables (e.g., difference tire

TABLE 2

CONTINENTAL/SPRINT COMPARISON

	Continental	Sprint
Position Control Steady-State Yaw Rate Gain (deg/sec/deg)		
6 mph	2.35	2.5
15 mph	5.8	6.35
Position Control Steady-State Roll Angle Sensitivity (deg/deg)		
6 mph	.64	.68
15 mph	1.60	1.70
Stability Roots - Speeds to 15 mph (rad/sec)	± 3.2	± 3.2
Position Control Steady-State Lateral Acceleration Gain (g's/deg)		
6 mph	.011	.012
15 mph	.028	.03

pressures, rider positioning, rider stature) may have effects that are of about the same consequence as the differences in the design parameters. On this basis, it seems fair to conclude this analysis shows the Sprint to be certainly an acceptable design from the standpoint of stability and control and that the added control sensitivity may be advantageous to the experienced rider.

REFERENCES:

1. Roland, R. D., Jr. and Massing, D. E., A Digital Computer Simulation of Bicycle Dynamics, Cornell Aeronautical Laboratory, Inc. Technical Report No. YA-3063-K-1, June 1971.

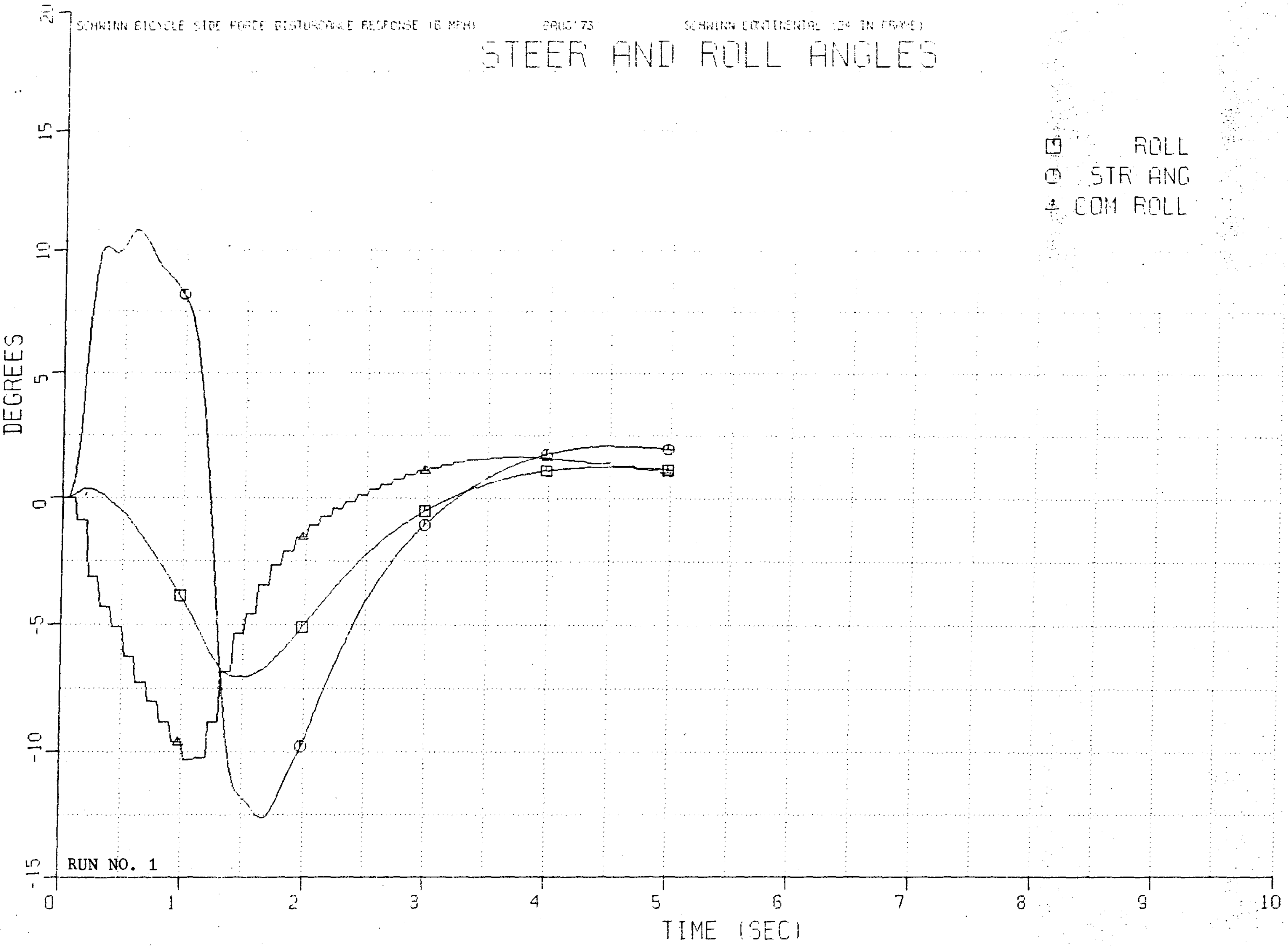
1. Roland, R. D., Jr. and Rice, R. S., Bicycle Dynamics Rider Guidance Modeling and Disturbance Response, Calspan Technical Report No. ZS-5157-K-1, April 1973.

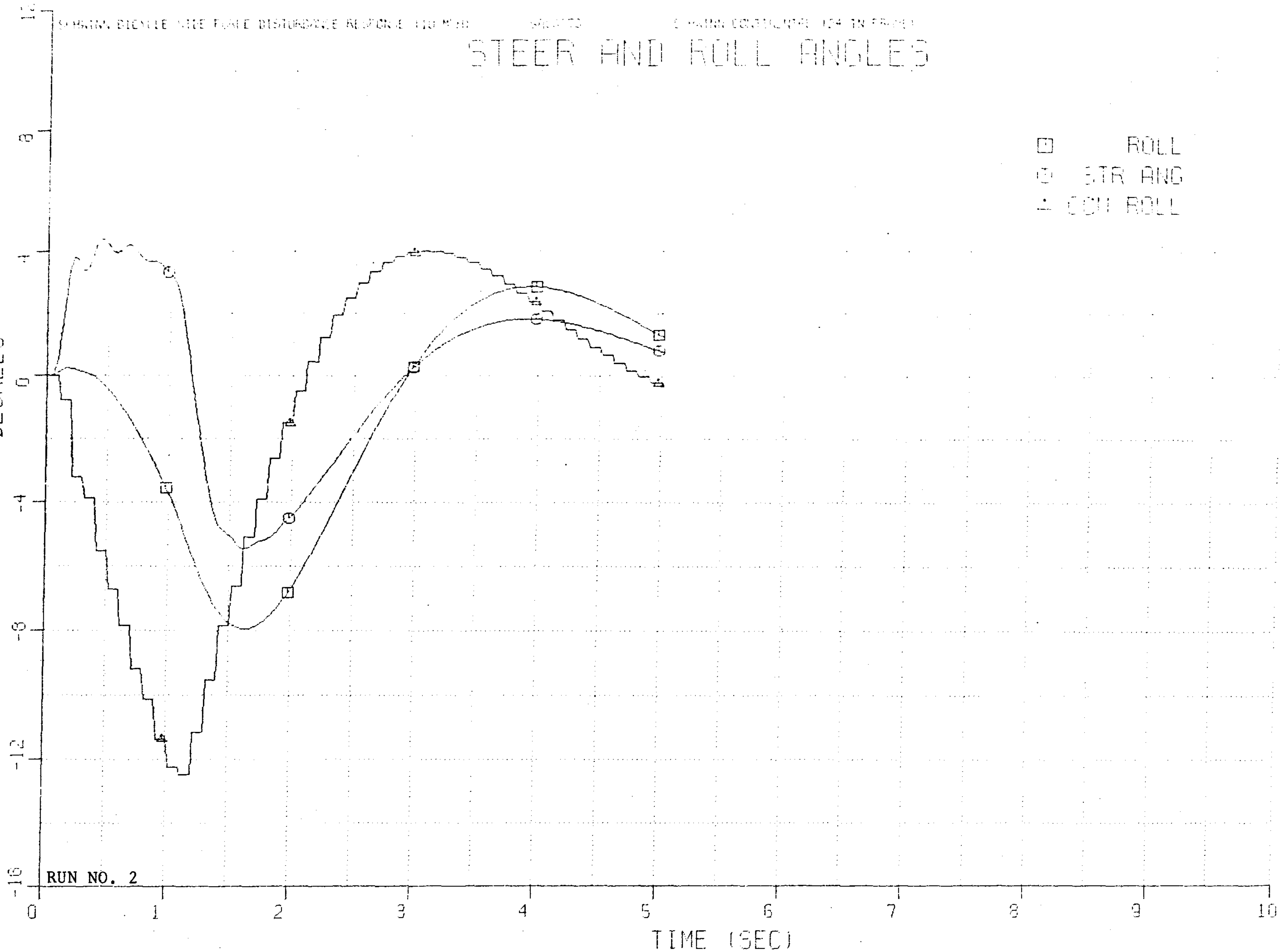
APPENDIX A

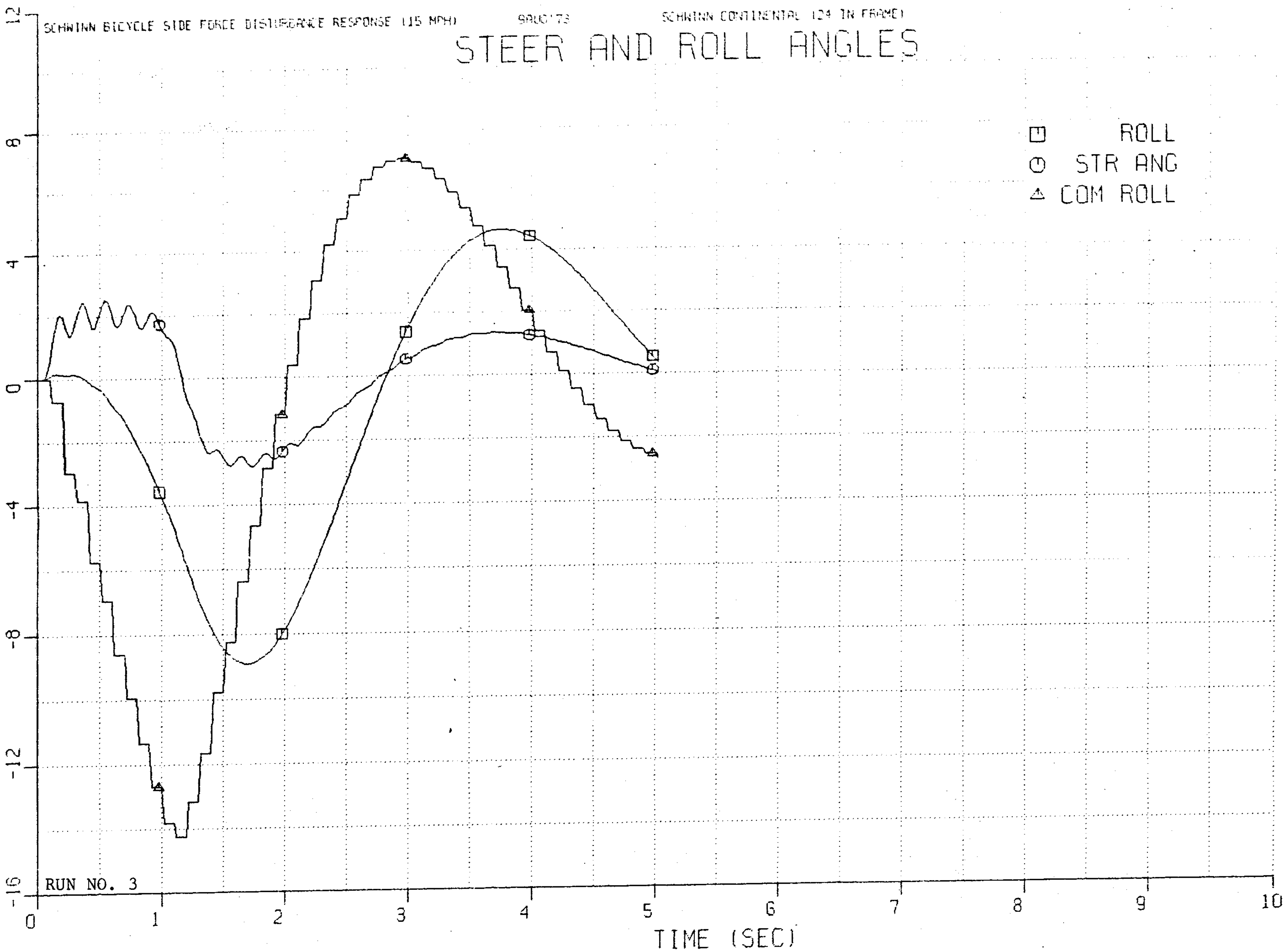
PLOTTED RESULTS OF SIMULATED BICYCLE - RIDER DISTURBANCE RESPONSE STABILITY STUDY

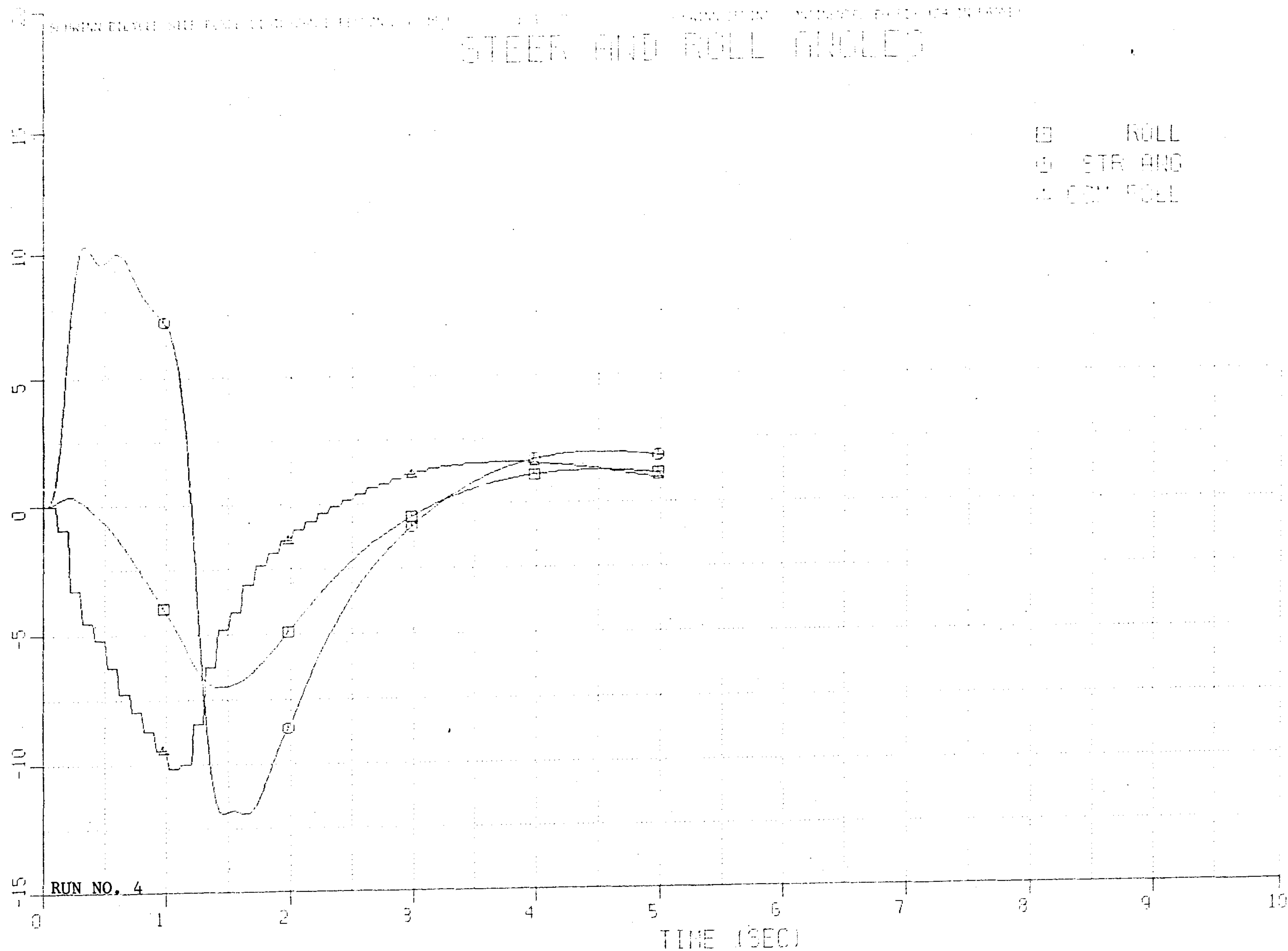
(1)	Continental	Straight Path	6 mph
(2)	Continental	Straight Path	10 mph
(3)	Continental	Straight Path	15 mph
(4)	Sprint	Straight Path	6 mph
(5)	Sprint	Straight Path	10 mph
(6)	Sprint	Straight Path	15 mph

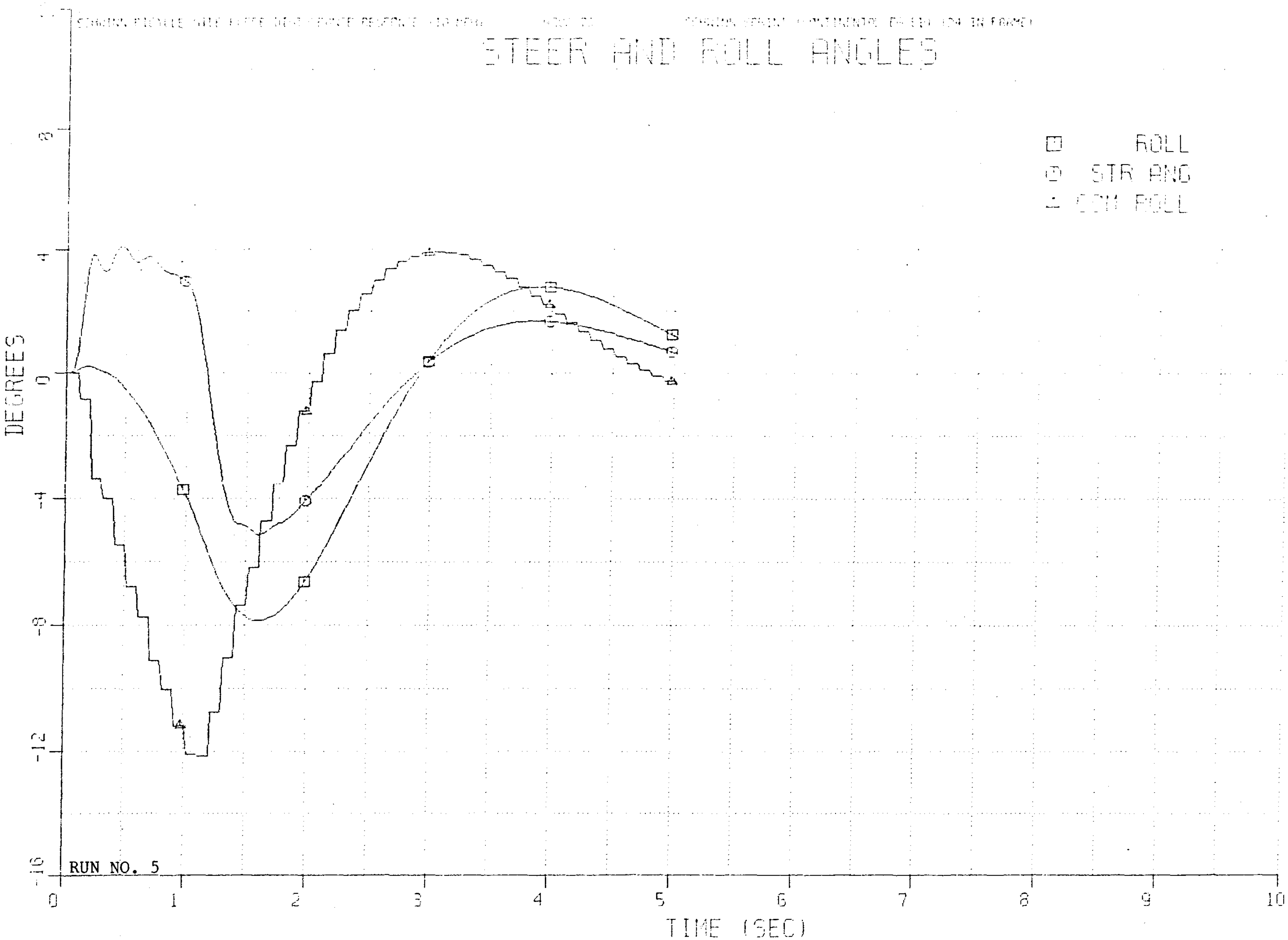
TABLE A-1 - TEST CONFIGURATIONS AND RUN NUMBERS

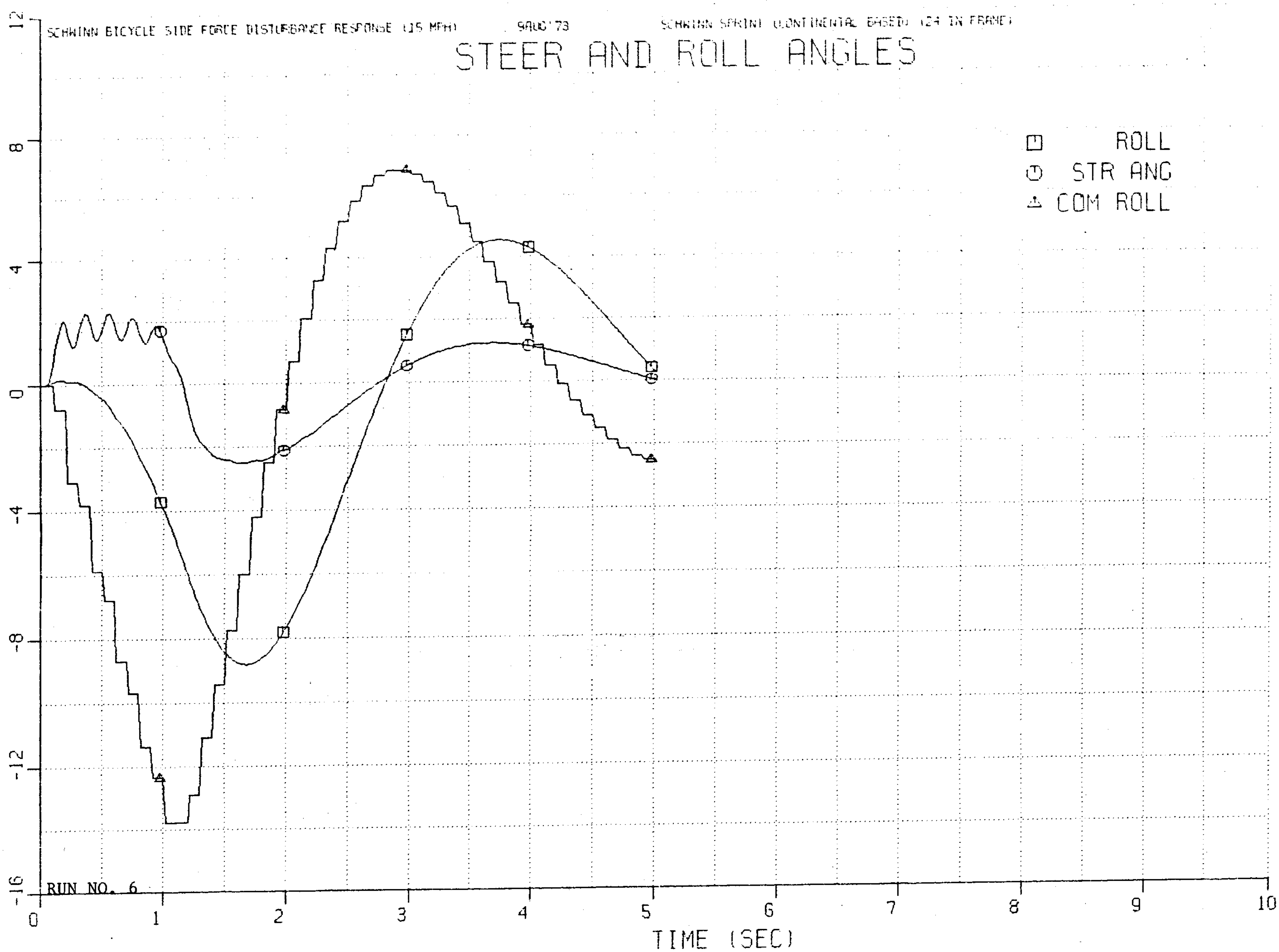

SCHWINN BICYCLE SIDE FORCE DISTURBANCE RESPONSE (16 MPH)
8AUG'73
SCHWINN CONTINENTAL (24 IN FRAME)
STEER AND ROLL ANGLES
ROLL
STR ANG
COM ROLL
DEGREES
20
15
10
5
0
-5
-10
-15
0
1
2
3
4
5
6
7
8
9
10
TIME (SEC)
RUN NO. 1


STEER AND ROLL ANGLES
ROLL
STR ANG
COM ROLL
DEGREES
12
8
4
0
-4
-8
-12
-16
0
1
2
3
4
5
6
7
8
9
10
TIME (SEC)
RUN NO. 2


SCHWINN BICYCLE SIDE FORCE DISTURBANCE RESPONSE (15 MPH)
9AUG'73
SCHWINN CONTINENTAL (24 IN FRAME)
STEER AND ROLL ANGLES
ROLL
STR ANG
COM ROLL
DEGREES
12
8
4
0
-4
-8
-12
-16
RUN NO. 3
0
1
2
3
4
5
6
7
8
9
10
TIME (SEC)


STEER AND ROLL ANGLES
ROLL
STR ANG
DEGREES
TIME (SEC)
RUN NO. 4


STEER AND ROLL ANGLES
ROLL
STR ANG
DEGREES
TIME (SEC)
RUN NO. 5
8
4
0
-4
-8
-12
-16
0
1
2
3
4
5
6
7
8
9
10


SCHWINN BICYCLE SIDE FORCE DISTURBANCE RESPONSE (15 MPH)
9AUG'73
SCHWINN SPRINT (CONTINENTAL BASED) (24 IN FRAME)
STEER AND ROLL ANGLES
ROLL
STR ANG
COM ROLL
DEGREES
12
8
4
0
-4
-8
-12
-16
RUN NO. 6
0
1
2
3
4
5
6
7
8
9
10
TIME (SEC)

APPENDIX B

RIDER SUBJECTIVE EVALUATIONS

This Appendix contains subjective evaluations of the Continental and Continental-based Sprint bicycles which were made by interested bicycle riders in the Vehicle Systems Department. Their comments are unedited and represent the results of an evaluation consisting of riding both bicycles through a slalom course and on the road. A brief summary of the bicycling experience of each of the riders follows on the next page.

The consensus opinion of the evaluators is that there is little difference between the two bicycles - the Sprint is considered to be slightly more responsive and the Continental to have slightly more straight-line stability. Opinions regarding the value of these characteristics differ among the evaluators and they therefore have different preferences but the Sprint, in all cases, has been judged to be <u>an acceptable design</u>. This is further supported by the opinion of other riders who have ridden the Sprint but have not made side-by-side comparisons as described here.

Rider Number 1 is a relative newcomer to lightweight bicycles but had done a considerable amount of riding on middleweight bicycles in previous years. He presently owns a lightweight 15-speed bicycle of English manufacture which he rides on short to medium length trips (5-30 miles).

Rider Number 2 is a relatively experienced rider, having ridden lightweight bicycles for pleasure for the past two years. He has owned two bicycles in the 25 lb weight range and normally takes trips 20 to 40 miles in length.

Rider Number 3 is a relatively experienced rider who has been riding an English made 3-speed bicycle for pleasure for the past two years. He also has a technical background in bicycle dynamics dating back two years. He normally rides on short trips (5-10 miles).

Rider Number 4 is an experienced rider and bicycle dynamicist. He has owned and ridden five bicycles over the last five years. He regularly rides on medium to long distance trips of 25 to 100 miles.

SUBJECTIVE EVALUATION - RIDER NO. 1

Overall, I would rate the Sprint as a slightly superior bicycle in comparison with the Continental. An experienced rider should find it a pleasure to ride, due to its increased responsiveness. An inexperienced rider, or a rider who has had no previous experience on drop-handlebar light weight bicycles may have some difficulty in adjusting to the Sprint due to the same responsiveness.

In my own case, I had not ridden a bicycle for several years when I became reinterested in bicycling at the suggestion of several people in the office. I ordered a bicycle, and while awaiting its arrival I took a fairly long ride (30+ miles) on the Sports Tourer version of the Sprint that Schwinn had sent to Calspan. At the beginning of the ride the bicycle seemed very "nervous" and I found it was difficult to steer a completely straight course. By the end of the ride I had everything sorted out and the bicycle actually became very easy to keep on a straight course. I now believe that the difficulty I had in the beginning was due mainly to the different riding position (I had not ridden in the touring position before) causing me to steer slightly as I pedaled. The Sprint's responsiveness allowed the bicycle to wander due to the small steering inputs, which would probably not have had an effect on a longer wheelbase bicycle. It should be noted, however, that the learning necessary to keep the bicycle on course was due mainly to the unfamiliar riding position rather than the bicycle.

In riding the Continental and the Continental-based Sprint in succession on a single night it became obvious that the Sprint required slightly more attention to ride well than did the Continental. The two bicycles can be compared to a sports car (the Sprint) and a family sedan (the Continental). The sports car is more responsive than the sedan, but in exchange for the responsiveness the driver must put more concentration into his driving.

To sum up my feelings, the Sprint is a good design and presents no major problems in riding. I do think that the bicycle should be sold in a higher price range (in the Sports Tourer version) where its responsiveness would appeal to the experienced rider who is likely to buy an expensive bicycle. I believe many of its virtues will be wasted on the buyer who is only interested in a low priced lightweight bicycle.

Some problems were encountered with the Sprint during testing which are worthwhile to bring to the attention of Schwinn. The rear wheel was only slightly out of true laterally, but this was enough to cause the sidewalls of the tire to rub on the rear frame rails every revolution. The frame tubes are much too close to the tire on the Continental version of the Sprint and it is suggested that the spacing be increased when the bicycle goes into production. Another interference problem occurred when the front derailleur was positioned to select low gear. The derailleur pivot made contact with the tread of the rear tire, increasing rolling resistance considerably. The problem appears to have been caused by improper bending of the vertical tube on the Continental-based Sprint. The Sports Tourer-based Sprint did not display either of the above problems, probably due to its different crankset and smaller diameter crank bearing housing.

SUBJECTIVE EVALUATION - RIDER NO. 2

Both bicycles were comfortable and reasonably easy to ride, but showed a marked difference in straight line stability and response to steering inputs. The Continental required less attention to steering to maintain a straight course, but responded slower to a given steering input than the Sprint, and seemed to require a greater steering force to cause the bike to go out of control.

The relationship of the seat, crank, and handlebars in the Continental was more comfortable than that of the Sprint, but I am unable to judge whether or not this is due to my own familiarity with a certain configuration.

Certain features common to both bikes were annoying. First of all, the position of the shift levers was disturbing since it required reaching up to shift, which adversely changed the center of gravity of the bike/rider. The shift travel was excessive, requiring the rider to first pull back and then push down on the lever to move across the full range of the rear cluster. Lastly, the seat angle adjustment was such that it had discrete positions, none of which were suitable. A continuous adjustment would have been much handier.

SUBJECTIVE EVALUATION - RIDER NO. 3

The overall ride and gear performance is virtually the same between bikes since both have the same basic running gear. Turn handling at moderate speeds appears to favor the Sprint, but its roll stability threshold seems to occur at a higher speed. A difference in ride pitch sensitivity is not discernible between the bikes because of the wheelbase difference. However the forward crank position of the Sprint was noticeable to me in terms of leg position. Being 6'2" and riding a 24" frame bike with the Sprint geometry may afford some mismatch that a larger frame size might resolve.

Although there are no drastic differences between the bikes, my purchase preference would be the Continental based on an overall feeling of better ride comfort.

SUBJECTIVE EVALUATION - RIDER NO. 4

My overall opinion is that the Sprint has slightly greater steering sensitivity primarily due to its shortened wheelbase. In riding through a slalom course at about 7 mph the Sprint was noticeably more maneuverable than the Continental. Although I did not time myself through the course I believe the Sprint would be faster.

I also rode the two bicycles at an average speed of about 18 mph for 25 miles on the road. I felt that the Sprint required more steering control activity to maintain a straight path. The Continental seemed to have greater straight line stability, however, the difference in stability between the bicycles was not great.

In conclusion I feel that the Sprint is only slightly different in performance from the Continental. It's characteristics seem somewhat better suited to lower speed operation (less than about 15 mph) where good maneuverability is an asset than higher speed riding where greater stability is desirable.