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CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Transient Aerodynamics in Vehicle Interactions: Data Base Summary

A.L. Chen
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University of California, Berkeley

California PATH Working Paper
UCB-ITS-PWP-98-3

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Transient Aerodynamics in Vehicle Interactions: Data Base Summary

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UCB-ITS-PRR-97-50
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University of California, Berkeley

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Executive Summary

The vehicles in a platoon will experience transient aerodynamic forces as vehicles leave and join the platoon at various locations. A platoon of scale vehicle models is placed in a wind tunnel and measurements are made of the transient forces and moments as one of the vehicles is moved into and out of the platoon. The results from the wind tunnel experiments will allow the computer vehicle control algorithms to better predict the transient aerodynamics the vehicles in the platoon will encounter during leaving and joining maneuvers.

Since a lane change (either leaving or joining a platoon) maneuver occurs on the same time scale as changes in the flow field, characterization of the transient forces and moments becomes of paramount importance. In these experiments, one vehicle is moved out of and into the platoon at six different accelerations to simulate lane changes at six different time scales, the longest (smallest acceleration) representing the static case and the shortest (largest acceleration) representing half of the nominal time of an actual lane change. Measurements are made with the displaced vehicle as each of the four members of the platoon. The increase in the drag on the remaining cars in the platoon as one vehicle leaves confirms that the close spacing between vehicles in a platoon results in streamlined flow. All of the cars experience side forces and yawing moments resulting from the interrupted flow field caused by the displaced car. These effects are more pronounced on a platoon of boxes, bluffer shapes. These forces and moments are summarized here as nondimensional coefficients plotted with the nondimensional lateral displacement of the maneuvering vehicle.

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Chapter 1

Description of Experiments

1.1 Introduction

In order to provide accurate and reliable control algorithms for a platoon of vehicles on an automated highway system, knowledge of the unsteady aerodynamic forces generated during platoon maneuvers, such as vehicles leaving or joining the platoon, is critical. Specifically, the control algorithms require estimates of the magnitude and time scales of the forces and moments resulting from interaction of the vehicle flow fields in the fundamental system configurations. The effects of inter-vehicle spacing and location of the maneuvering vehicle are also important. To investigate these problems, experiments are performed in a low turbulence, low-speed wind tunnel on scale model vehicles. The transient aerodynamic drag, side forces, and yawing moment, both on a vehicle maneuvering in and out of a platoon and on the cruising members, are measured to characterize the interaction of the flow fields. These results are compiled here in graphical form for quick access.

1.2 Scaling of Measured Quantities

For complete dynamic similarity, in addition to geometric similarity, the Reynolds number ***Re***

$$Re = \frac{Ul}{\nu} \tag{1.1}$$

where U is the flow velocity, l is the characteristic length scale, and ν is the kinematic viscosity, in the experiments should be the same as that of the full scale flow. However, this is often not achievable in the laboratory. In this case, the experiments are conducted at $Re = O(10^5)$ while the full scale flow has $Re = O(10^7)$, two orders of magnitude higher. Despite the mismatch, the Reynolds number in both cases are sufficiently high that the inertia forces dominate the viscous forces, except in boundary layers.

To compare quantities for different flows, nondimensional parameters are defined. The measured transient aerodynamic forces are nondimensionalized by defining force coefficients. A drag coefficient C_D is defined by scaling the drag force with the dynamic head as

$$C_D = \frac{D}{\frac{1}{2}\rho U^2 A_f} \tag{1.2}$$

where D is the drag force and A_f is the frontal area exposed to the oncoming flow. In this case, the frontal area is

$$A_f = wh \tag{1.3}$$

where w is the width and h is the height of the body displacing the fluid. Similarly, a side force coefficient C_S is defined as

$$C_S = \frac{S}{\frac{1}{2}\rho U^2 A_f} \tag{1.4}$$

where S is the side force. A moment coefficient C_M is defined as

$$C_M = \frac{M}{\frac{1}{2}\rho U^2 V} \tag{1.5}$$

where M is the moment. Here, the moment is scaled with the volume of the body where

$$V = A_f l \tag{1.6}$$

and l is the length of the body. These nondimensional coefficients will characterize the transient aerodynamics measured in the different experimental cases and can be applied to the full scale case.

1.3 Organization of Data

In the experiments, a platoon of four vehicle models is aligned in the center of the wind tunnel test section. Details of the experimental apparatus can be found in Chen [1]. The 1997 Buick LeSabre is used in these experiments as a representative vehicle shape and size. Specifications for the 1997 Buick LeSabre and the scale model appear in Table **1.1.** Scaling the vehicle down to 1/20 of full scale allows a platoon consisting of four vehicles spaced at one vehicle length apart to be placed in the wind tunnel. This arrangement also allows a lateral separation of 2.5 vehicle widths for a vehicle model leaving the platoon.

The experiments are designed around the expected operating conditions of a full scale platoon. The design conditions are defined as follows: inter-vehicle spacing of $s_d = 0.41$ and lane change duration of $t_d = 0.5$ seconds. Figure **1.1** shows the platoon configurations used in the experiments. Three inter-vehicle spacings are tested: 0.21, 0.41 (s_d), l. In addition, any one of the four models can be arranged as the mobile car. For each location of the mobile vehicle and each vehicle separation, the mobile car is moved at six different accelerations (equivalent to different durations of time required for a lane change). These three variables result in a minimum of 72 platoon configurations. The time required for the slowest move (lowest acceleration) is much longer than the time required for the flow to recover and become steady. Thus, these measurements are labeled *static* (t_∞) and represent steady-state

measurements. Three experimental runs are made for each configuration of the platoon. For each experimental run, the mobile car is moved out of the platoon $2.5w$, paused, and returned back into the platoon. During these motion profiles, the drag, side force, and yaw moment of each car is simultaneously measured. Typically, three experimental runs are performed for each setting. All measurements are made at $Re = 3.4 \cdot 10^5$, where the Reynolds number is defined by Equation 1.1 and the characteristic length is the model length.

Measurements are also made on a single vehicle model for comparison with the measurements for vehicles in a platoon configuration. In addition, measurements are made at the design separation t_s using a platoon of rectangular boxes, simpler shapes than the cars, for comparison. These boxes have dimensions of 25.4 cm (10 in.) x 10.2 cm (4 in.) x 7.6 cm (3 in.) and approximate the volume of the vehicle models. Measurements on a single rectangular box are also made for comparison.

Three main parameters are varied in the experiments and are designated by the indices ijk. The variables of the experiment are the location of the mobile car in the platoon [four locations, $i = 1$ (first car), ..., 4 (last car)], the separation distance between the models [three separations, $j = 1\ (0.2l)$, ..., $3\ (l)$], and the acceleration profile of the moving car [six profiles, $k = 1\ (t_\infty)$, ..., $6\ (0.5\ t_d)$]. In addition, measurements for each configuration are repeated three times, where each trial is specified by the index 1. All combinations of these variables result in a minimum of 216 experimental runs. Each run is uniquely specified as E_{ijkl} by the four indices representing these variables, as shown in Table 1.2. Analysis of a specific run is performed by specifying E_{ijkl} in the in-house program `spec10.pro`, written in Research Systems Incorporated Interactive Data Language (IDL). Similarly, each experimental run with the platoon of boxes is designated by B_{ijkl} as shown in Table 1.4. Since measurements

are made for the **box** platoon with only one separation ***0.41, j*** is always 2.

The data presented in the following figures summarize the large data base collected during the experiments. **A** discussion of these results can be found in Chen [1].

1.4 Acknowledgments

We thank **Philip** Snyder and Lun Tsuei for their assistance.

1.5 References

1. Chen, **A. L.** 1997 *An Experimental Investigation of Transient Aerodynamics in Vehicle Interactions.* Ph.D. Dissertation, University of California, Berkeley.

1.6 Tables & Figures

dimensions	car	model
vehicle length	5.1 m	25.5 cm
vehicle width	1.9 m	9.4 cm
vehicle height	1.4 m	7.1 cm
ground clearance	0.26 m	1.3 cm

Table 1.1: 1997 Buick **LeSabre dimensions.**

acceleration (time scale)	trial	maneuver position					
		1			2		
		separation			separation		
		1	2	3	1	2	3
t_∞	1	E_{1111}	E_{1211}	E_{1311}	E_{2111}	E_{2211}	E_{2311}
	2	E_{1112}	E_{1212}	E_{1312}	E_{2112}	E_{2212}	E_{2312}
	3	E_{1113}	E_{1213}	E_{1313}	E_{2113}	E_{2213}	E_{2313}
$2t_d$	1	E_{1121}	E_{1221}	E_{1321}	E_{2112}	E_{2221}	E_{2321}
	2	E_{1122}	E_{1222}	E_{1322}	E_{2122}	E_{2222}	E_{2322}
	3	E_{1123}	E_{1223}	E_{1323}	E_{2123}	E_{2223}	E_{2323}
$1.5t_d$	1	E_{1131}	E_{1231}	E_{1331}	E_{2131}	E_{2231}	E_{2331}
	2	E_{1132}	E_{1232}	E_{1332}	E_{2132}	E_{2232}	E_{2332}
	3	E_{1133}	E_{1233}	E_{1333}	E_{2133}	E_{2233}	E_{2333}
t_d	1	E_{1141}	E_{1241}	E_{1341}	E_{2141}	E_{2241}	E_{2341}
	2	E_{1142}	E_{1242}	E_{1342}	E_{2142}	E_{2242}	E_{2342}
	3	E_{1143}	E_{1243}	E_{1343}	E_{2143}	E_{2243}	E_{2343}
$0.67t_d$	1	E_{1151}	E_{1251}	E_{1351}	E_{2151}	E_{2251}	E_{2351}
	2	E_{1152}	E_{1252}	E_{1352}	E_{2152}	E_{2252}	E_{2352}
	3	E_{1153}	E_{1253}	E_{1353}	E_{2153}	E_{2253}	E_{2353}
$0.5t_d$	1	E_{1161}	E_{1261}	E_{1361}	E_{2161}	E_{2261}	E_{2361}
	2	E_{1162}	E_{1262}	E_{1362}	E_{2162}	E_{2262}	E_{2362}
	3	E_{1163}	E_{1263}	E_{1363}	E_{2163}	E_{2263}	E_{2363}

Table 1.2: Test Matrix - Cars.

acceleration (time scale)	trial	maneuver position					
		3			4		
		separation			separation		
		1	2	3	1	2	3
t_∞	1	E3111	E3211	E3311	E4111	E4211	E4311
	2	E3112	E3212	E3312	E4112	E4212	E4312
	3	E3113	E3213	E3313	E4113	E4213	E_{4313}
$2t_d$	1	E3121	E3221	E3321	E4112	E4221	E4321
	2	E3122	E3222	E3322	E4122	E4222	E4322
	3	E3123	E3223	E3323	E4123	E4223	E_{4323}
$1.5t_d$	1	E3131	E3231	E3331	E4131	E4231	E4331
	2	E3132	E3232	E3332	E4132	E4232	E4332
	3	E3133	E3233	E3333	E4133	E4233	E4333
t_d	1	E3141	E3241	E3341	E4141	E4241	E4341
	2	E3142	E3242	E3342	E4142	E4242	E4342
	3	E3143	E3243	E3343	E4143	E4243	E4343
$0.67t_d$	1	E3151	E3251	E3351	E4151	E4251	E4351
	2	E3152	E3252	E3352	E4152	E4252	E4352
	3	E3153	E3253	E3353	E4153	E4253	E4353
$0.5t_d$	1	E3161	E3261	E3361	E4161	E4261	E4361
	2	E3162	E3262	E3362	E4162	E4262	E4362
	3	E3163	E3263	E3363	E4163	E4263	E4363

Table 1.3: Test Matrix - Cars.

acceleration (time scale)	trial	maneuver position 1	2	3	4
t_∞	1	B_{1211}	B_{2211}	B_{3211}	B_{4211}
	2	B_{1212}	B_{2212}	B_{3212}	B_{4212}
	3	B_{1213}	B_{2213}	B_{3213}	B_{4213}
$2t_d$	1	B_{1221}	B_{2221}	B_{3221}	B_{4212}
	2	B_{1222}	B_{2222}	B_{3222}	B_{4222}
	3	B_{1223}	B_{2223}	B_{3223}	B_{4223}
$1.5t_d$	1	B_{1231}	B_{2231}	B_{3231}	B_{4231}
	2	B_{1232}	B_{2232}	B_{3232}	B_{4232}
	3	B_{1233}	B_{2233}	B_{3233}	B_{4233}
t_d	1	B_{1241}	B_{2241}	B_{3241}	B_{4241}
	2	B_{1242}	B_{2242}	B_{3242}	B_{4242}
	3	B_{1243}	B_{2243}	B_{3243}	B_{4243}
$0.67t_d$	1	B_{1251}	B_{2251}	B_{3251}	B_{4251}
	2	B_{1252}	B_{2252}	B_{3252}	B_{4252}
	3	B_{1253}	B_{2253}	B_{3253}	B_{4253}
$0.5t_d$	1	B_{1261}	B_{2261}	B_{3261}	B_{4261}
	2	B_{1262}	B_{2262}	B_{3262}	B_{4262}
	3	B_{1263}	B_{2263}	B_{3263}	B_{4263}

Table 1.4: Test Matrix - Boxes.

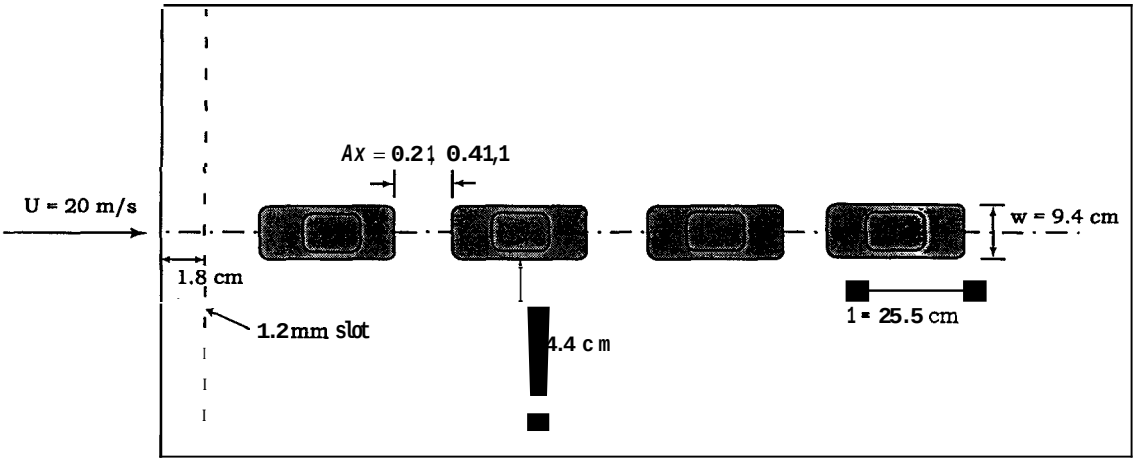
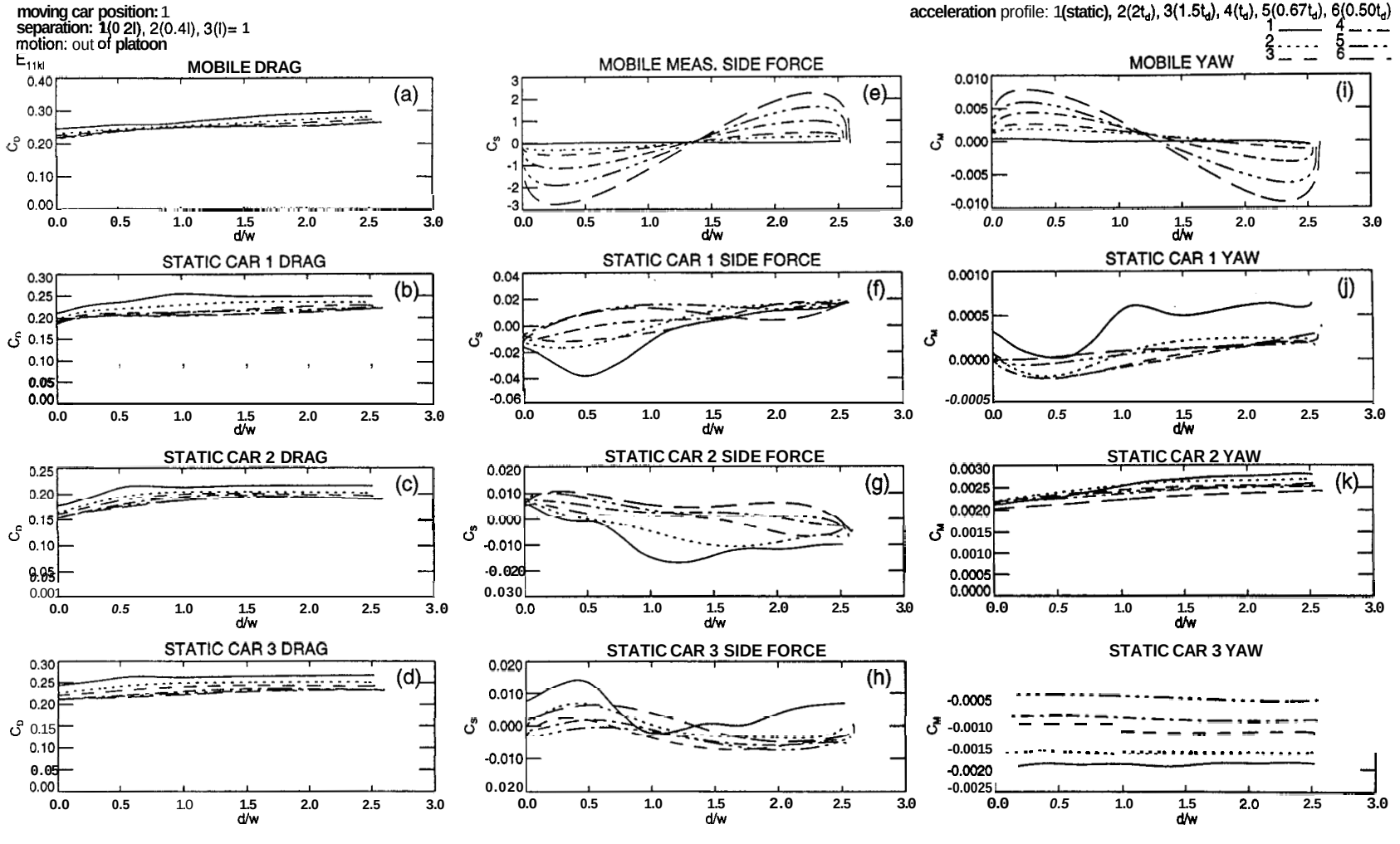


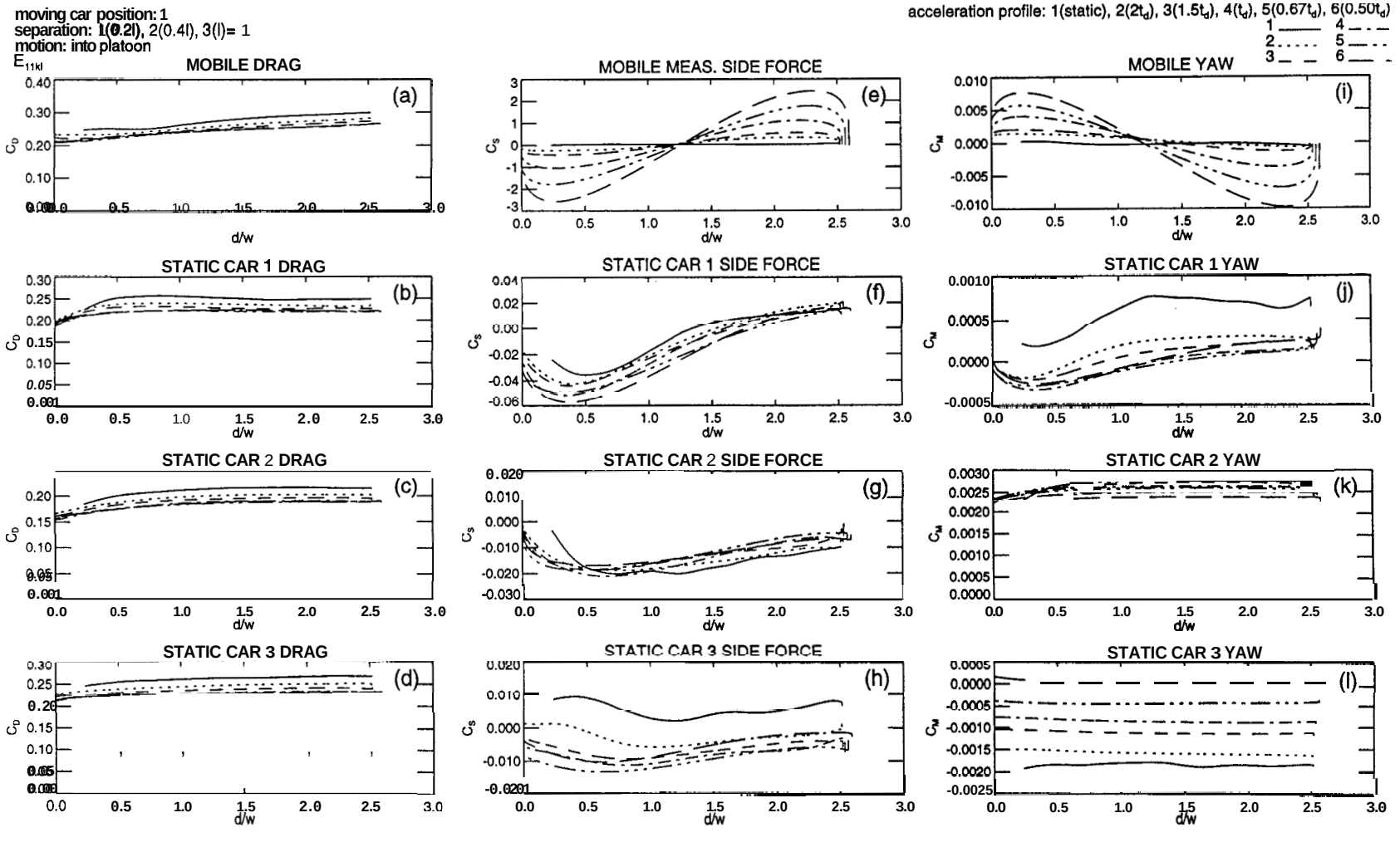
Figure 1.1: Experiment parameters.
The parameters for the measurements of the transient aerodynamic forces on a four-car platoon are shown. Any one of the four cars is moved in and out of the platoon at six different accelerations. In addition, three vehicle spacings are used.

Chapter 2

Acceleration Profiles - Cars

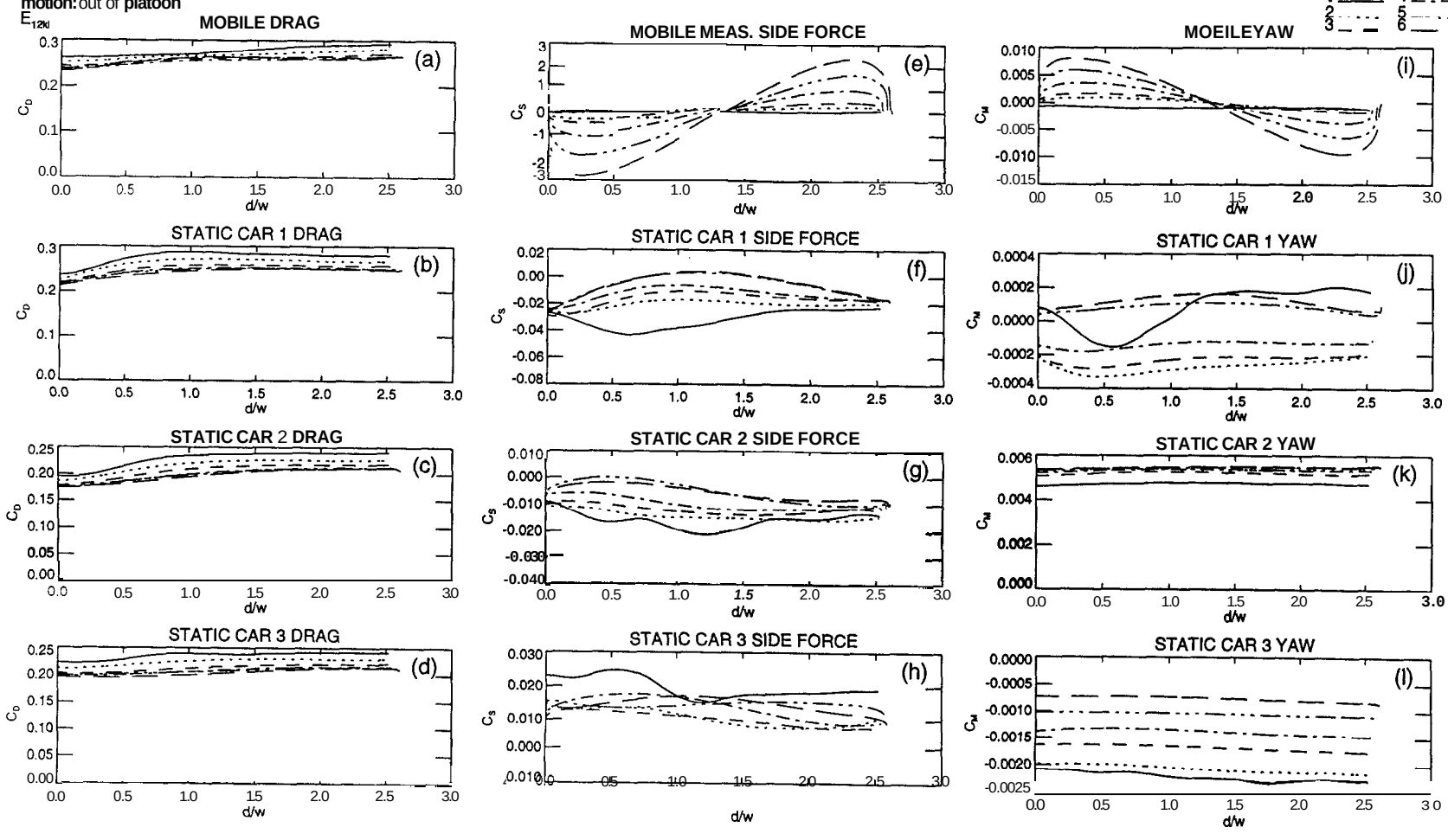
The drag, side force, and yawing moment coefficients measured on each of the four cars in a platoon during a simulated lane change are shown in the following figures. One of the cars moves out of the platoon, and after a pause, returns into the platoon. The coefficients are plotted with respect to the nondimensional lateral displacement of the maneuvering car d/w, where the displacement d is scaled with the car width w. The measurements made during movement out of the platoon for one platoon configuration are shown first. The measurements made during movement into the platoon for the same configuration are shown in the next figure. This arrangement of the figures for motion out of the platoon and into the platoon is used for all of the platoon configurations. Each figure represents one of the four possible locations of the mobile car and a platoon configuration at one of the three possible inter-vehicle spacings. The different linetypes in each figure represent the six acceleration profiles used by the maneuvering car. For simplification, the curve for each acceleration profile is an average of the three experimental runs performed with that particular platoon configuration.


moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: out of platoon
F_{11kl}
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)
1
2
3
4
5
6
MOBILE DRAG
(a)
C_D
d/w
MOBILE MEAS. SIDE FORCE
(e)
C_S
d/w
MOBILE YAW
(i)
C_M
d/w
STATIC CAR 1 DRAG
(b)
C_D
d/w
STATIC CAR 1 SIDE FORCE
(f)
C_S
d/w
STATIC CAR 1 YAW
(j)
C_M
d/w
STATIC CAR 2 DRAG
(c)
C_D
d/w
STATIC CAR 2 SIDE FORCE
(g)
C_S
d/w
STATIC CAR 2 YAW
(k)
C_M
d/w
STATIC CAR 3 DRAG
(d)
C_D
d/w
STATIC CAR 3 SIDE FORCE
(h)
C_S
d/w
STATIC CAR 3 YAW
C_M
d/w


moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: into platoon
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)
1
2
3
4
5
6
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
d/w

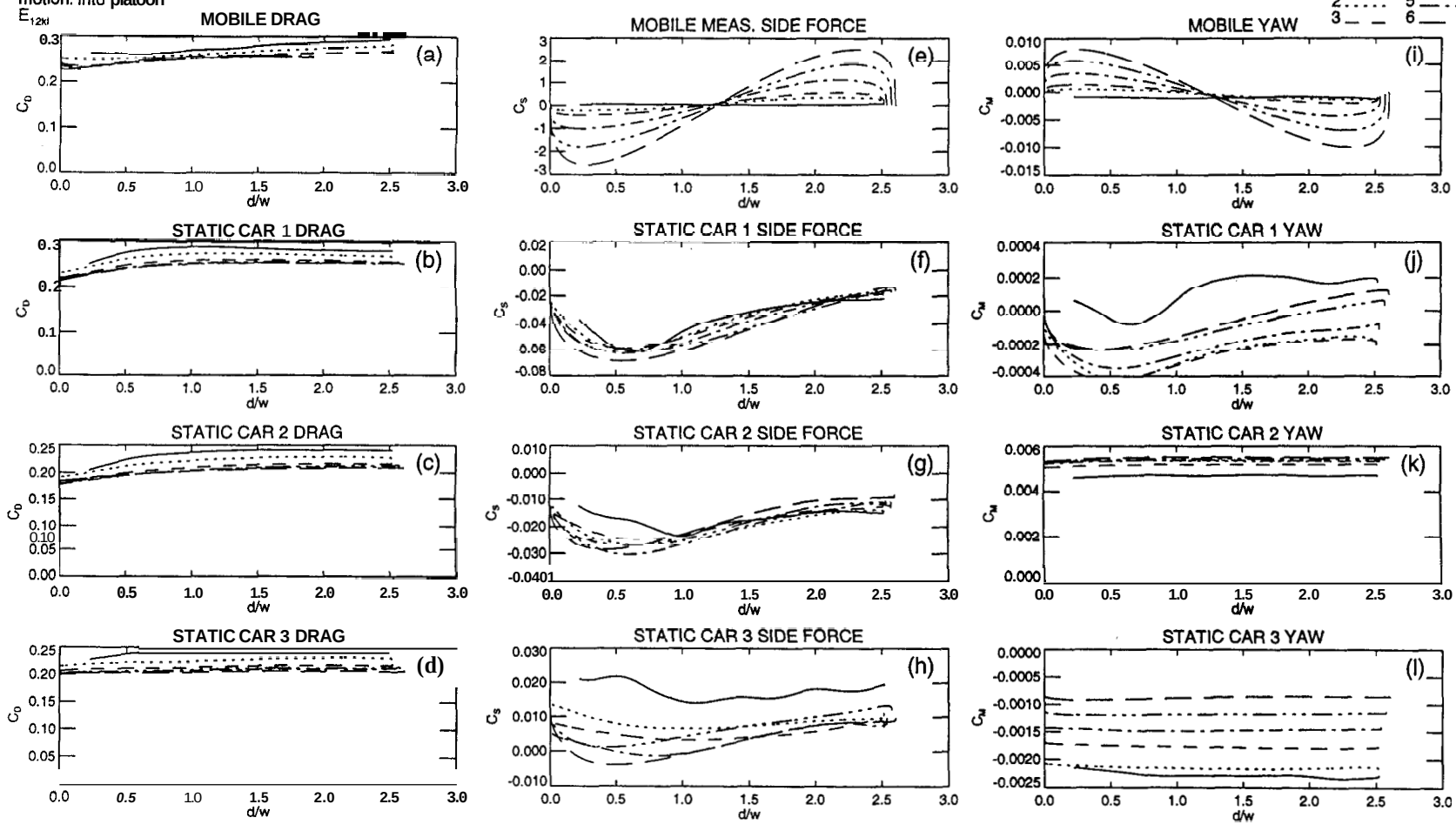
moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



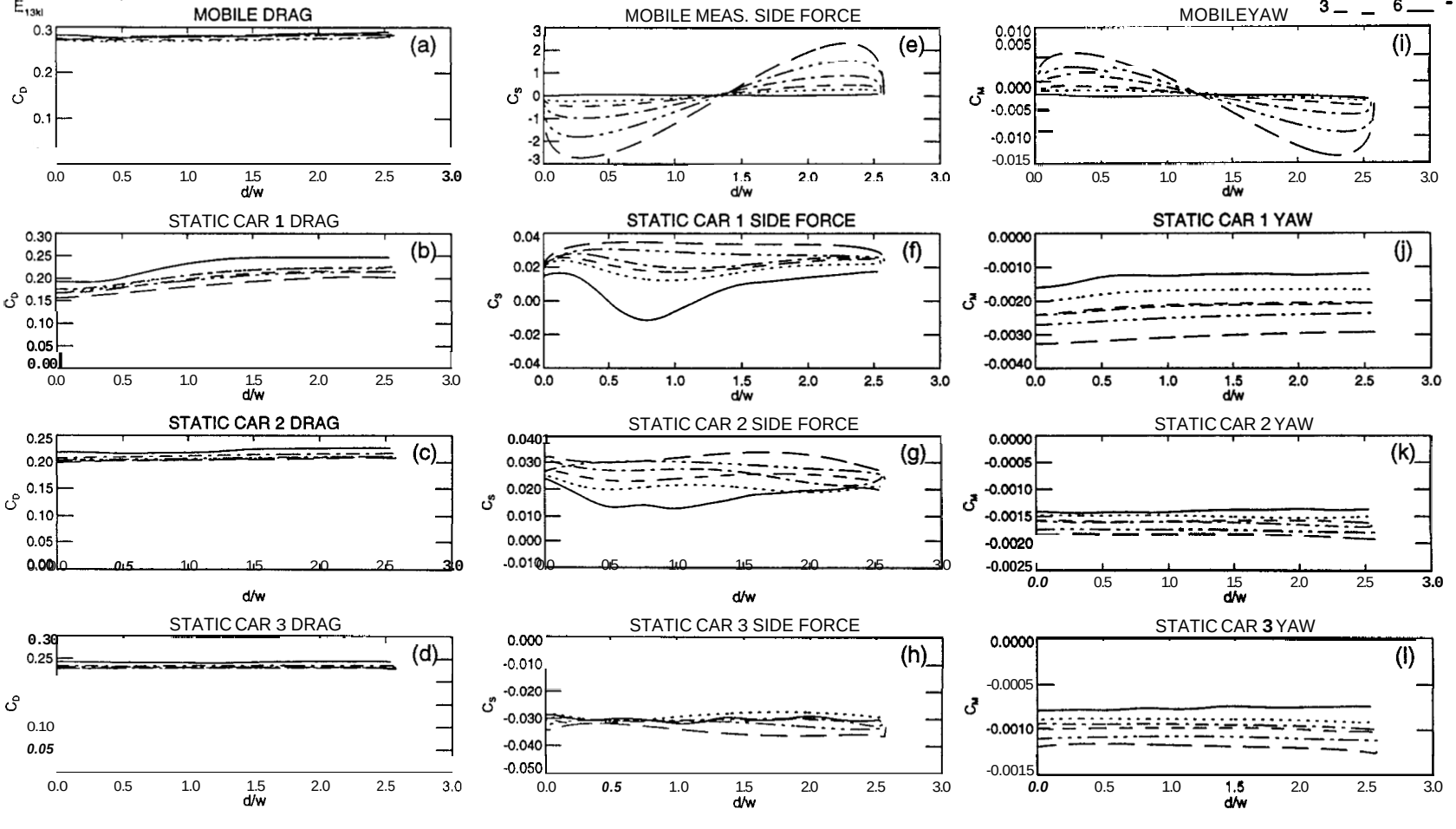
moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



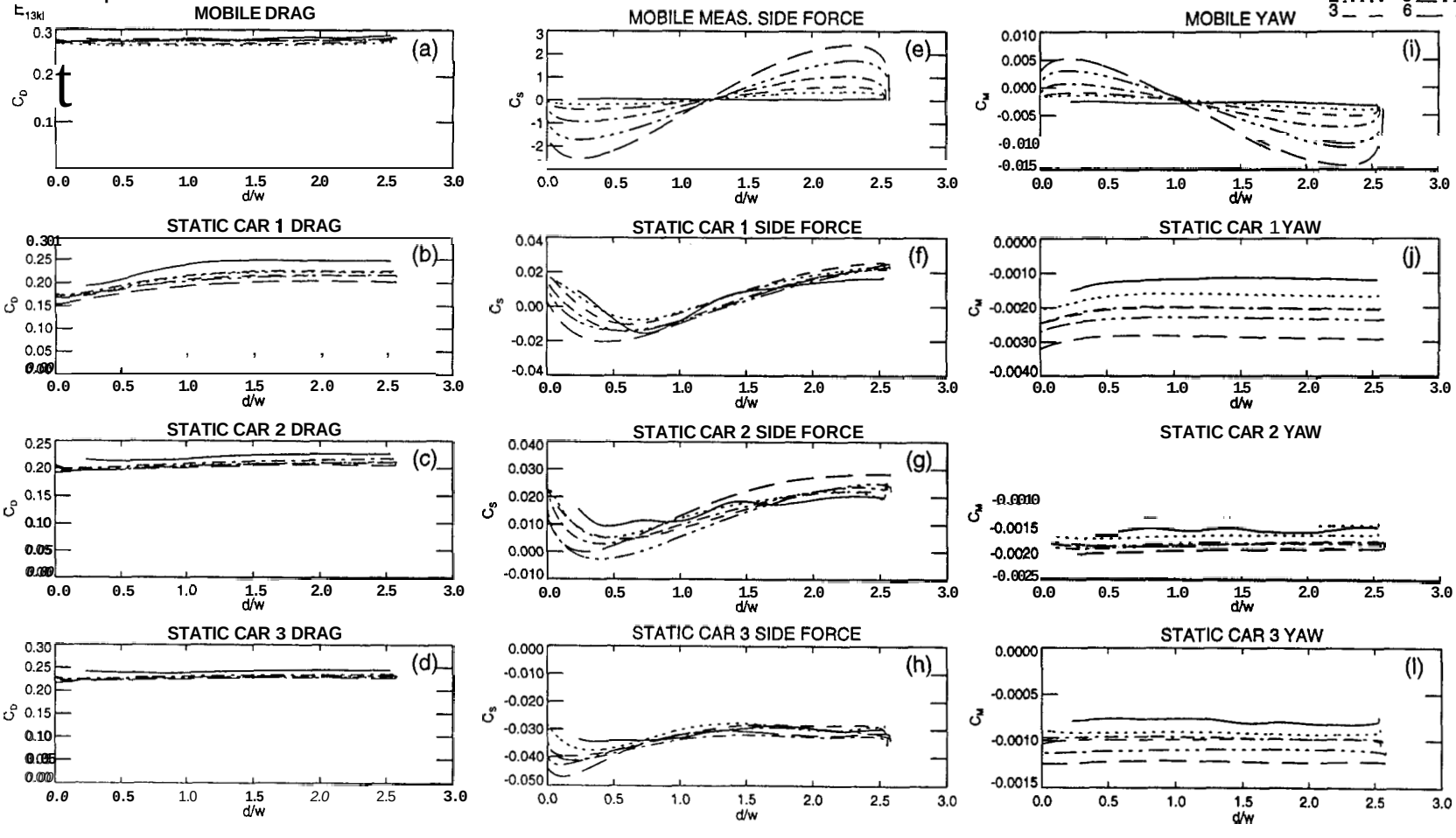
moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 3
potion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



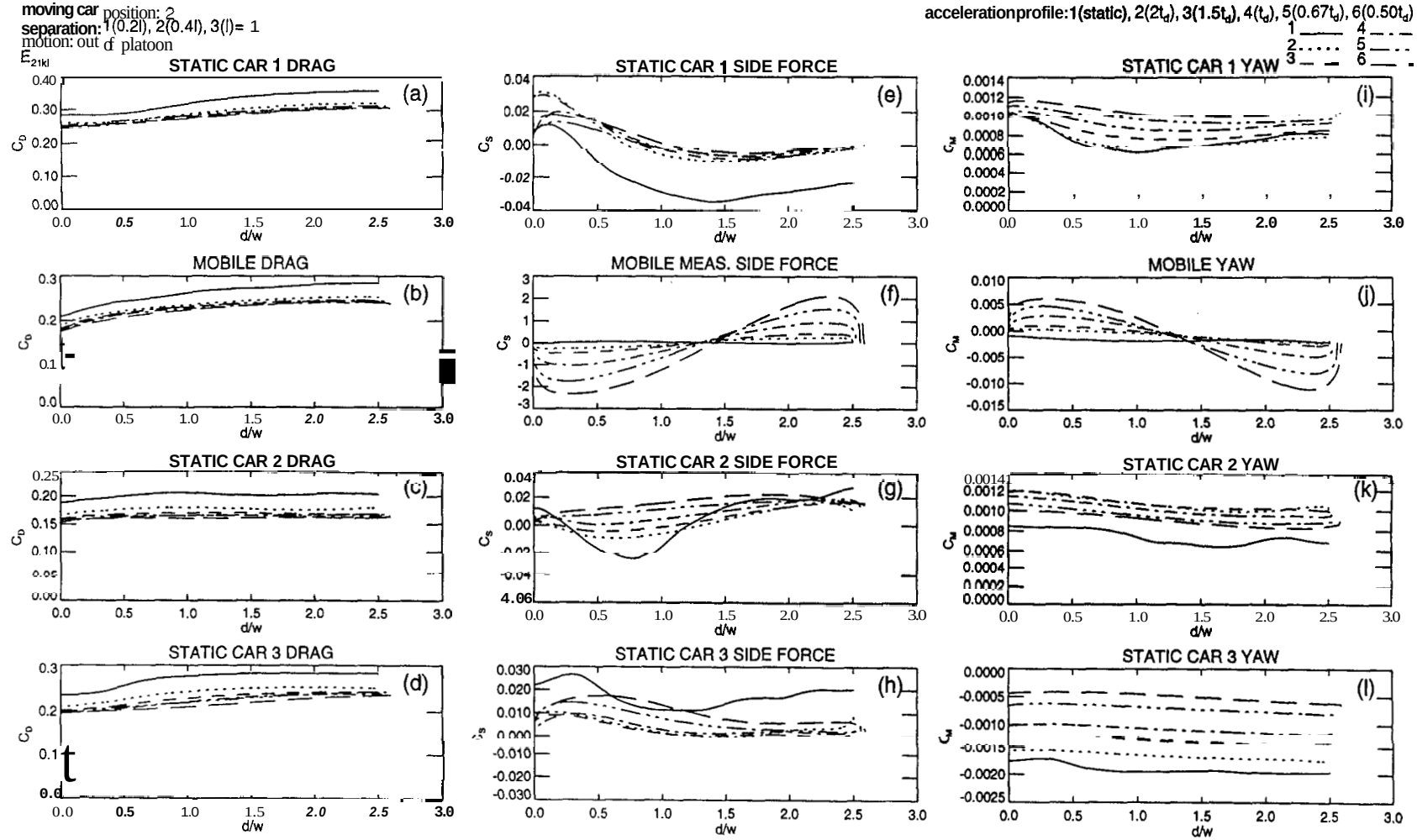
moving car position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: out of platoon

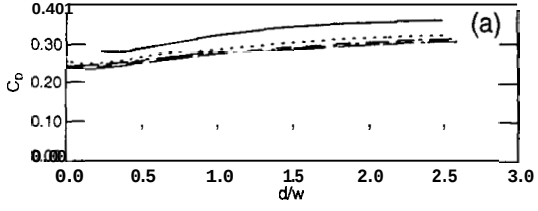
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



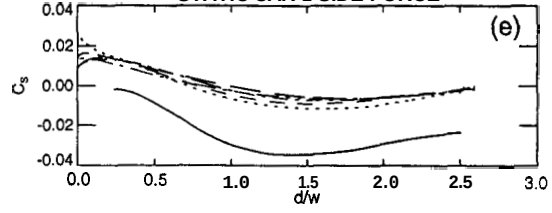
moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: into platoon
E_{21kl}

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)
1 —— 4 — · —
2 ····· 5 — · ·
3 — — 6 — · —

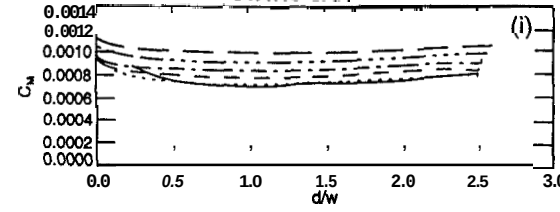
STATIC CAR 1 DRAG



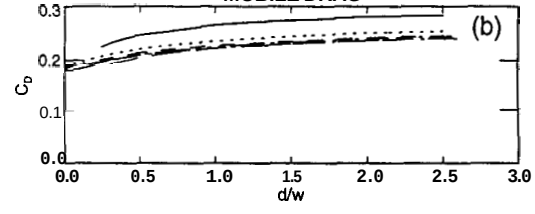
STATIC CAR 1 SIDE FORCE



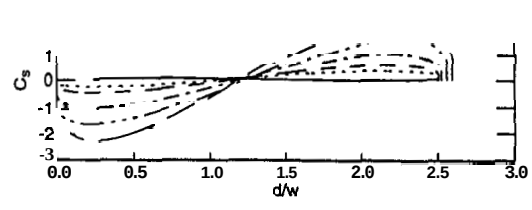
STATIC CAR 1 YAW



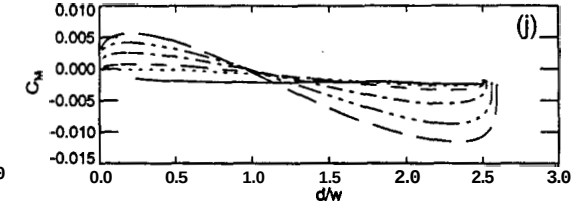
MOBILE DRAG



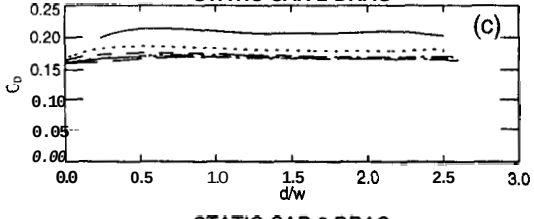
MOBILE MEAS. SIDE FORCE



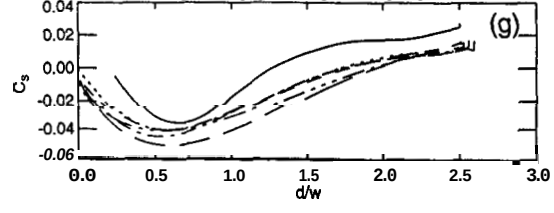
MOBILE YAW



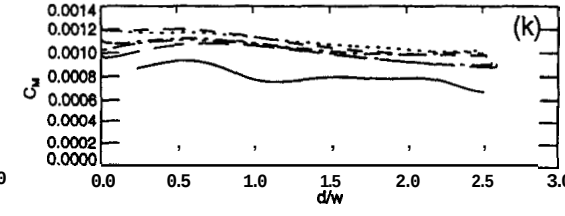
STATIC CAR 2 DRAG



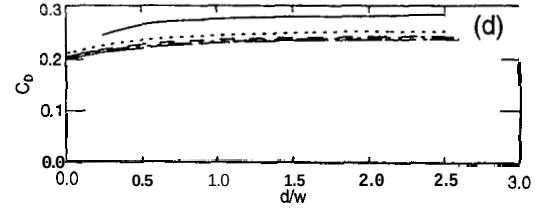
STATIC CAR 2 SIDE FORCE



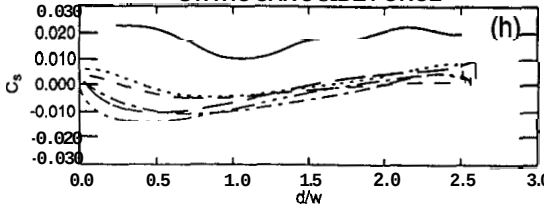
STATIC CAR 2 YAW



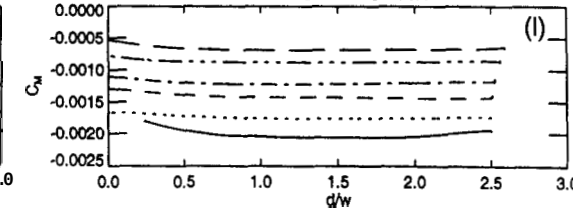
STATIC CAR 3 DRAG



STATIC CAR 3 SIDE FORCE



STATIC CAR 3 YAW



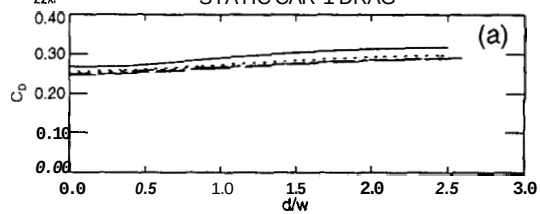
moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)

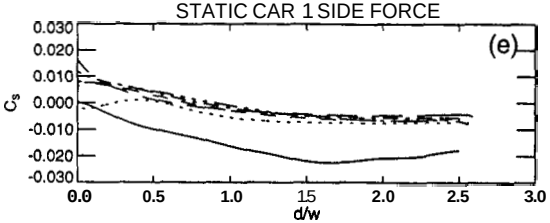
1 2 3 4 5 6

E_{22kl}

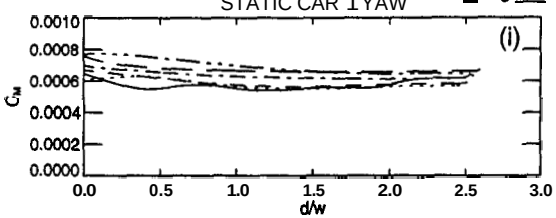
STATIC CAR 1 DRAG



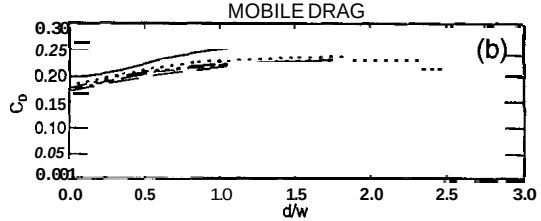
STATIC CAR 1 SIDE FORCE



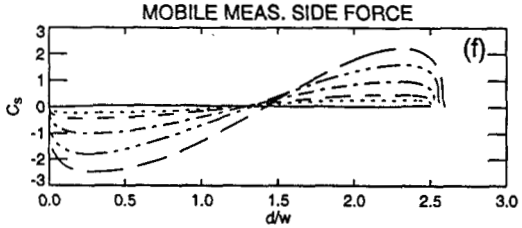
STATIC CAR 1 YAW



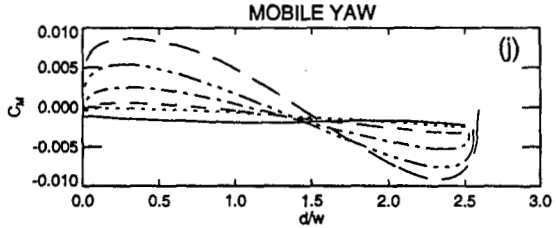
MOBILE DRAG



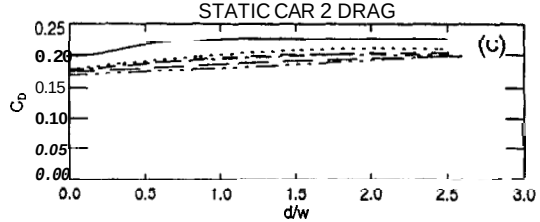
MOBILE MEAS. SIDE FORCE



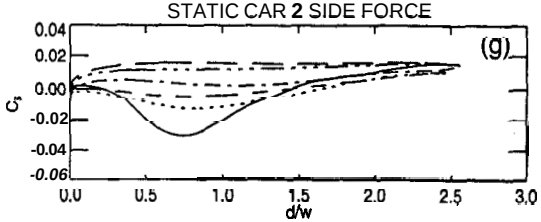
MOBILE YAW



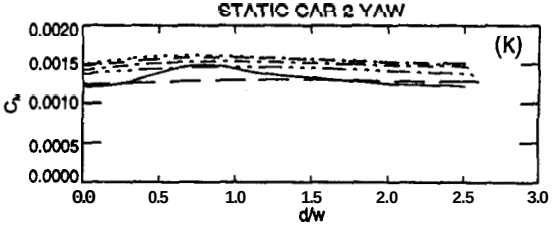
STATIC CAR 2 DRAG



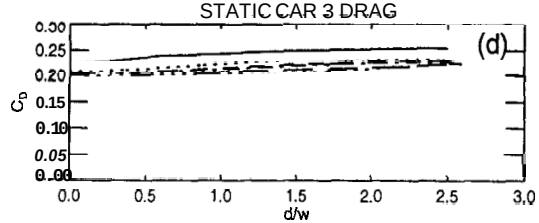
STATIC CAR 2 SIDE FORCE



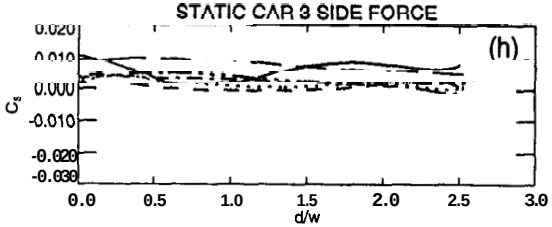
STATIC CAR 2 YAW



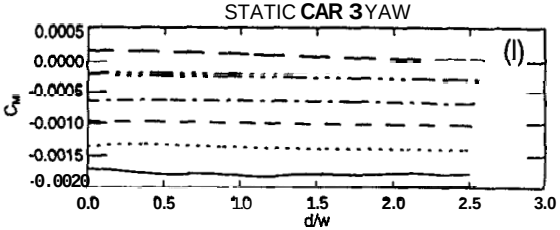
STATIC CAR 3 DRAG



STATIC CAR 3 SIDE FORCE



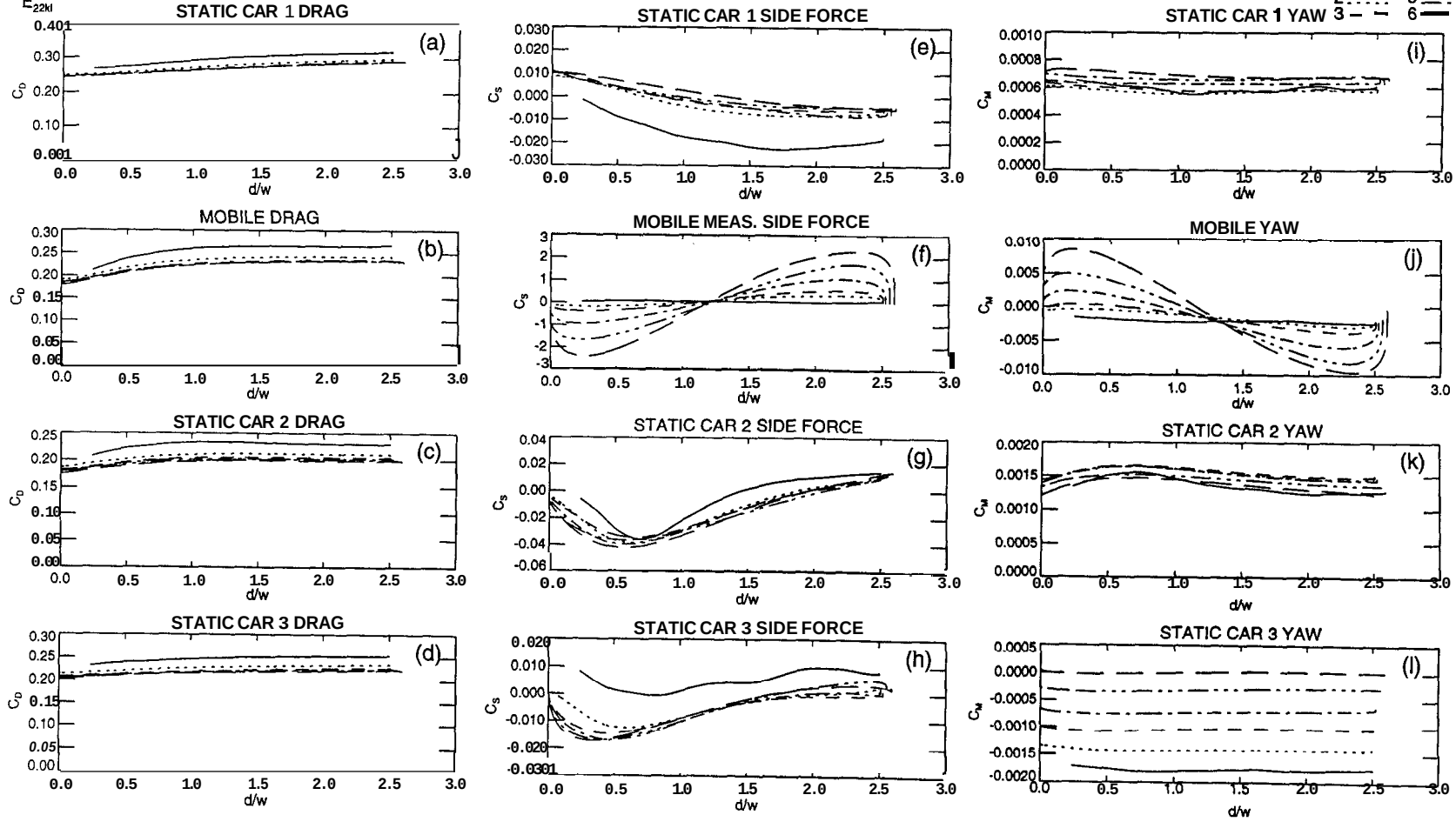
STATIC CAR 3 YAW

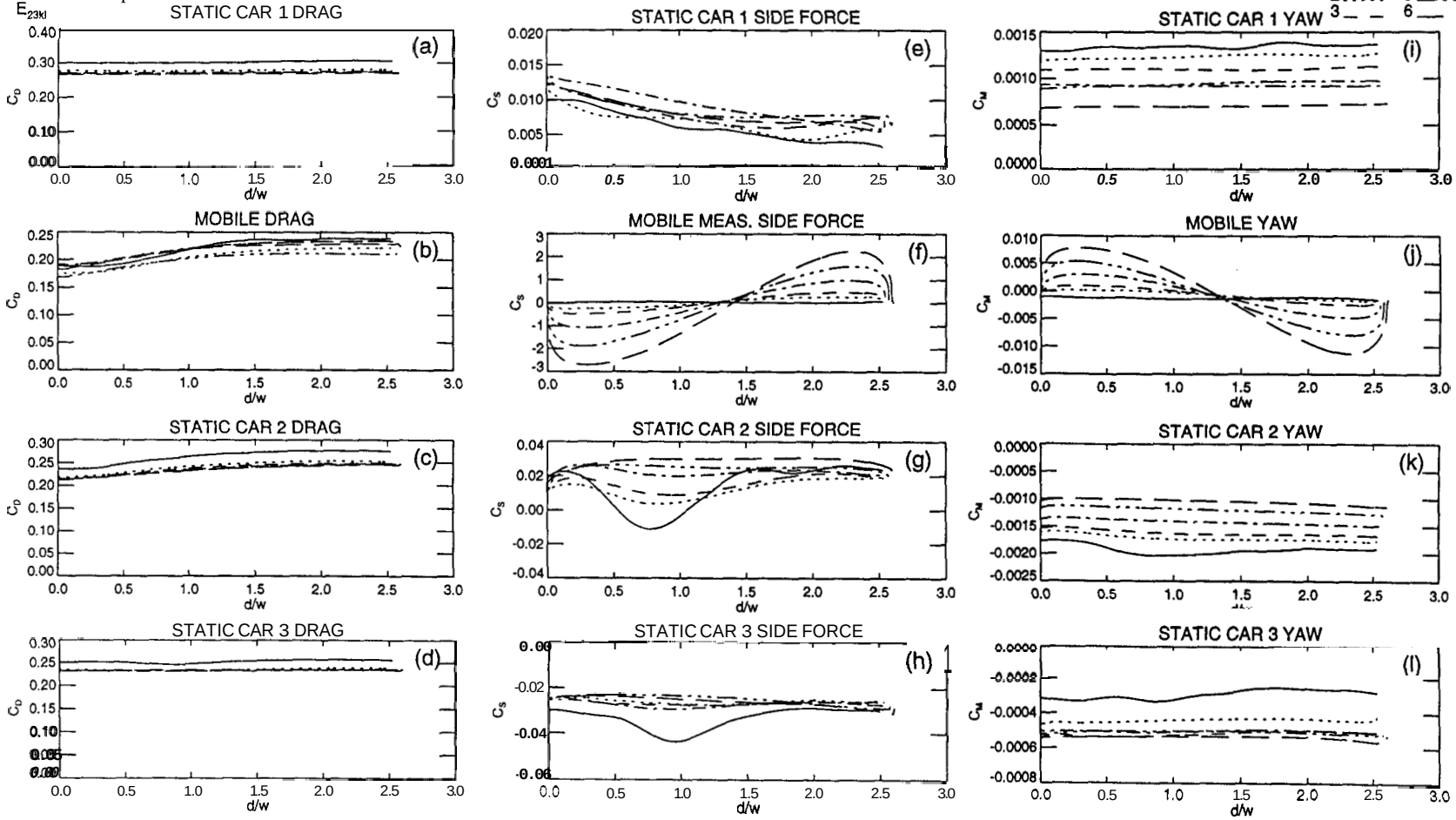


moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)

1 4
2 5
3 6

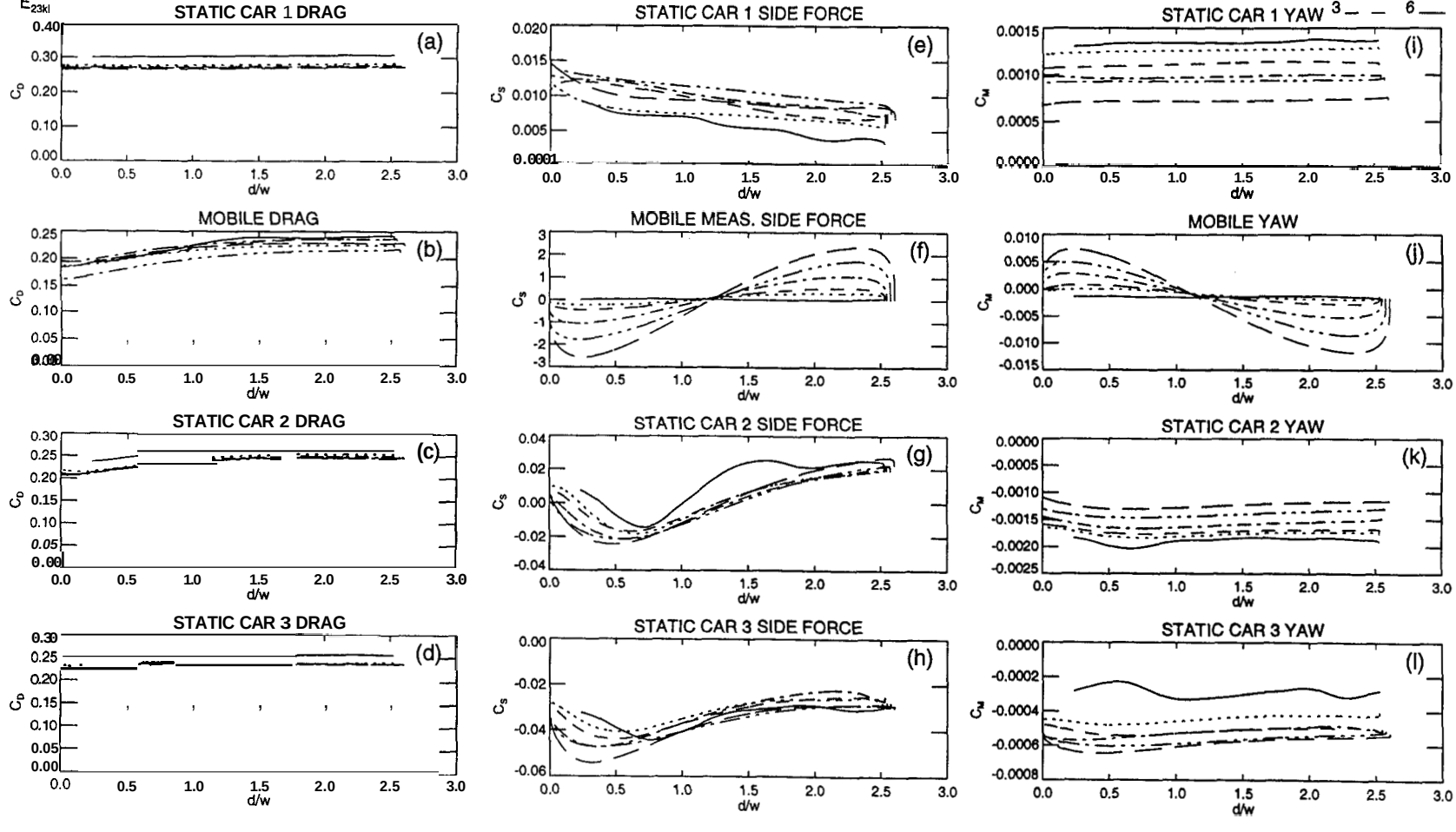



moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: out of platoon
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)
STATIC CAR 1 DRAG
(a)
MOBILE DRAG
(b)
STATIC CAR 2 DRAG
(c)
STATIC CAR 3 DRAG
(d)
STATIC CAR 1 SIDE FORCE
(e)
MOBILE MEAS. SIDE FORCE
(f)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 1 YAW
(i)
MOBILE YAW
(j)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 YAW
(l)
d/w

moving car position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: into platoon
E_{23kl}

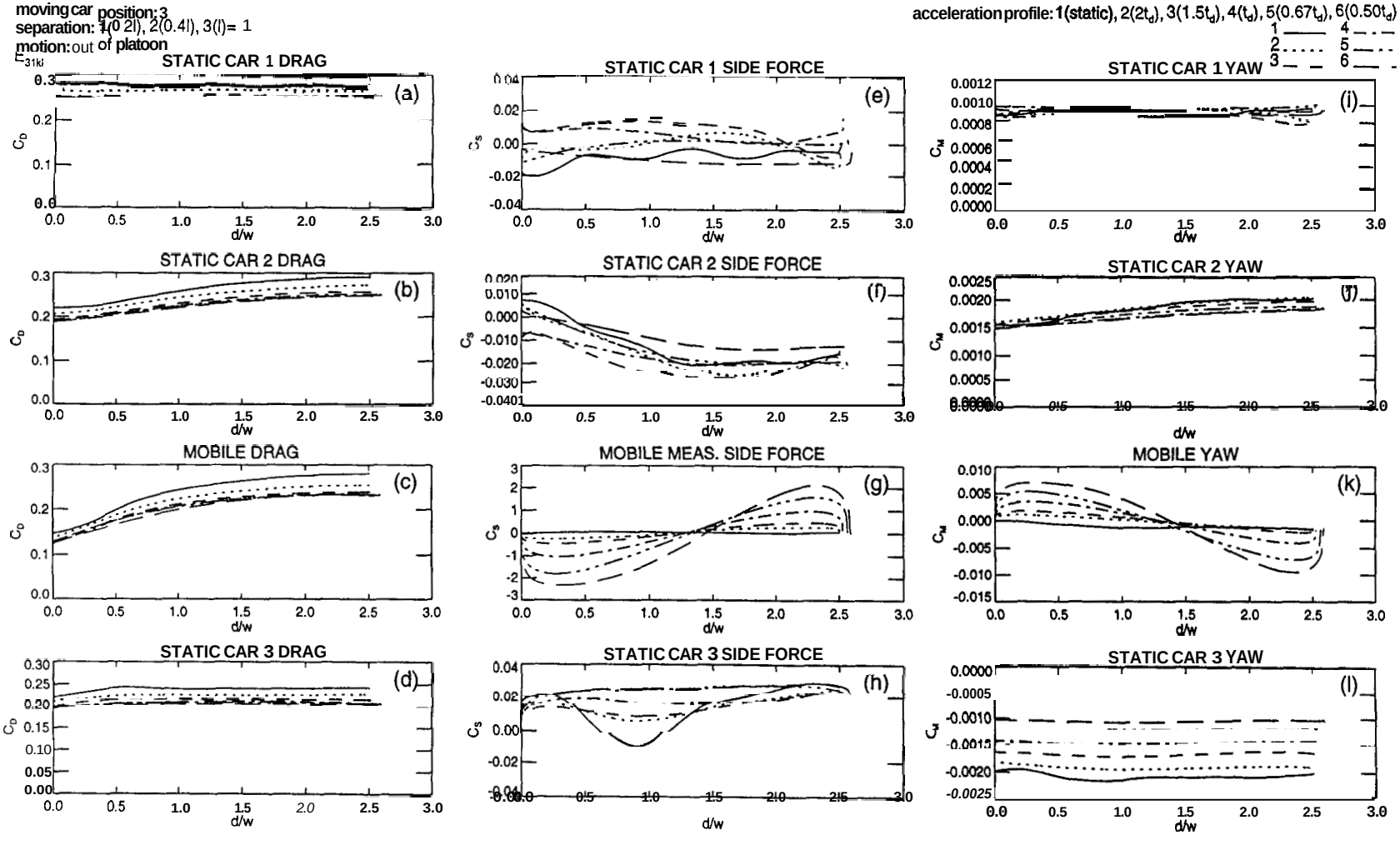
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)

1 2 3 4 5 6



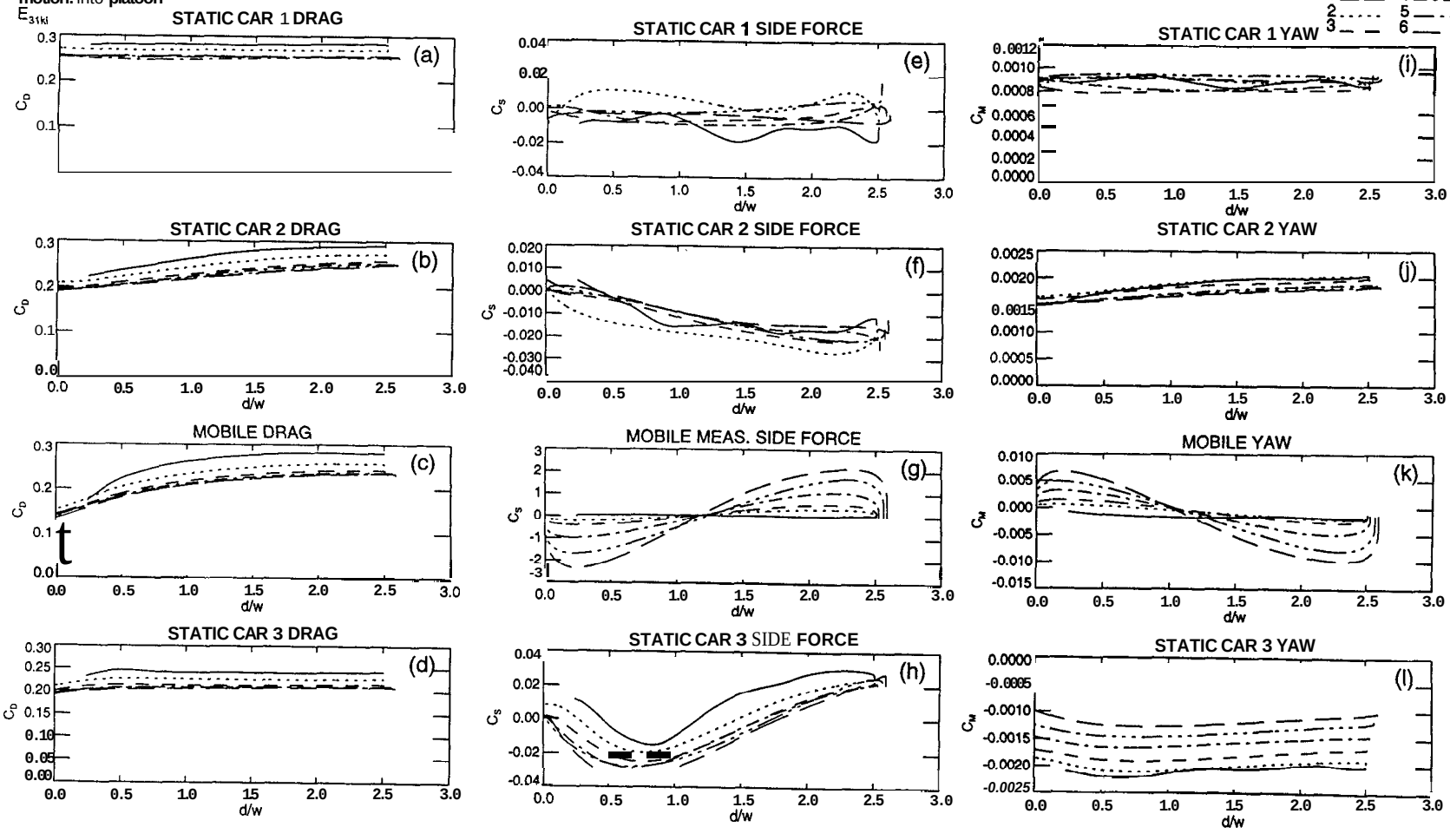
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



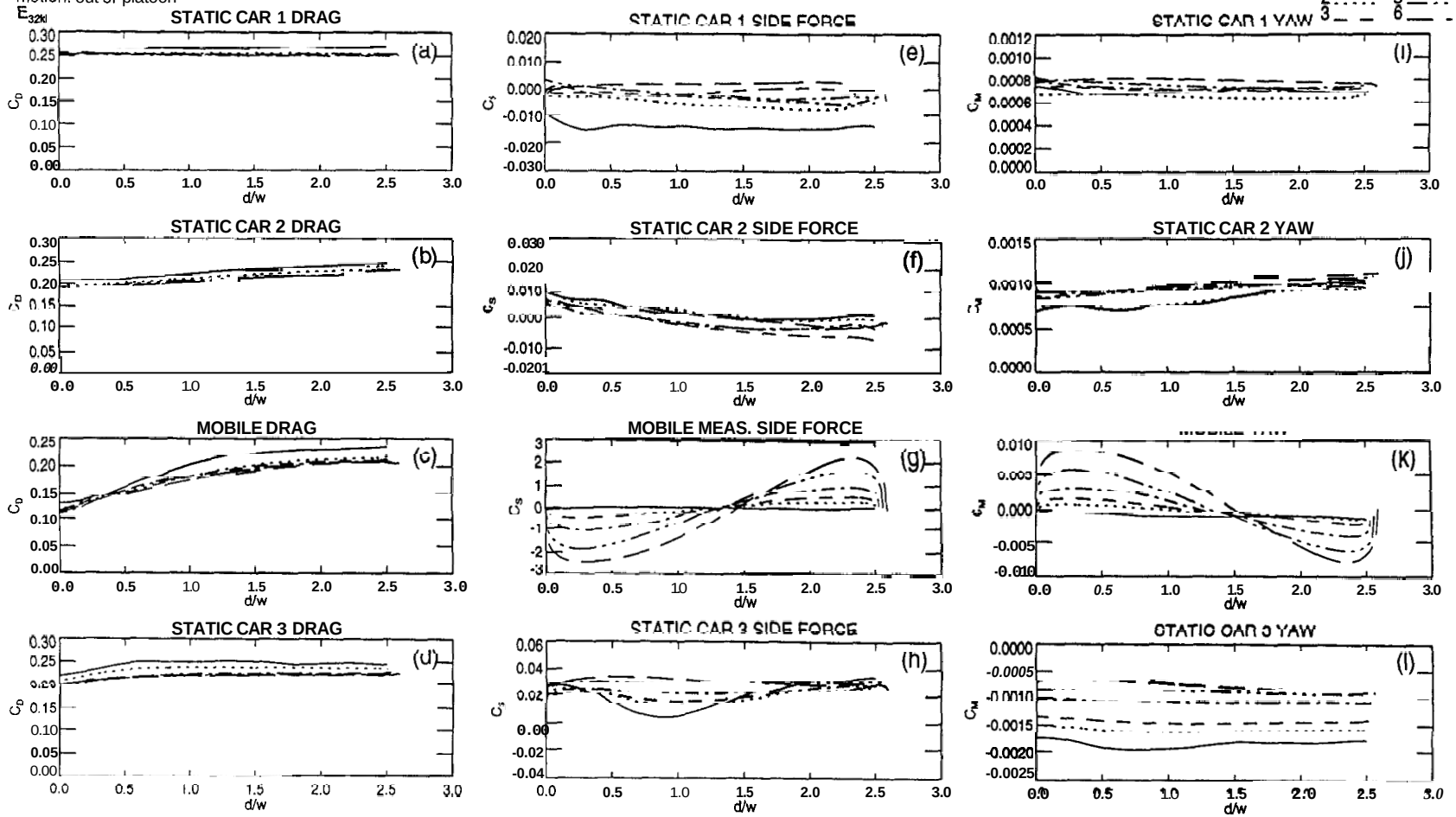
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



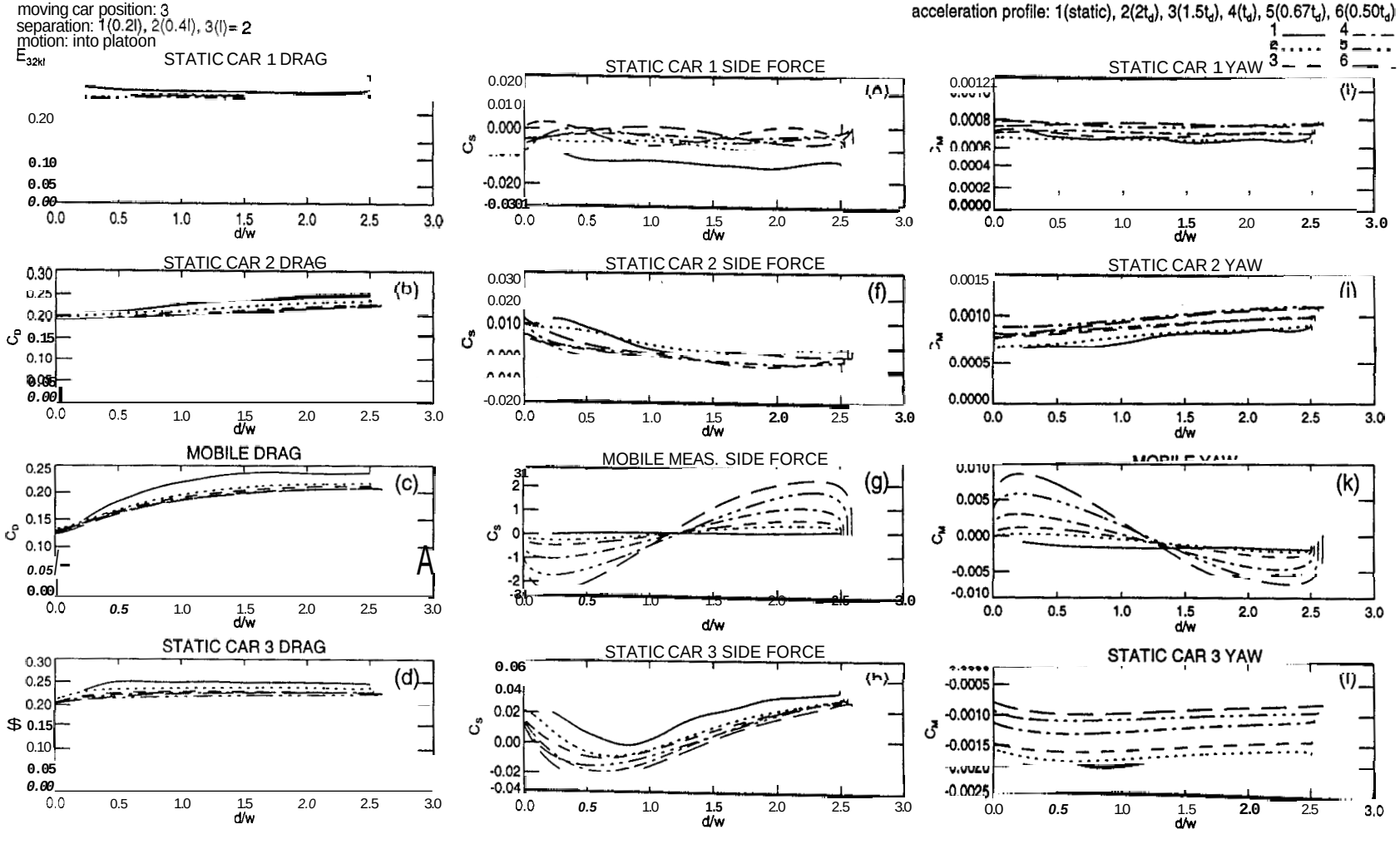
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



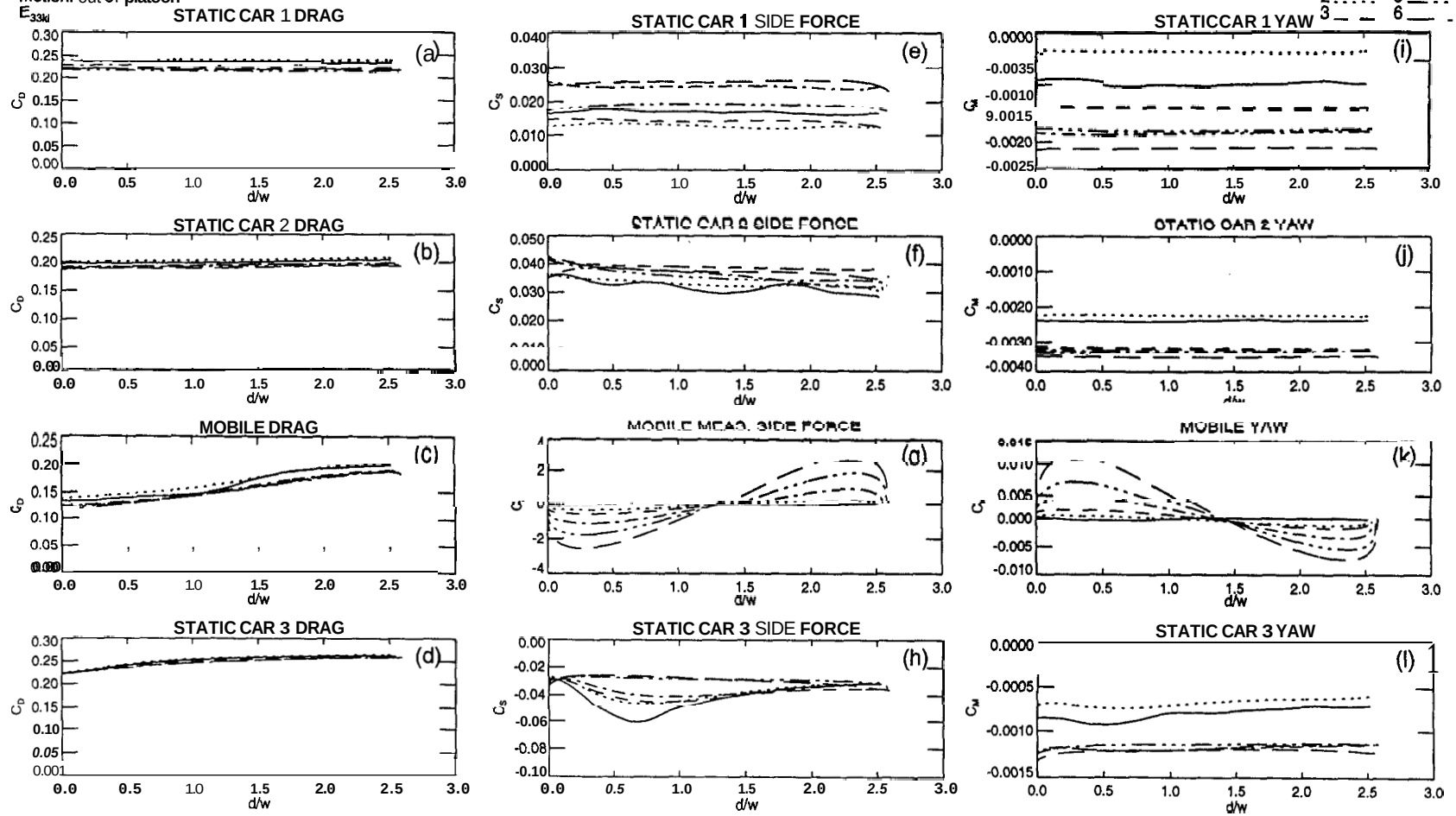
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon
E_{32kl}

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



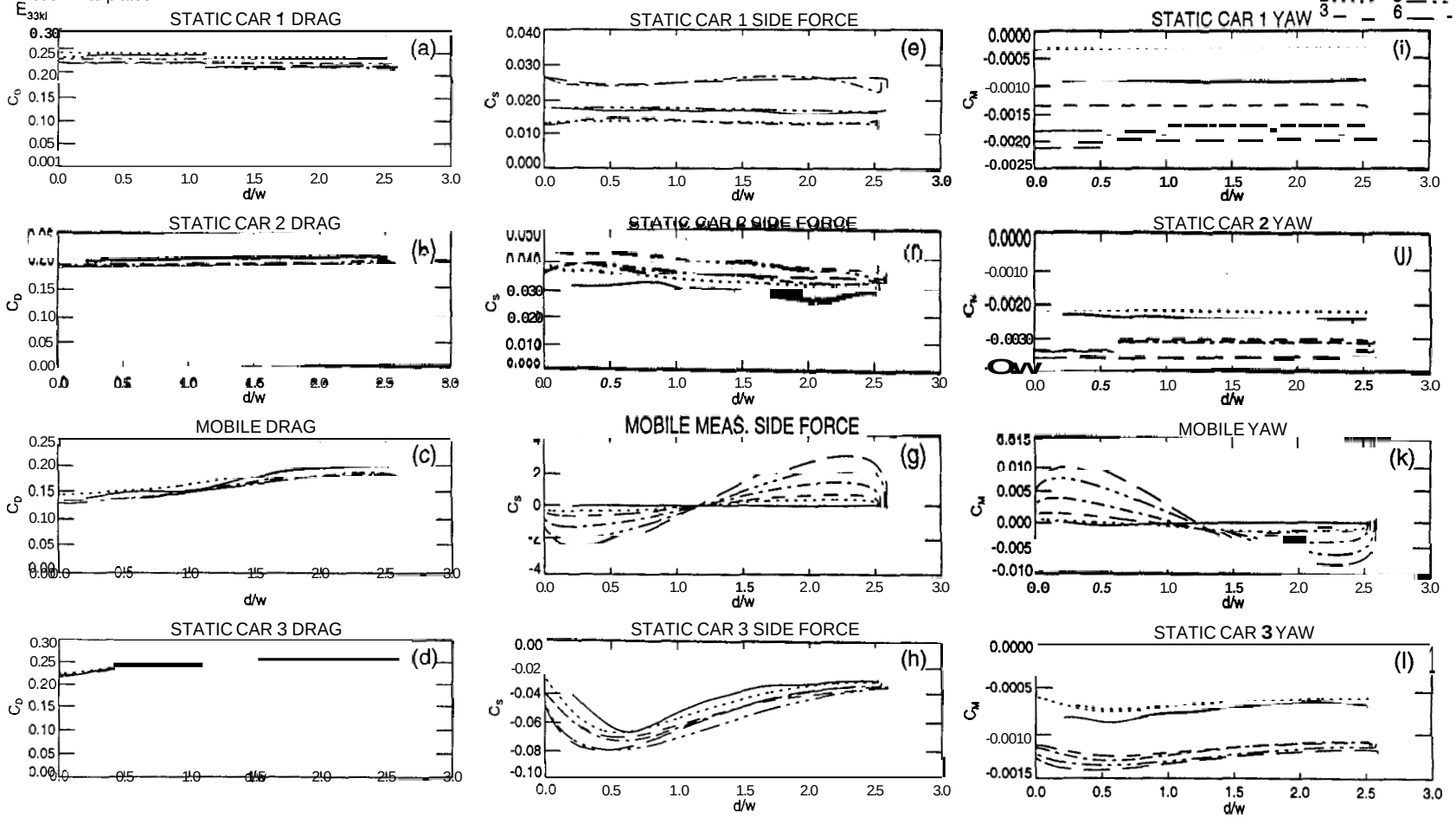
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



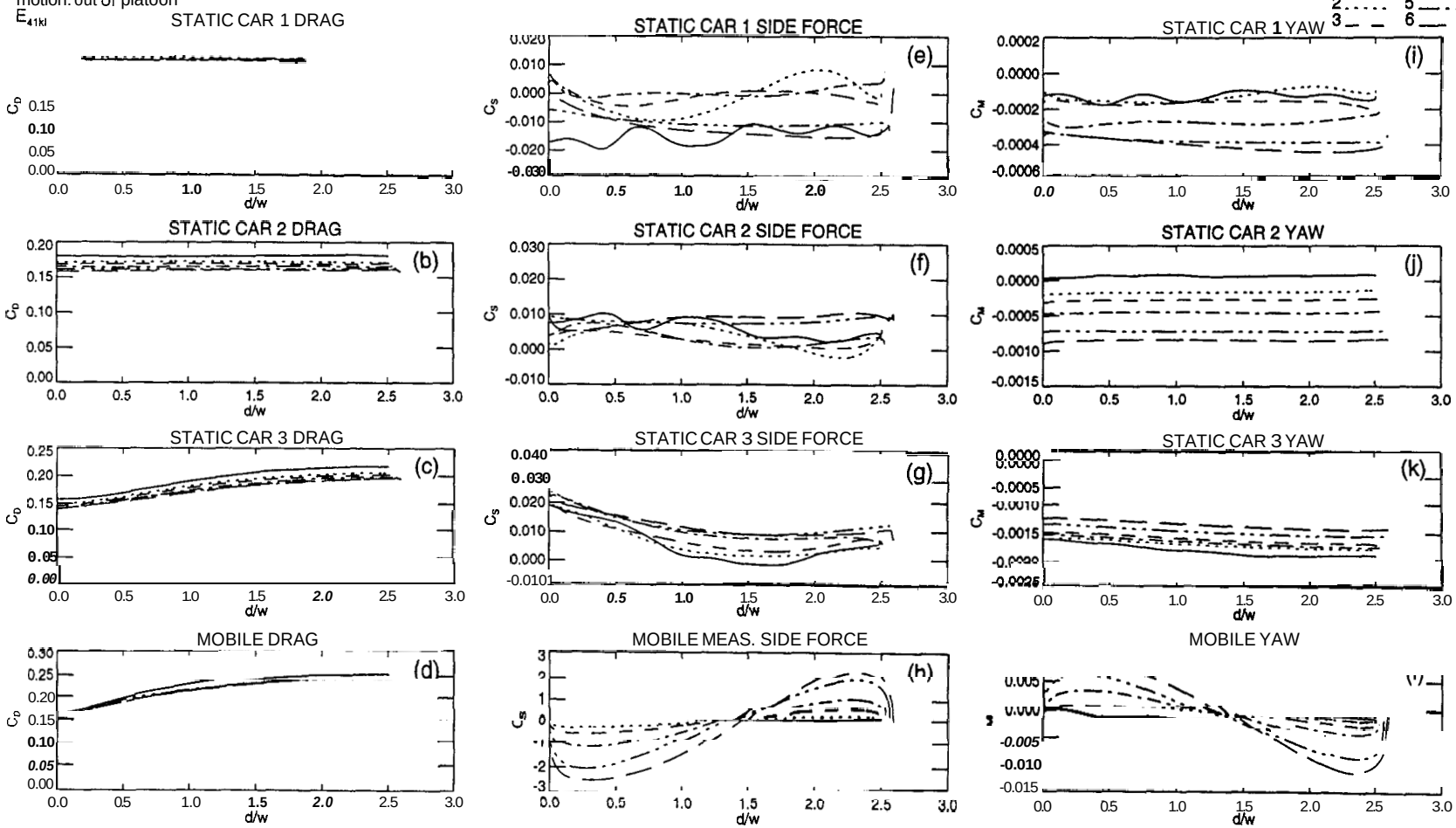
moving car position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



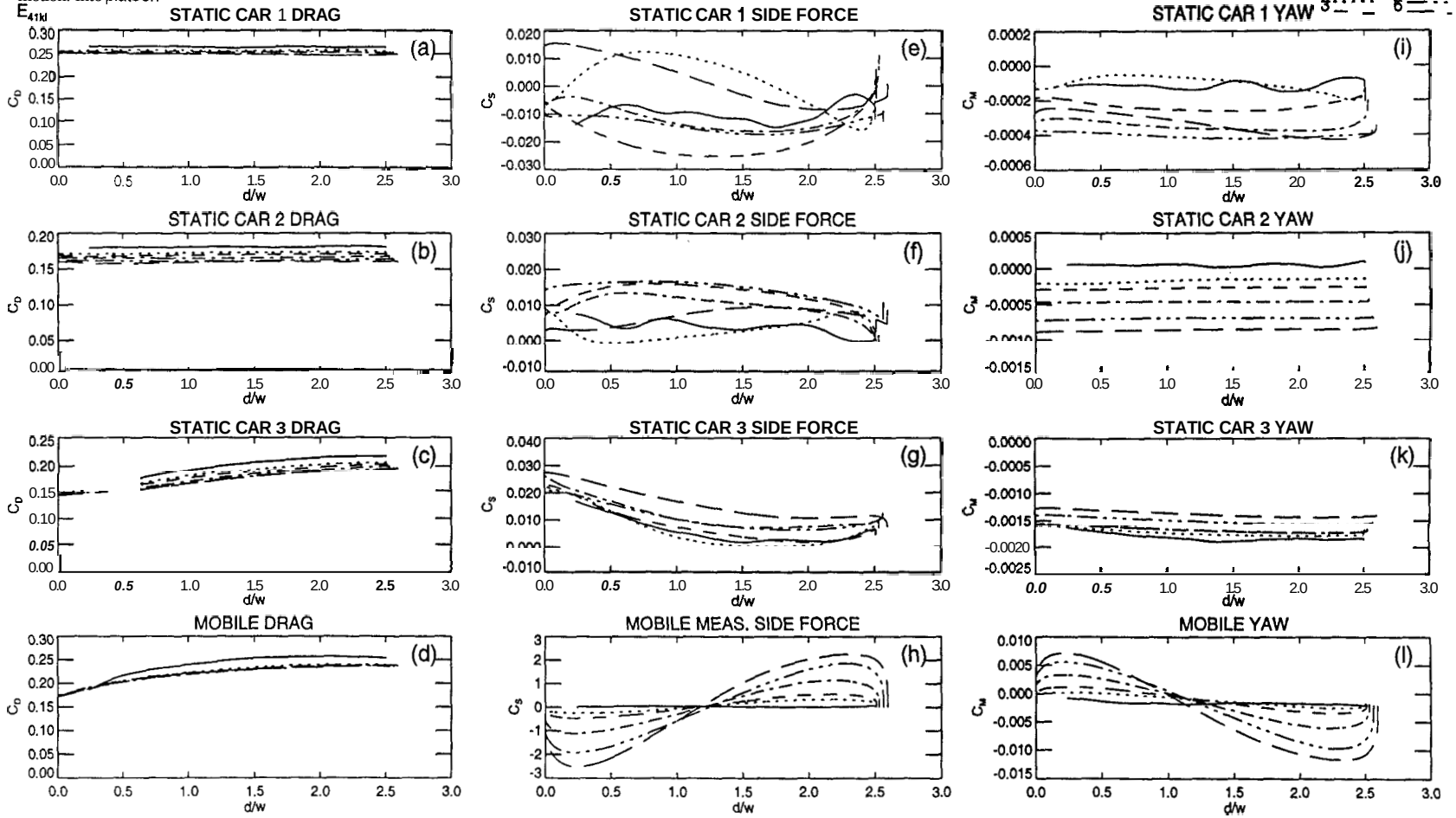
moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



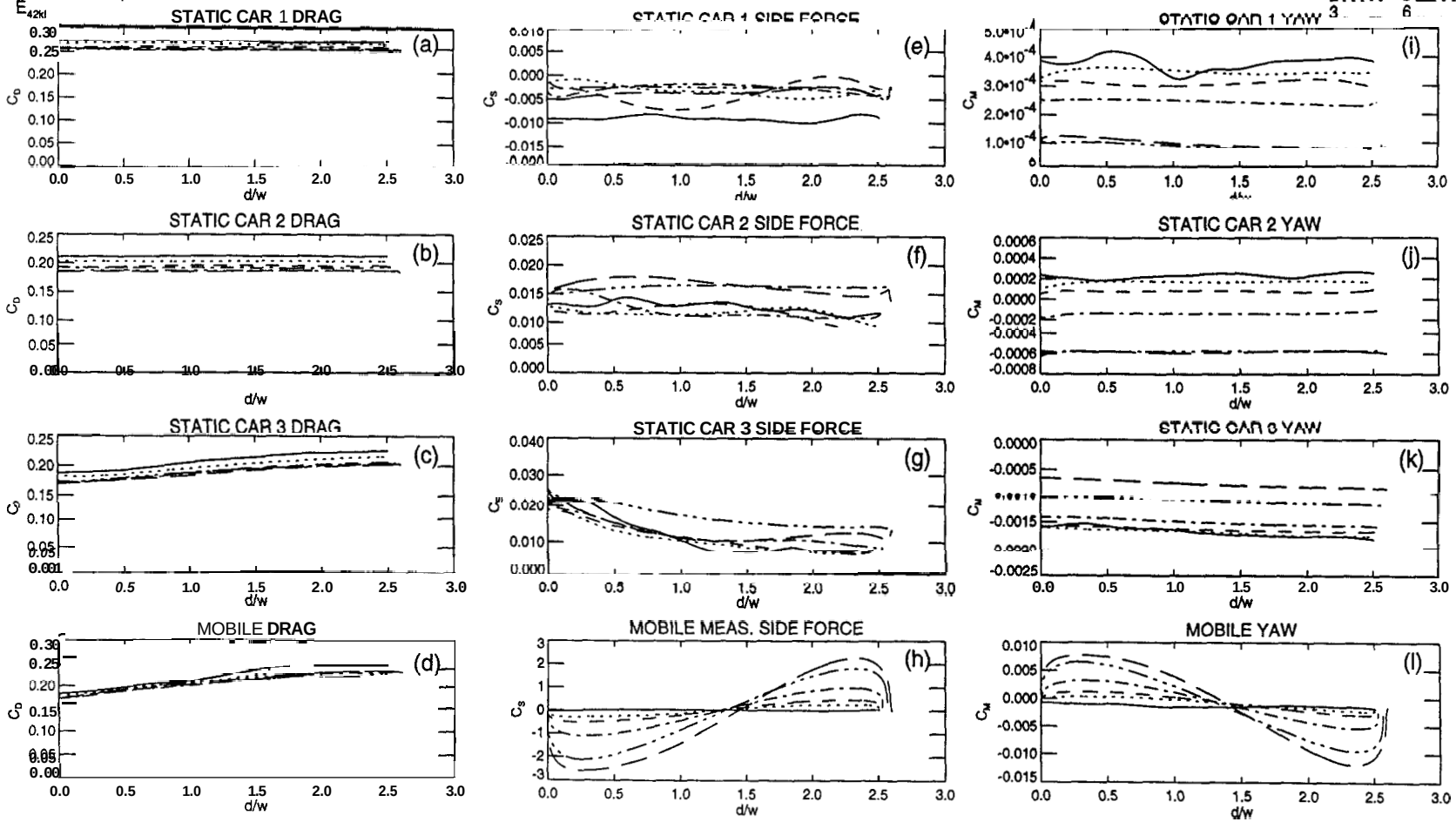
moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 1
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



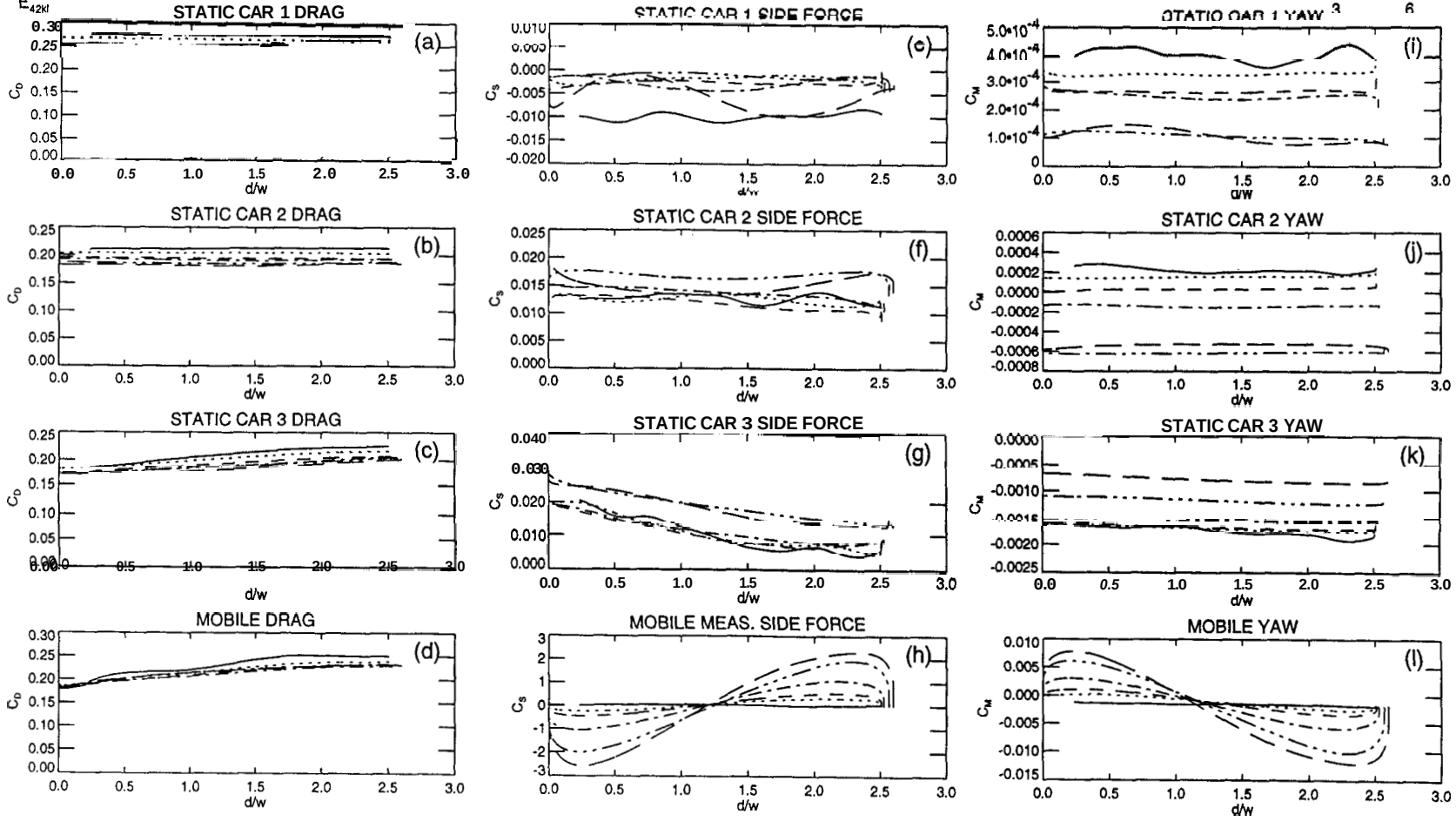
moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



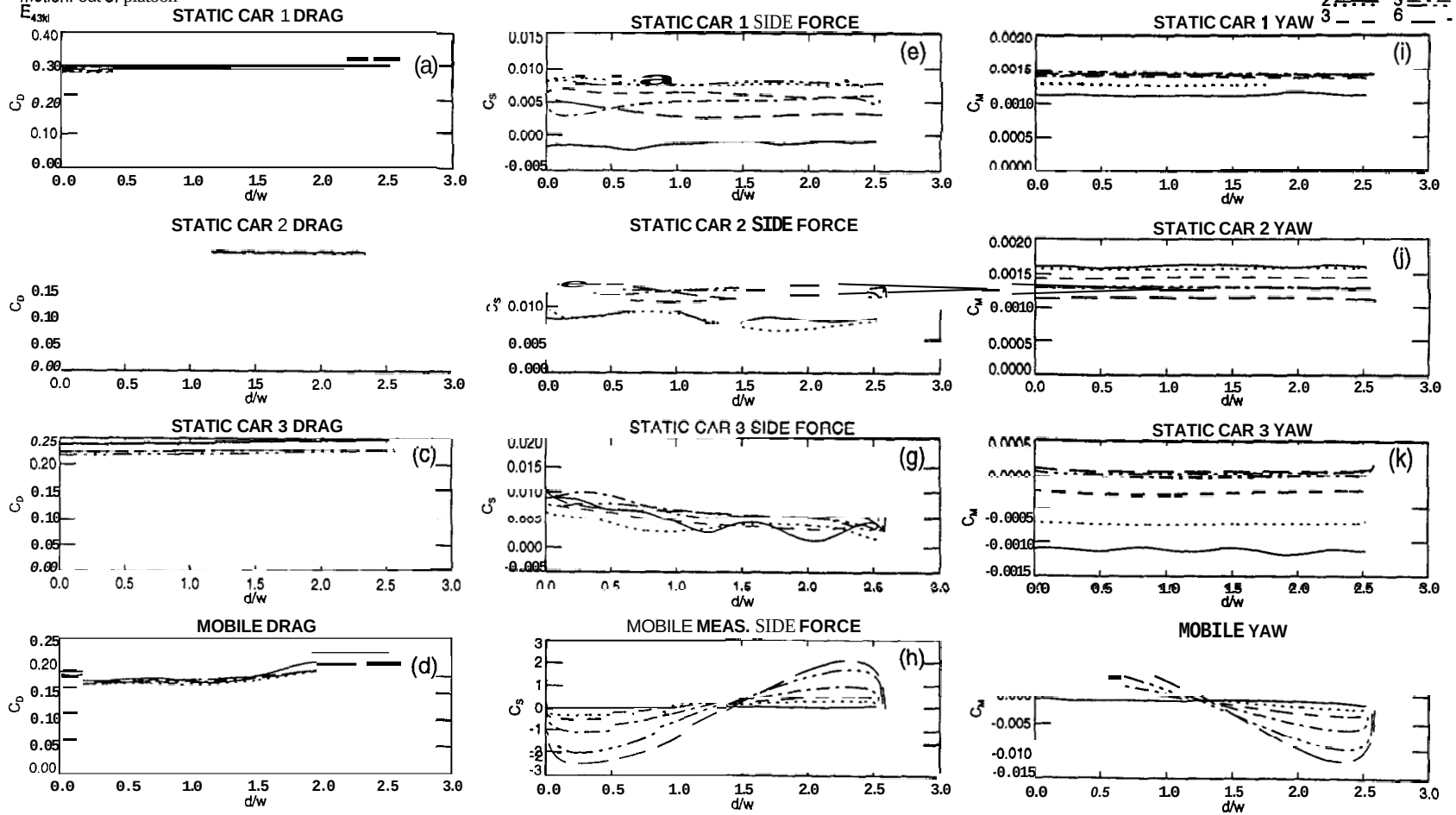
moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into **platoon**
E_{42kl}

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)
1 —— 4 — · —
2 ····· 5 — ··
3 6



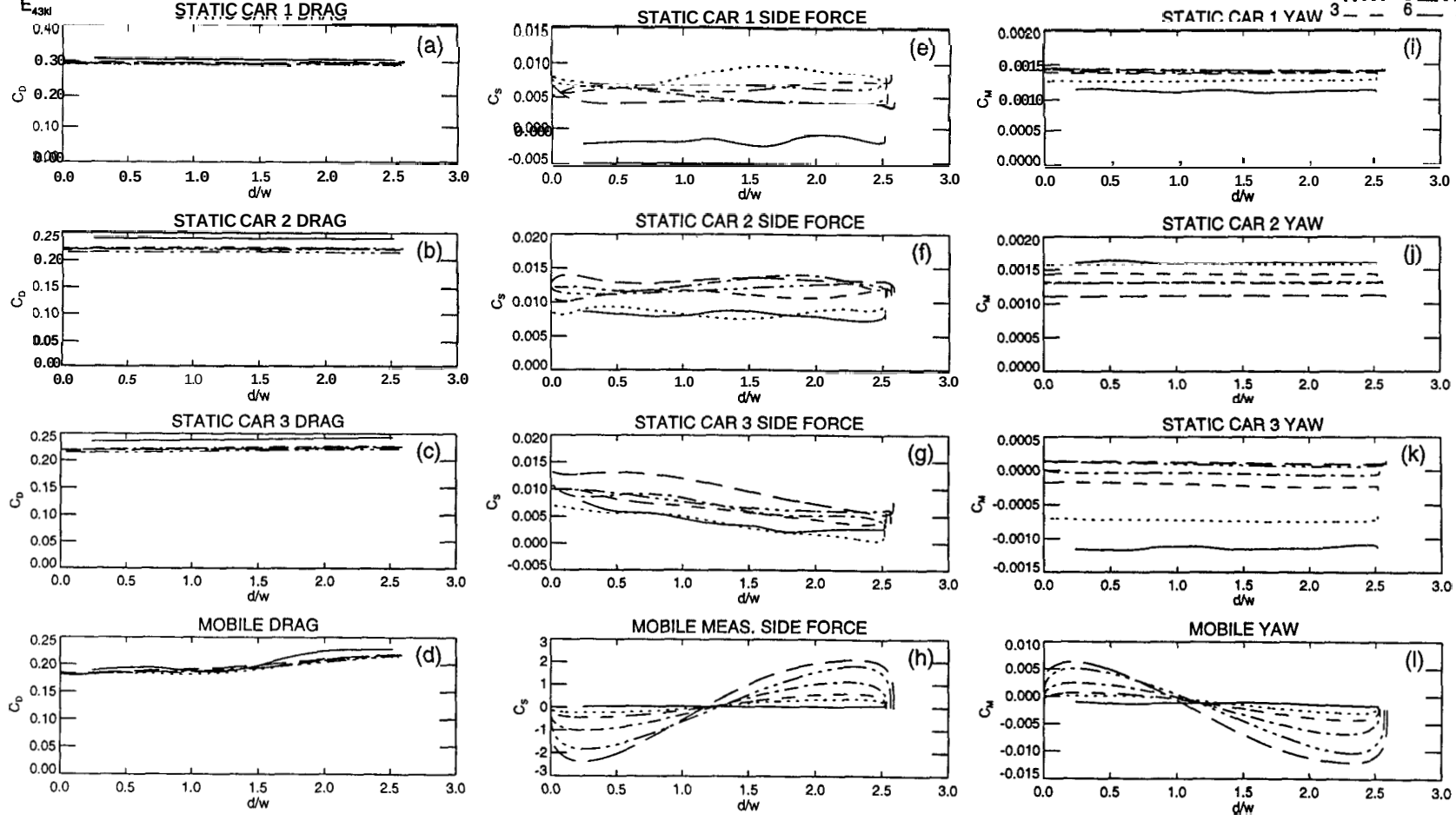
moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



moving car position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 3
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



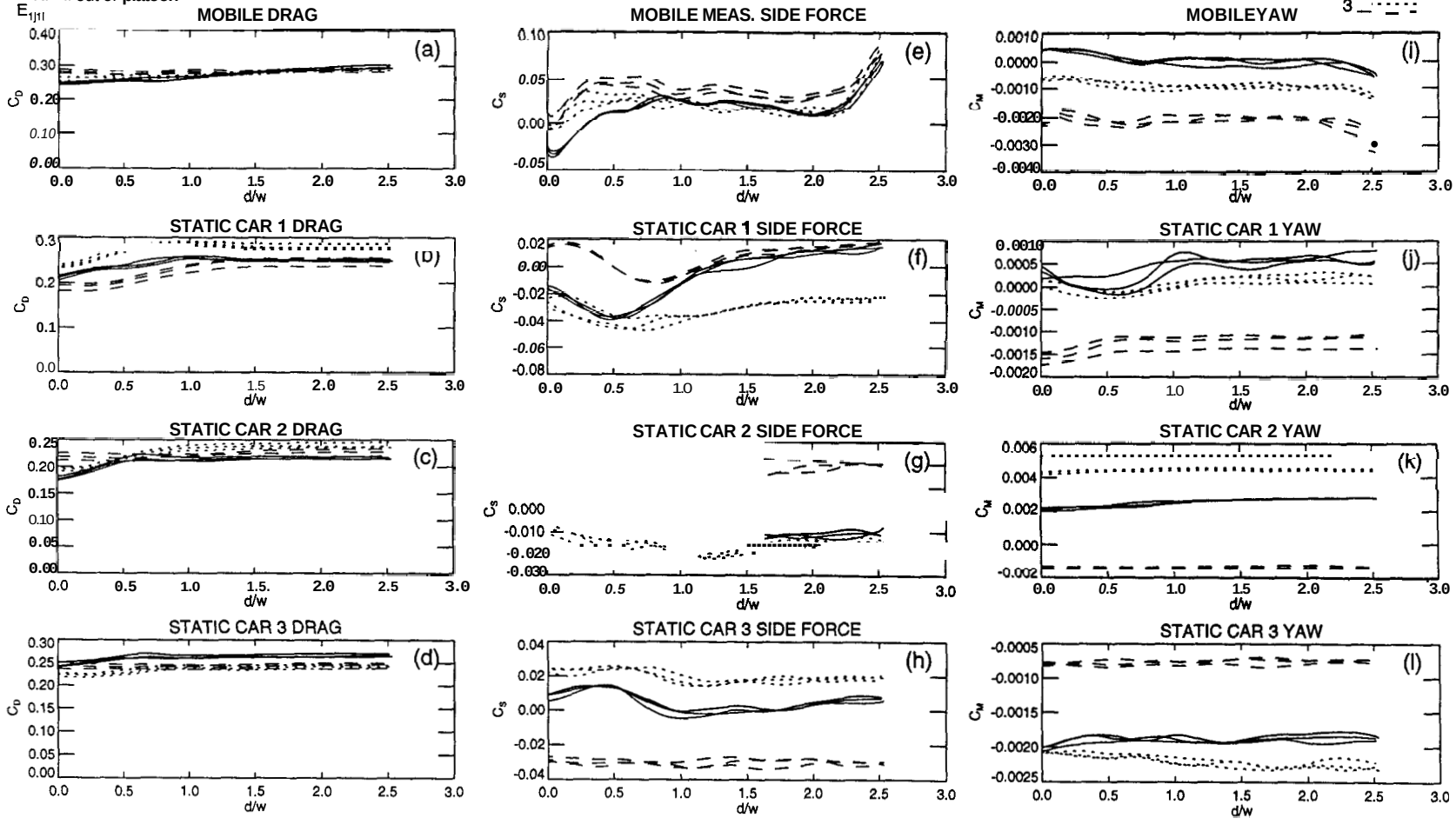
Chapter 3

Separation Profiles - Cars

The drag, side force, and yawing moment coefficients measured on each of the four cars in a platoon during a simulated lane change are shown in the following figures. One of the cars moves out of the platoon, and after a pause, returns into the platoon. The coefficients are plotted with respect to the nondimensional lateral displacement of the maneuvering car d/w, where the displacement d is scaled with the car width w. The measurements made during movement out of the platoon for one platoon configuration are shown first. The measurements made during movement into the platoon for the same configuration are shown in the next figure. This arrangement of the figures for motion out of the platoon and into the platoon is used for all of the platoon configurations. Each figure represents one of the four possible locations of and one acceleration profile used by the maneuvering car. The different linetypes in each figure represent the three platoon configurations consisting of different inter-vehicle spacings. The three experimental runs performed with each platoon configuration are shown.

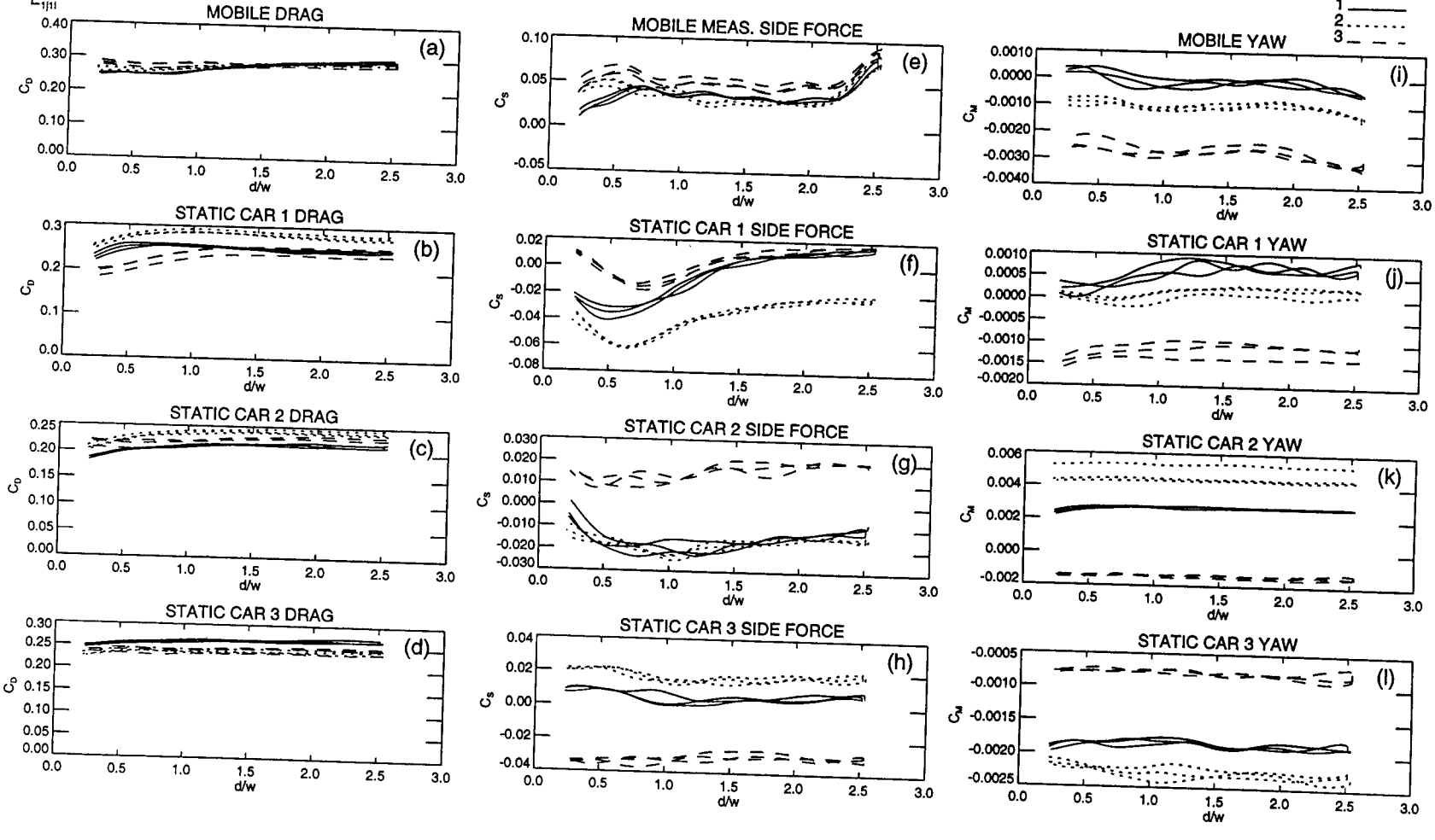
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



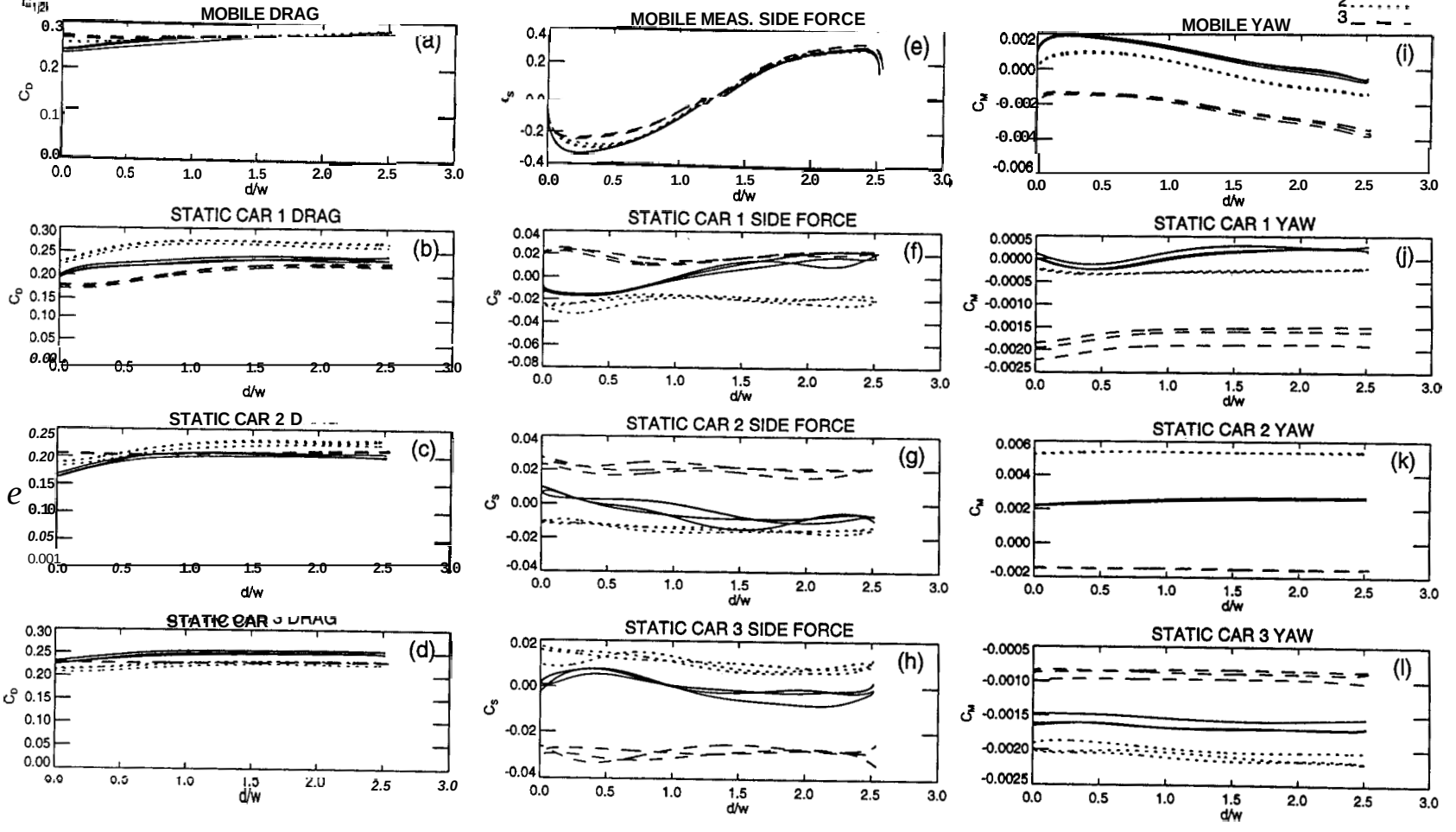
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: into platoon
E_{1j1l}

separation: 1(0.2l), 2(0.4l), 3(l)



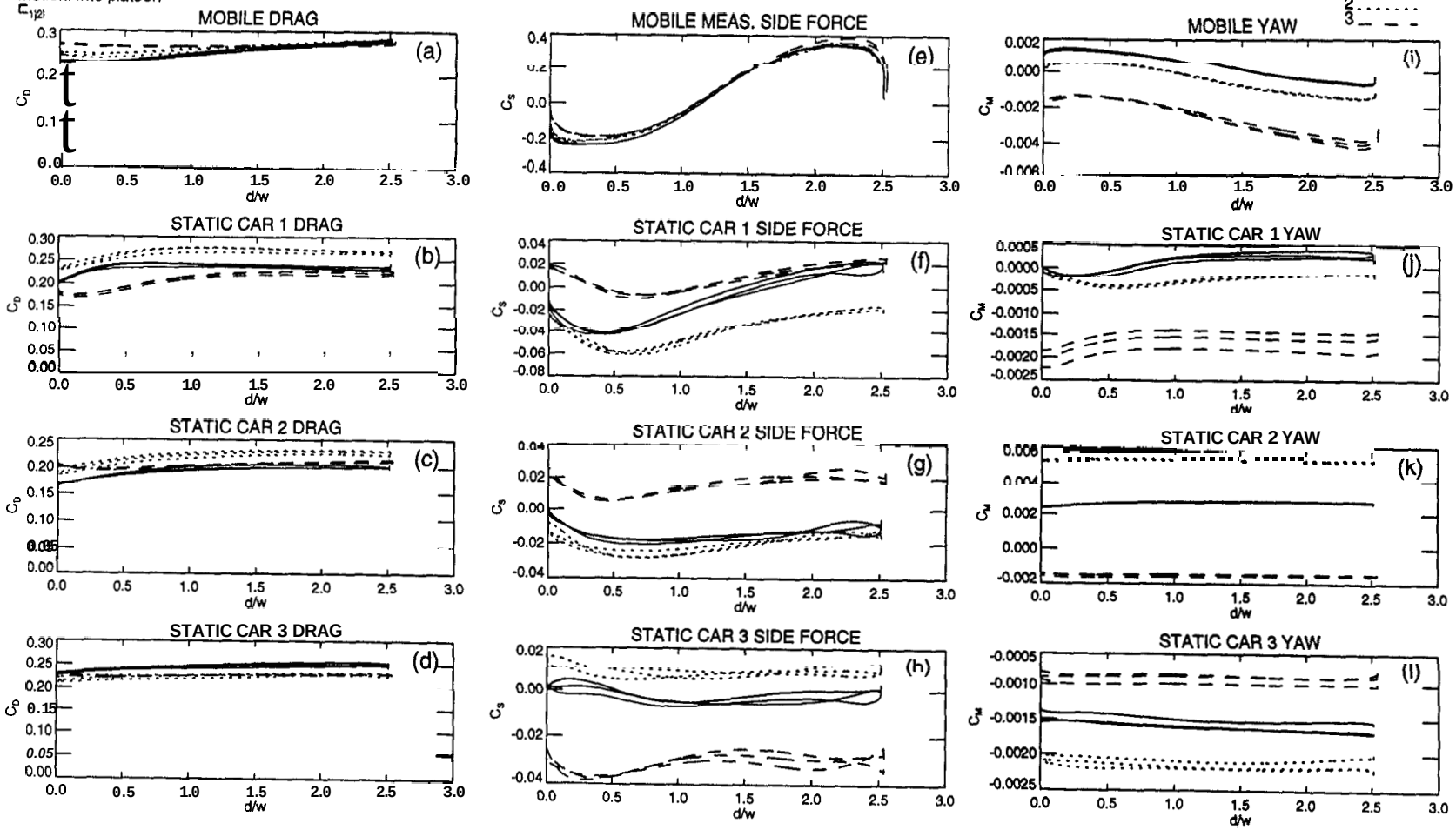
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: into platoon

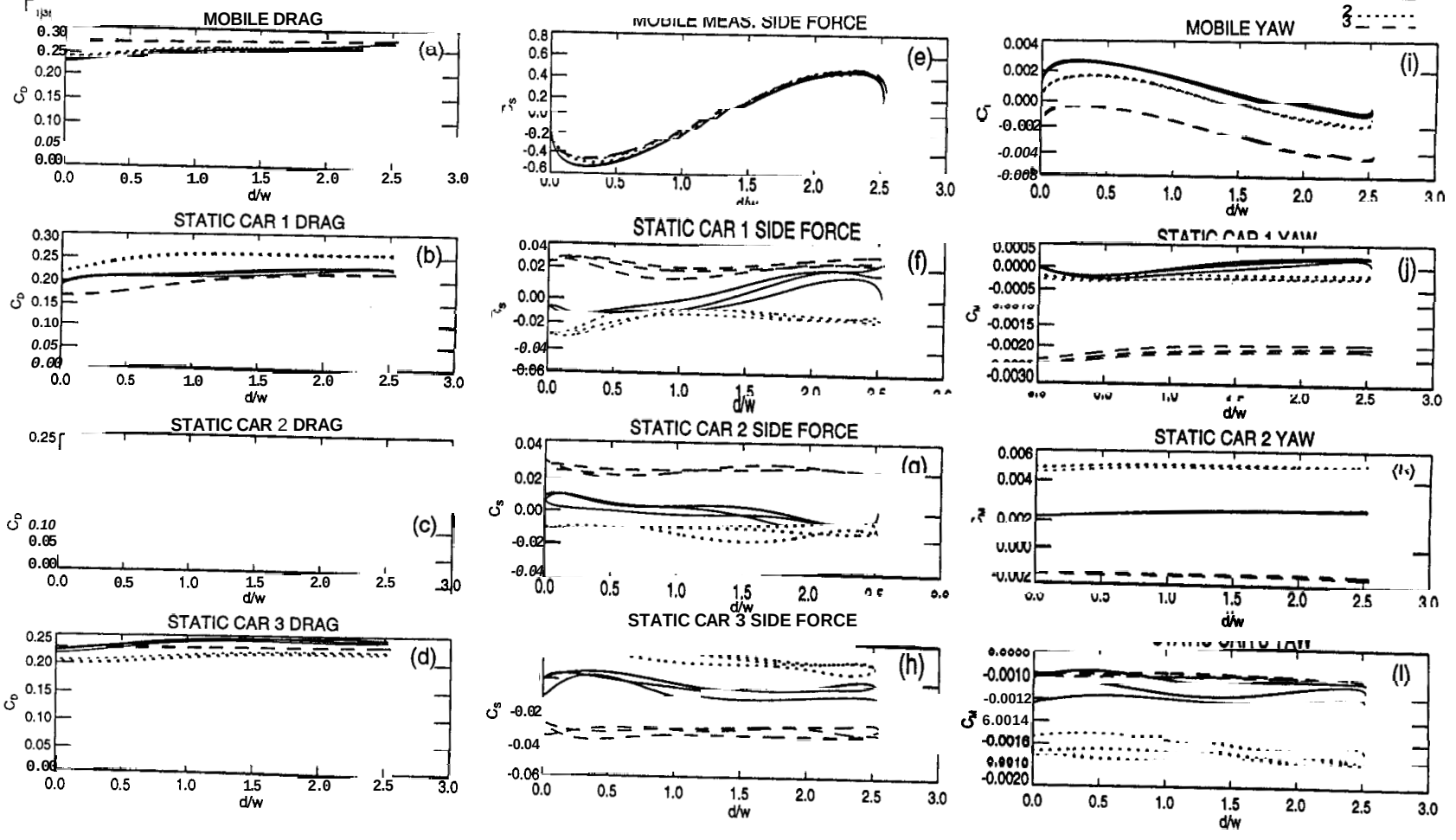
separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= 1

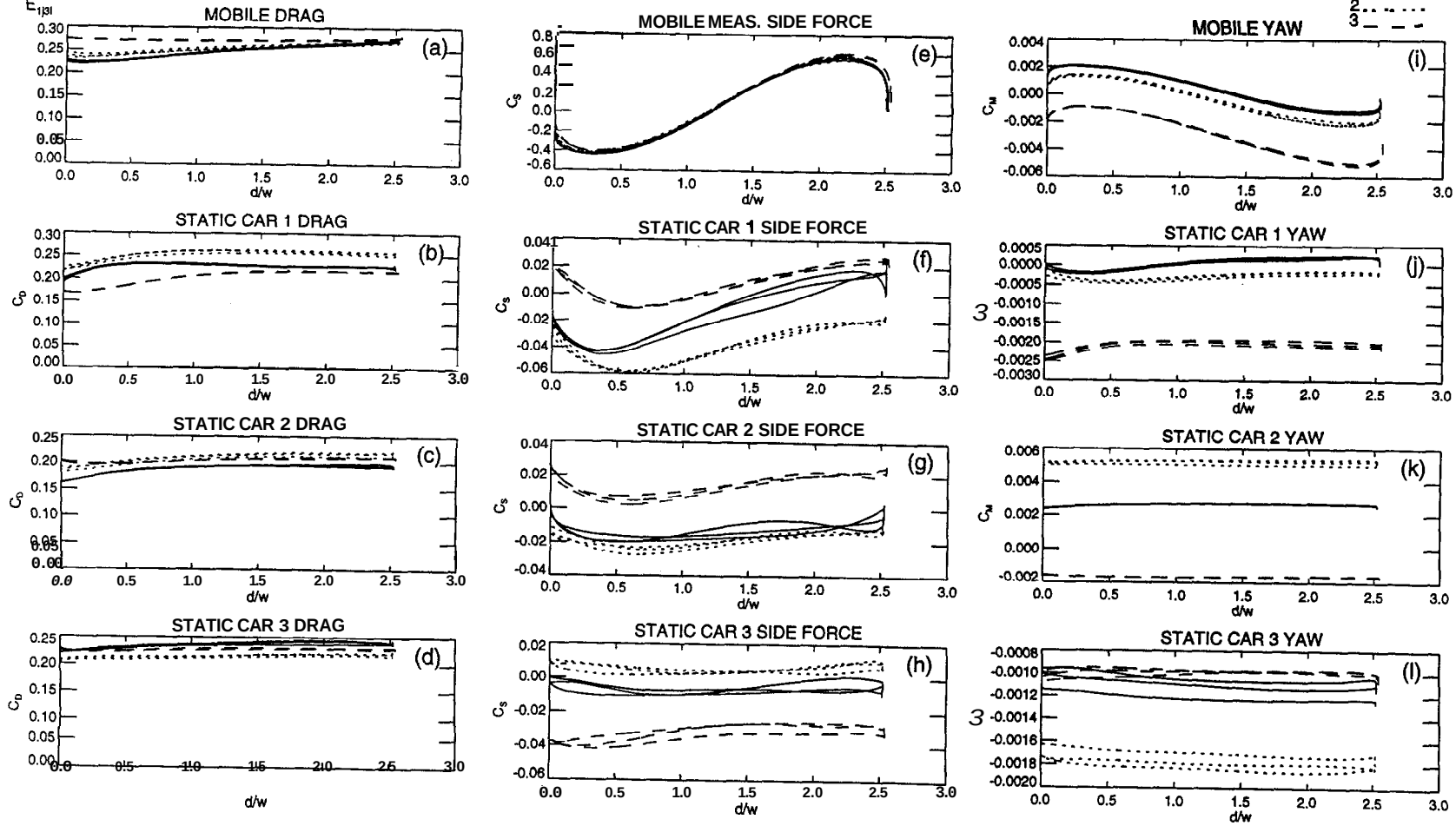
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3

separation: 1(0.2l), 2(0.4l), 3(l)



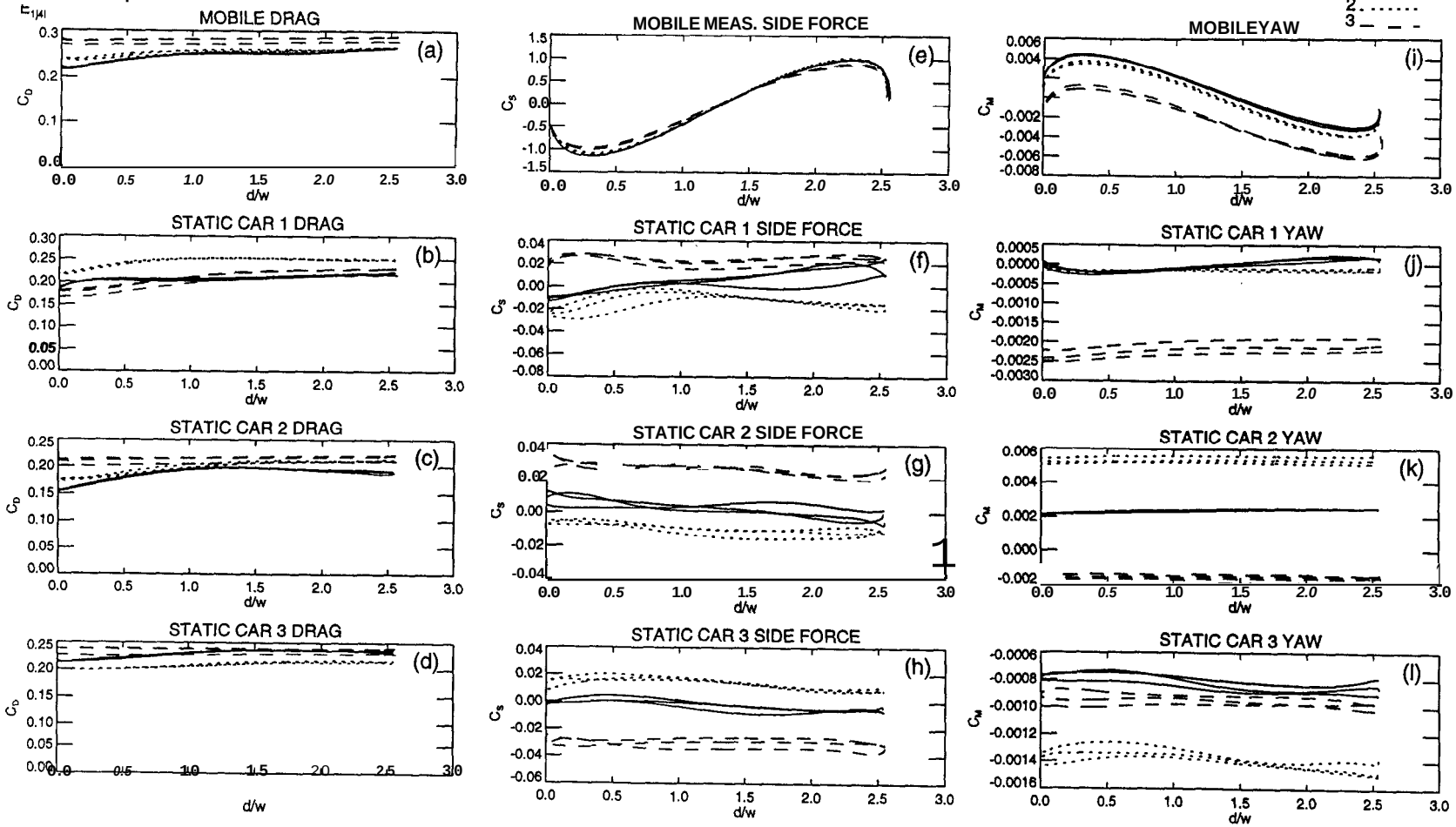
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: into platoon

separation: 1(0.2l), 2(0.4l), 3(l)



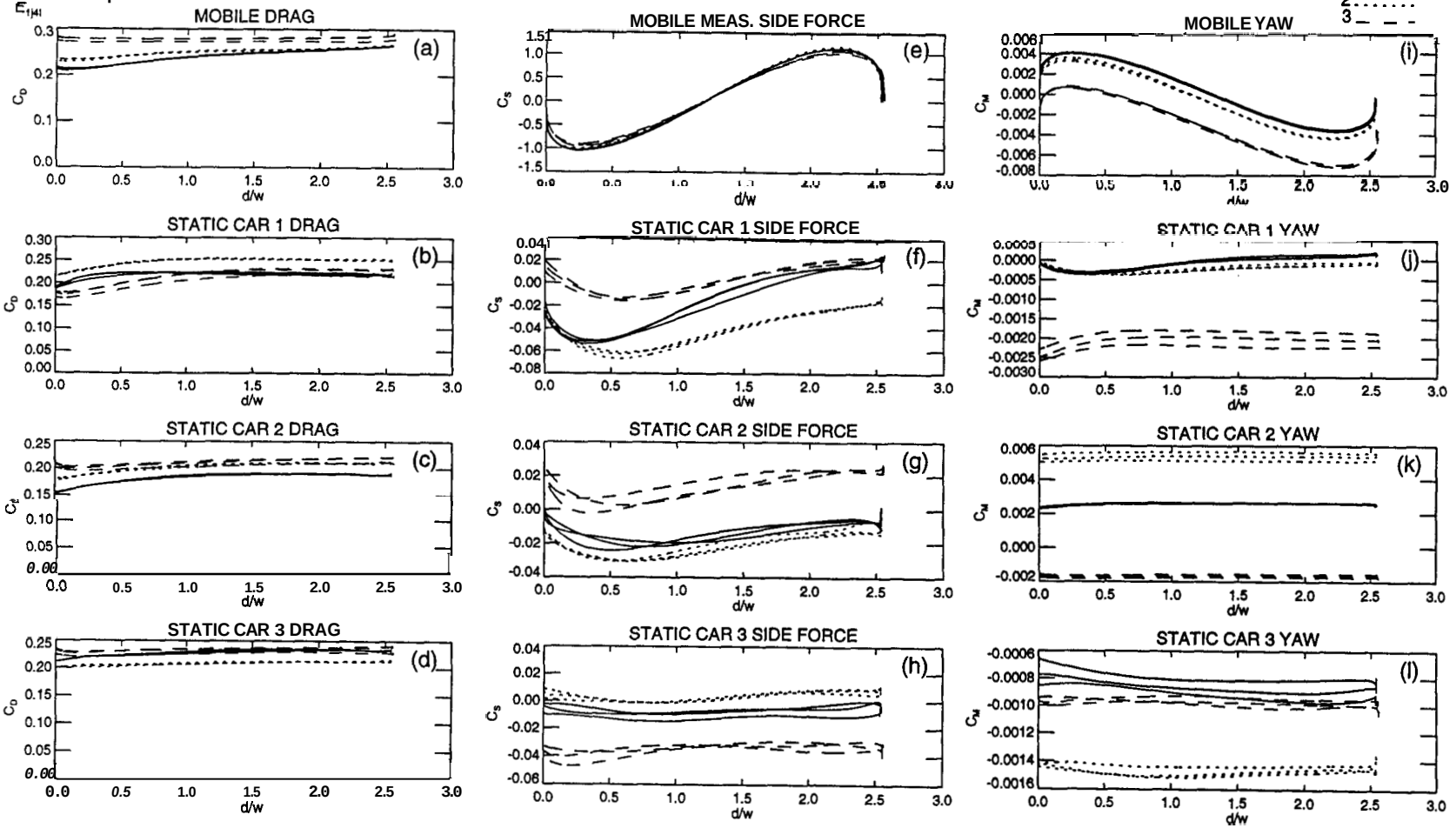
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



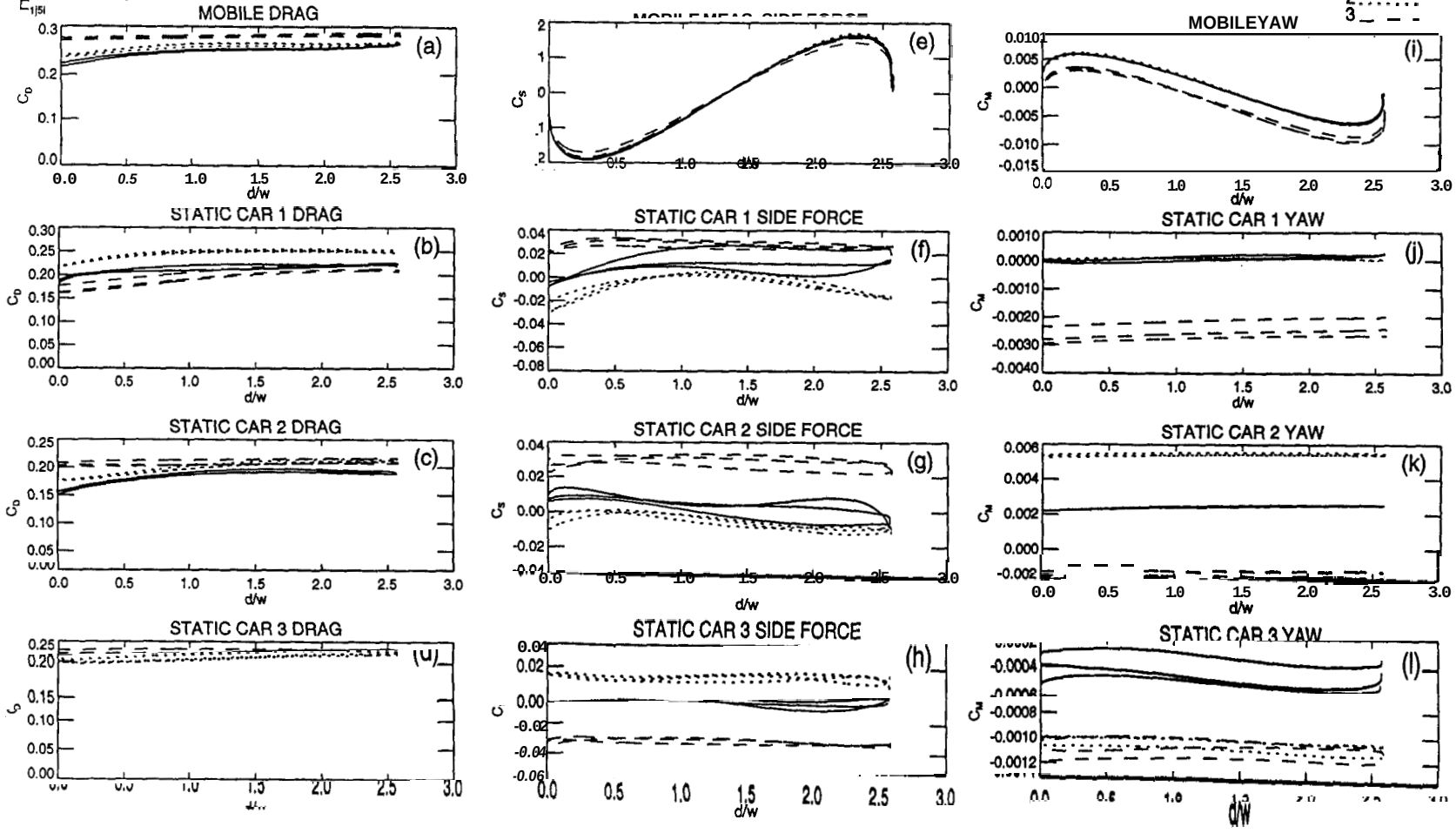
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon

separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –



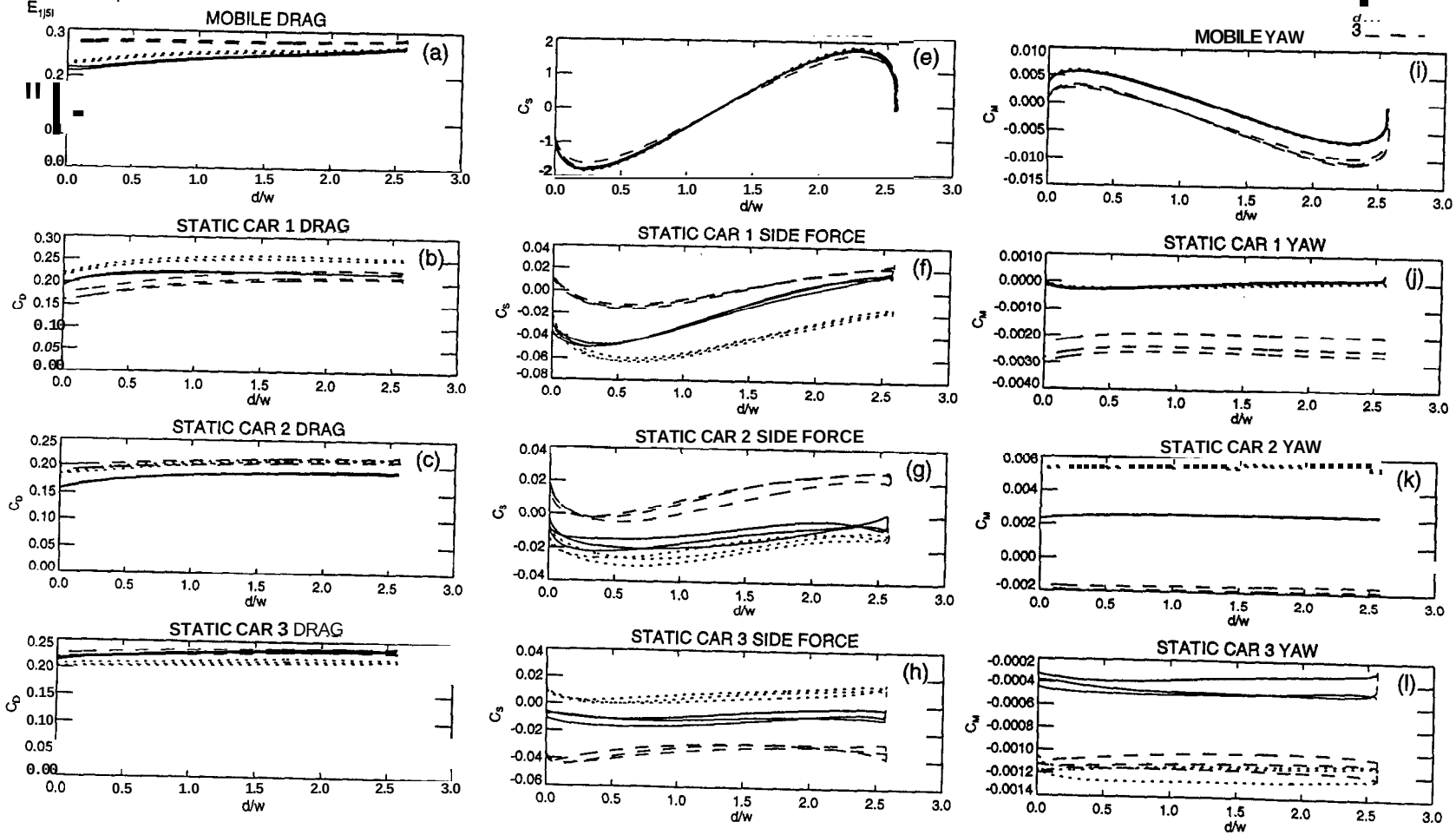
moving car position=1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: out of platoon

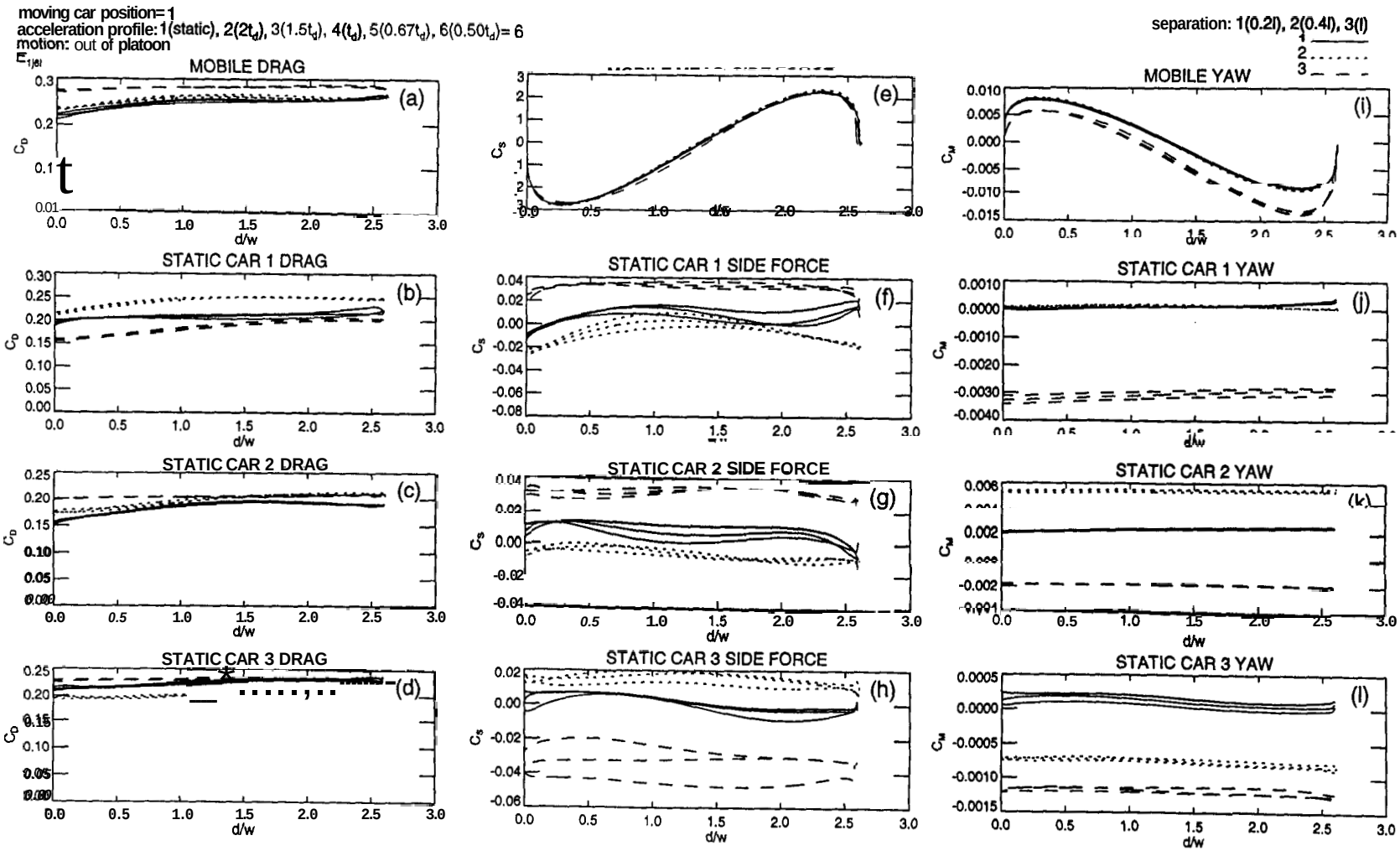
separation: 1(0.2l), 2(0.4l), 3(l)



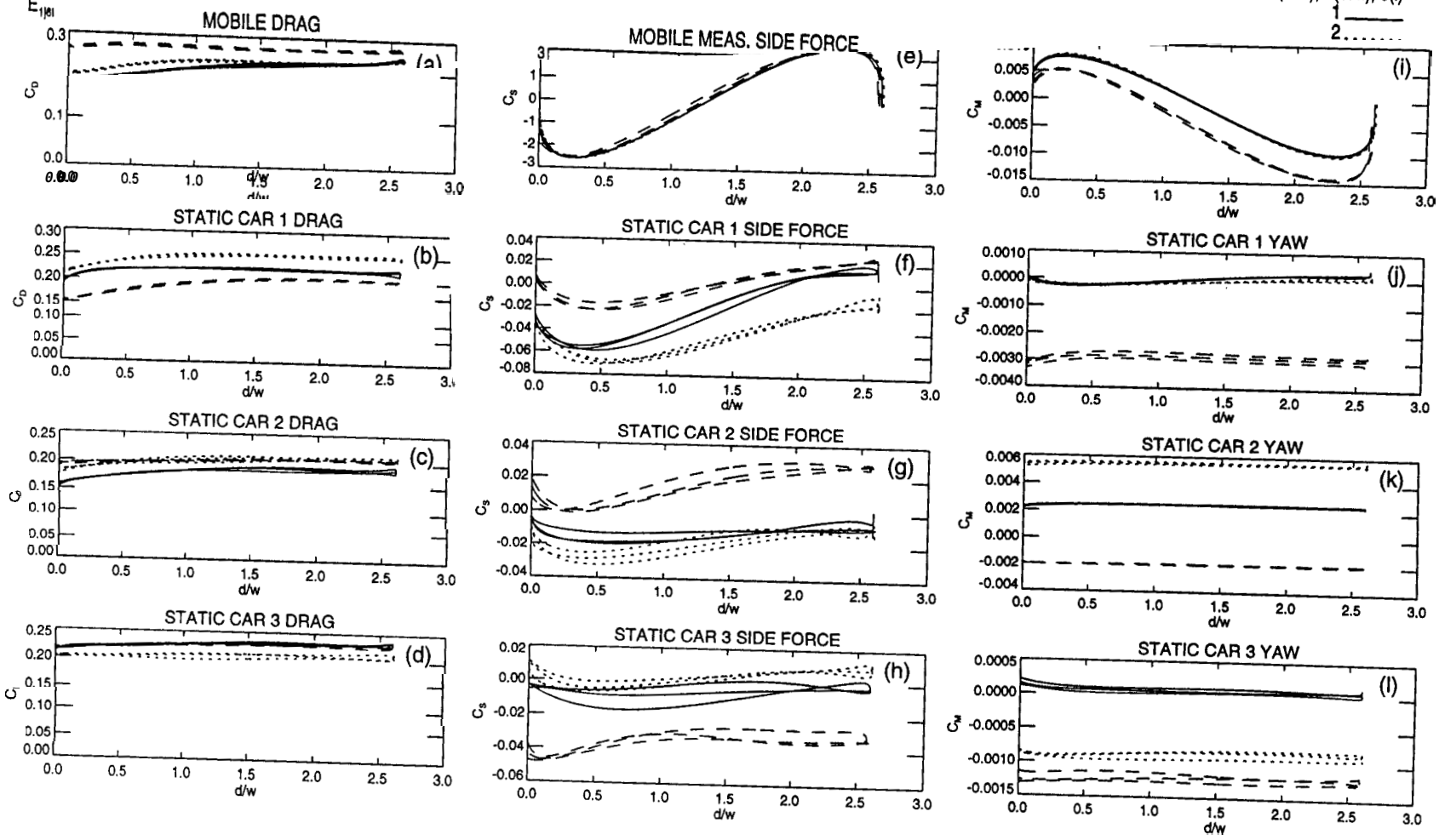
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: into platoon

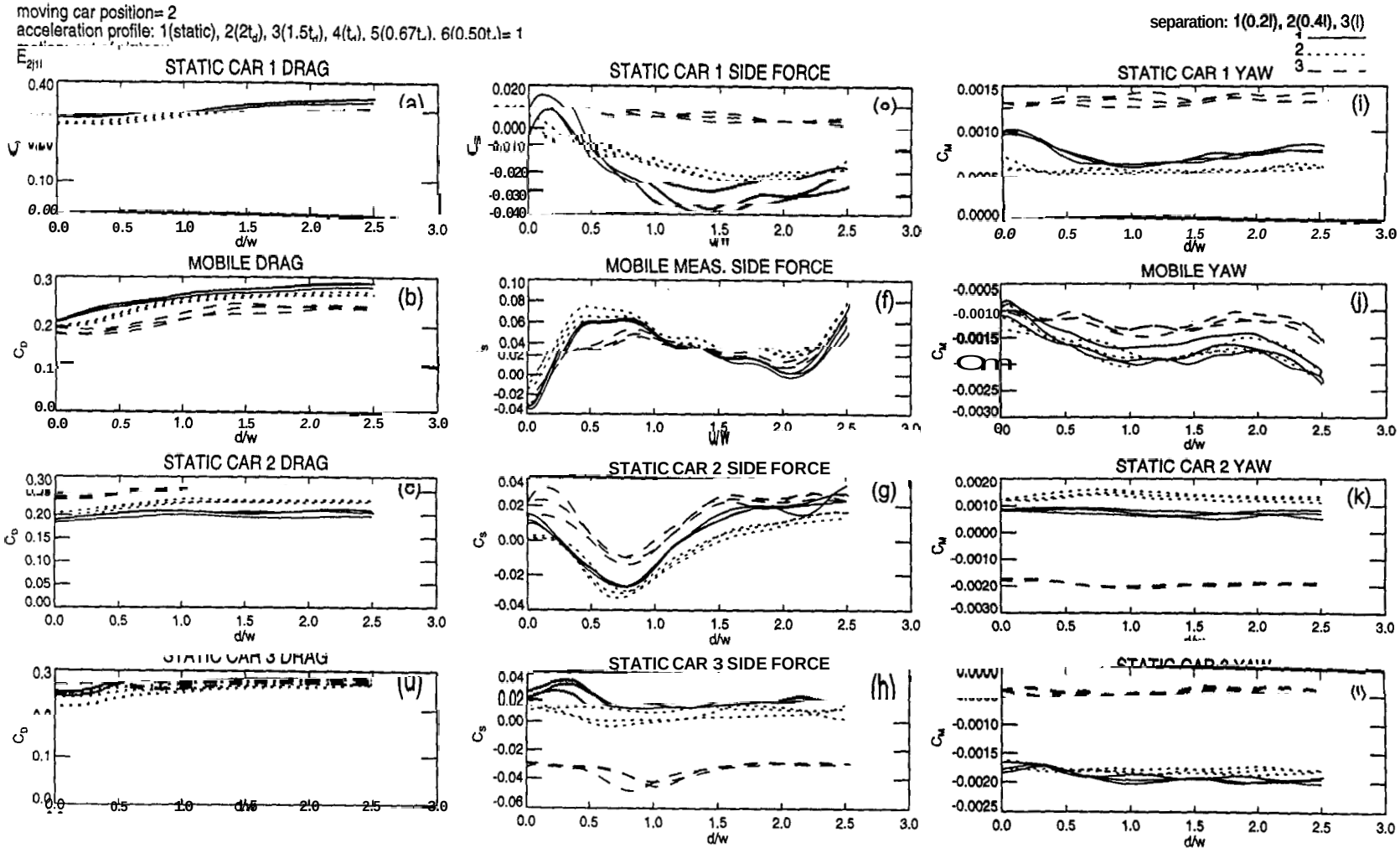
separation: 1(0.2l), 2(0.4l), 3(l)




moving car position= 1
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: out of platoon
separation: 1(0.2l), 2(0.4l), 3(l)
MOBILE DRAG
(a)
STATIC CAR 1 DRAG
(b)
STATIC CAR 2 DRAG
(c)
STATIC CAR 3 DRAG
(d)
(e)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 3 SIDE FORCE
(h)
MOBILE YAW
(i)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 YAW
(l)
d/w

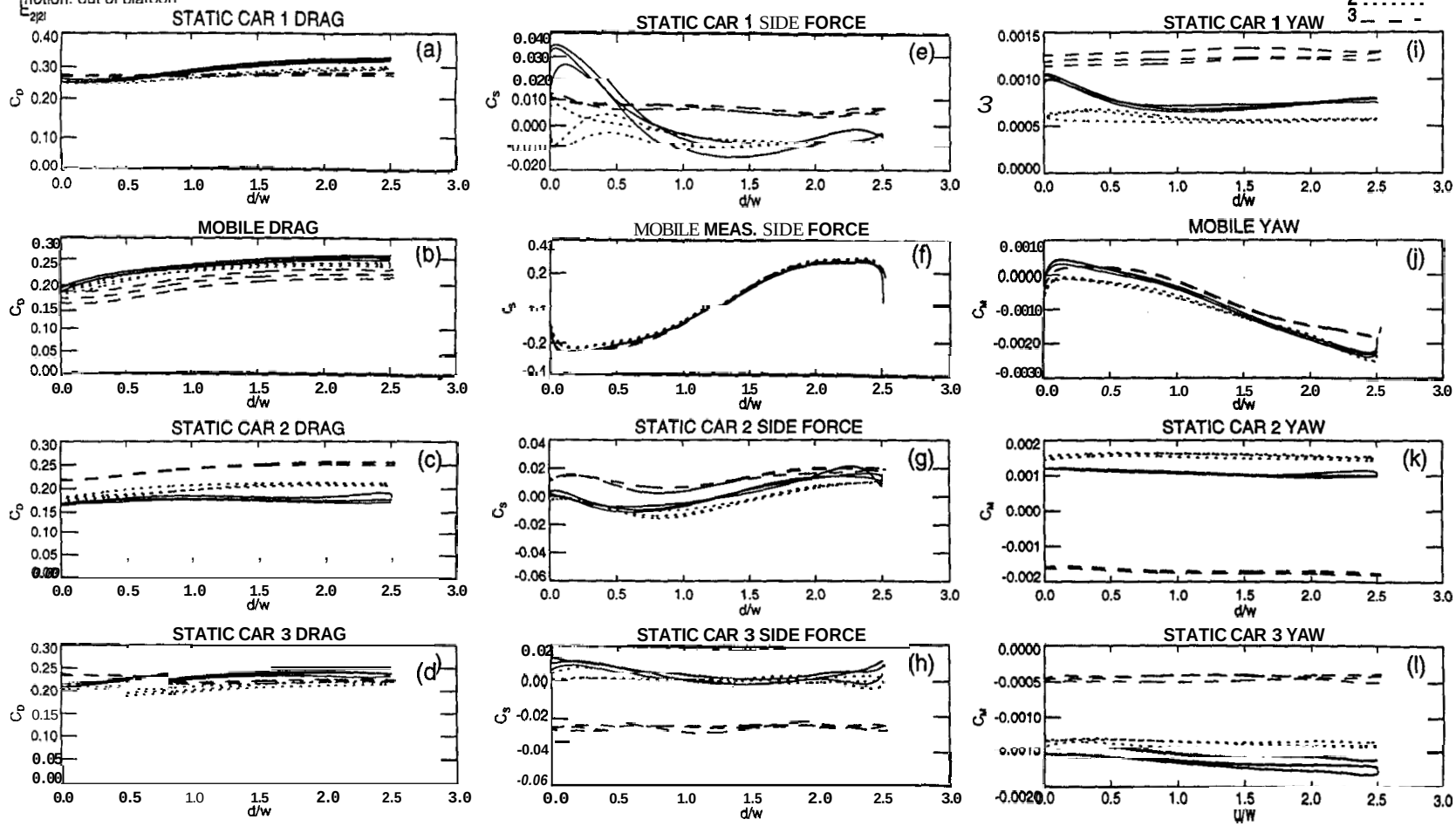
moving car position= 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: into platoon
separation: 1(0.2l), 2(0.4l), 3(l)




moving car position= 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 1
separation: 1(0.2l), 2(0.4l), 3(l)
STATIC CAR 1 DRAG
STATIC CAR 1 SIDE FORCE
STATIC CAR 1 YAW
MOBILE DRAG
MOBILE MEAS. SIDE FORCE
MOBILE YAW
STATIC CAR 2 DRAG
STATIC CAR 2 SIDE FORCE
STATIC CAR 2 YAW
STATIC CAR 3 DRAG
STATIC CAR 3 SIDE FORCE
STATIC CAR 3 YAW
d/w

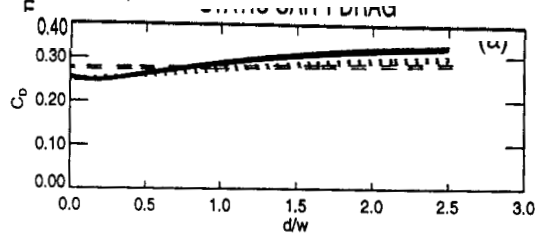
moving car position= 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon

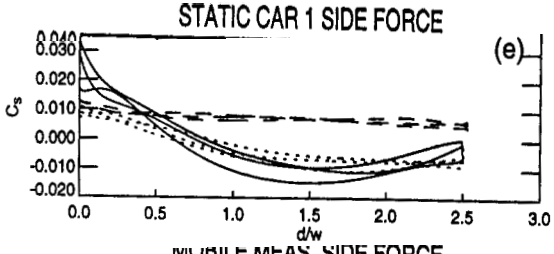
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

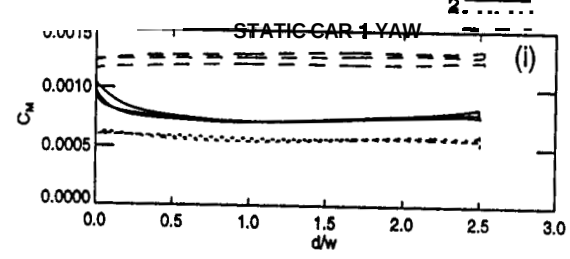


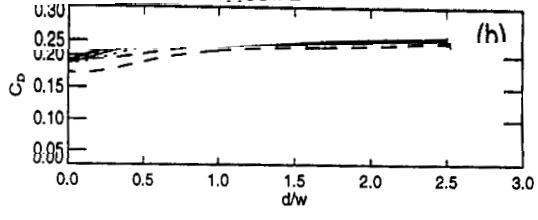
moving car position= 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: into platoon

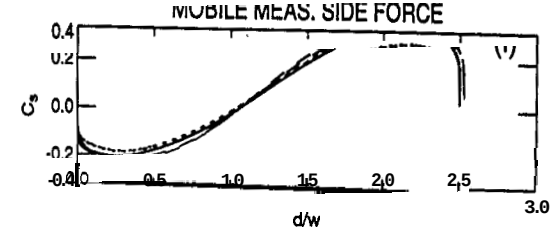
separation: 1(0.2l), 2(0.4l), 3(l)

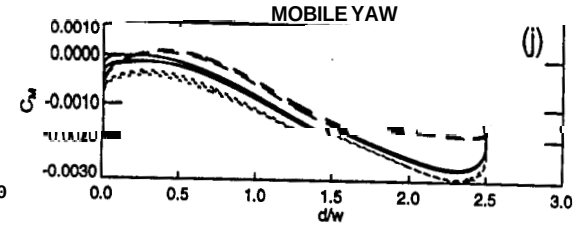


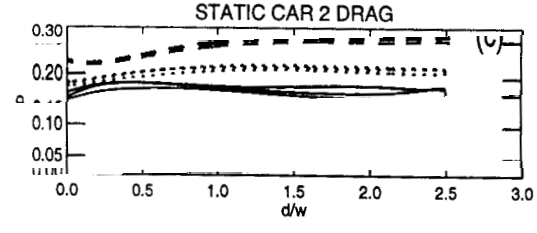


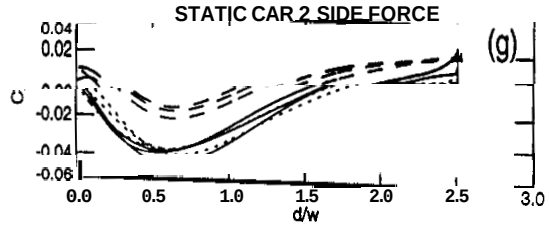


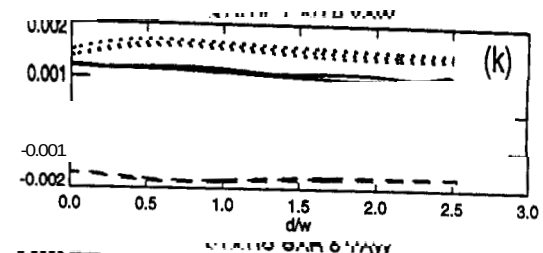


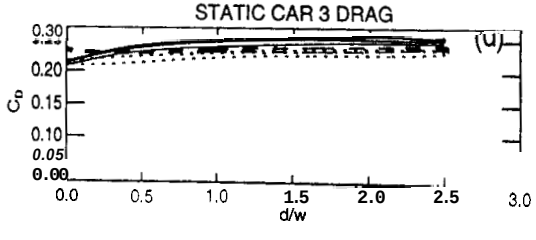


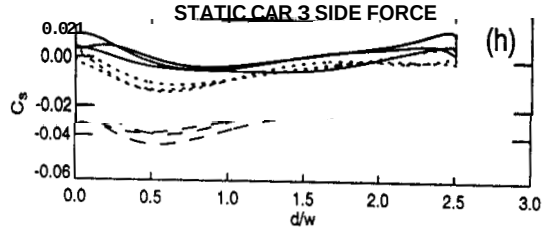


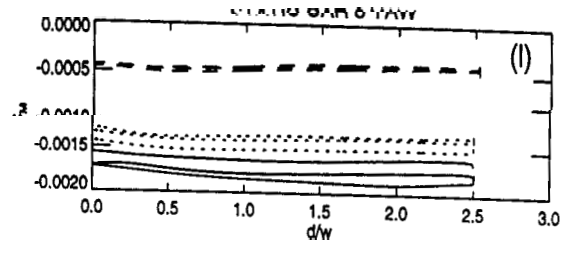






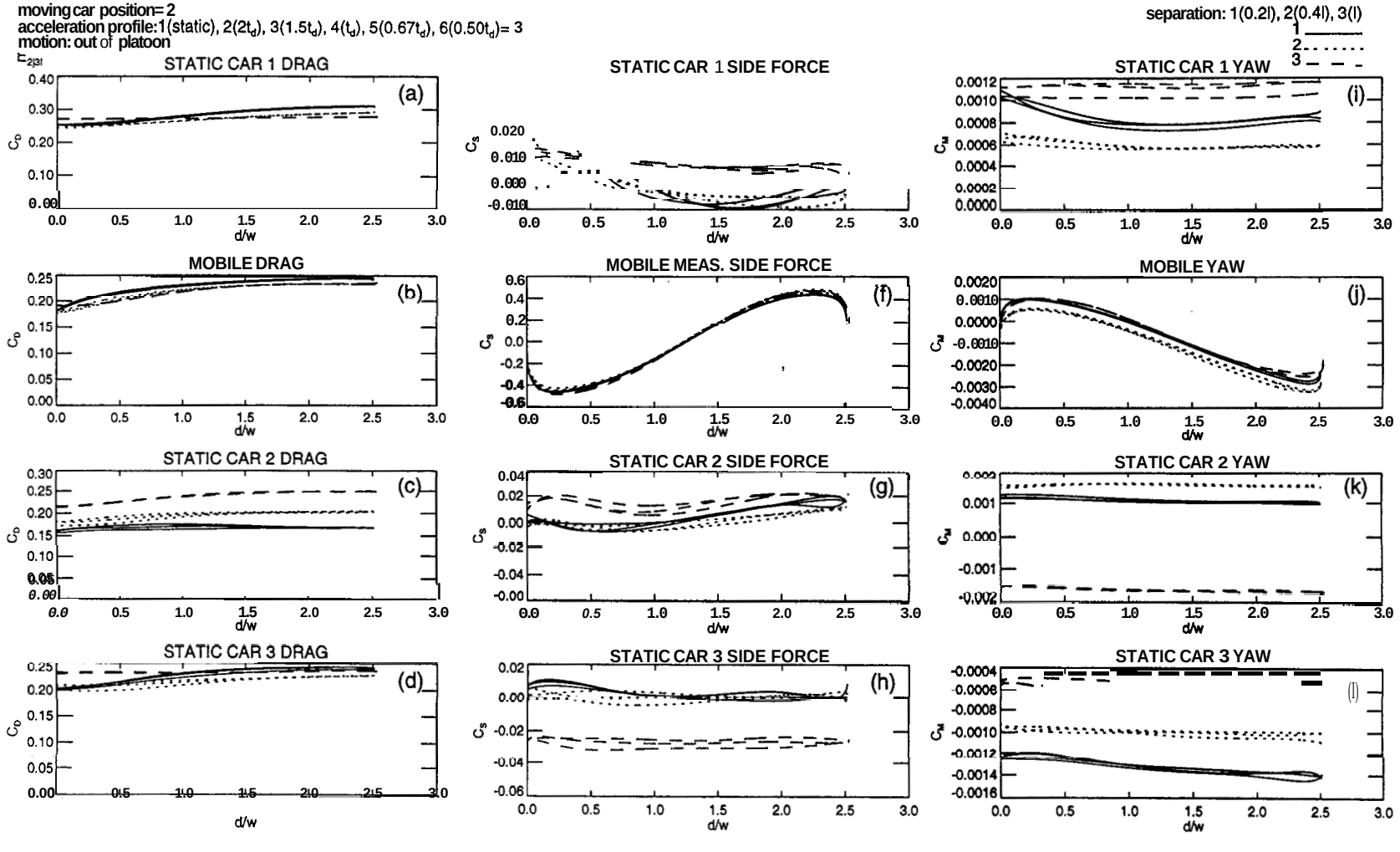


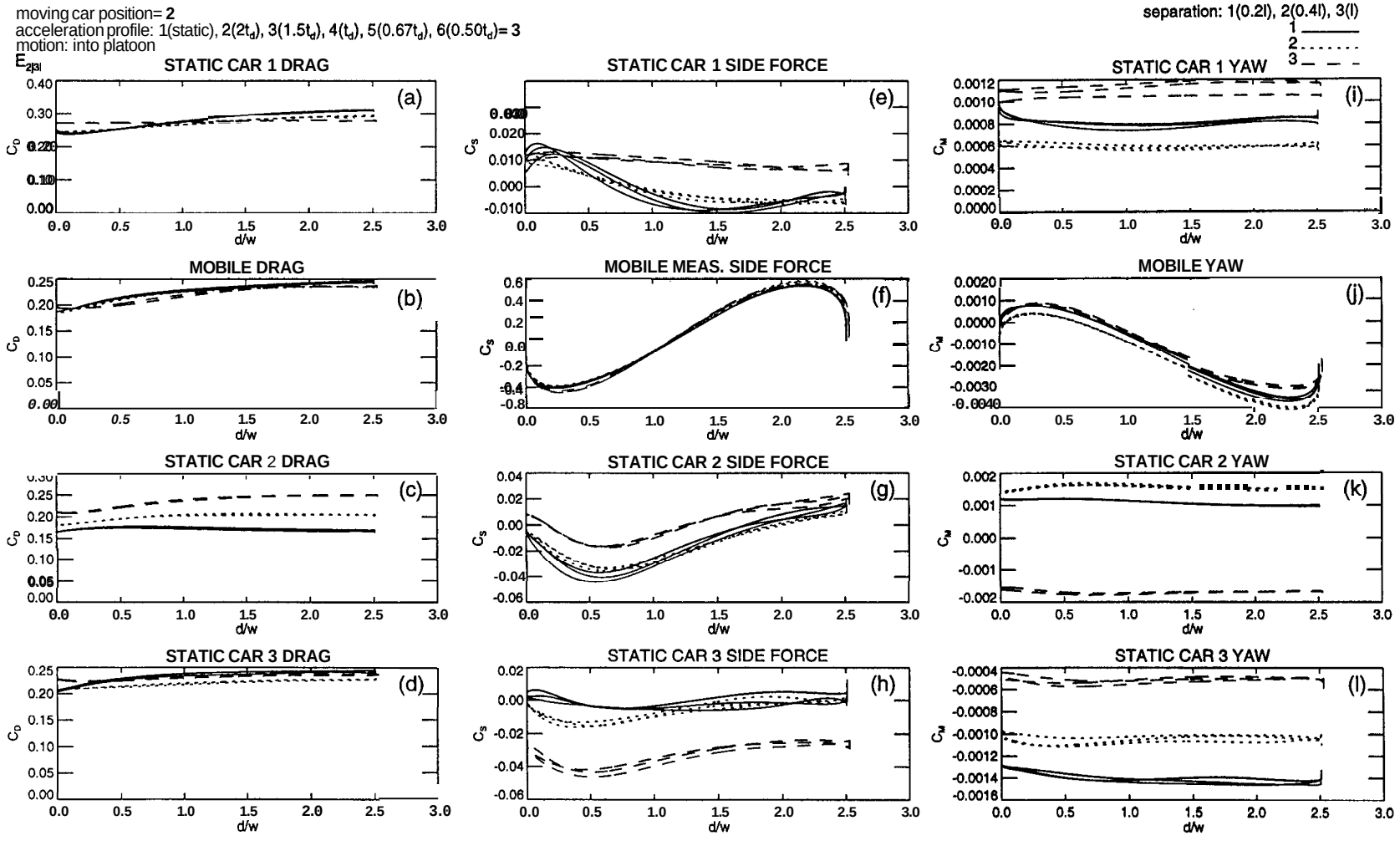




moving car position= 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: out of platoon

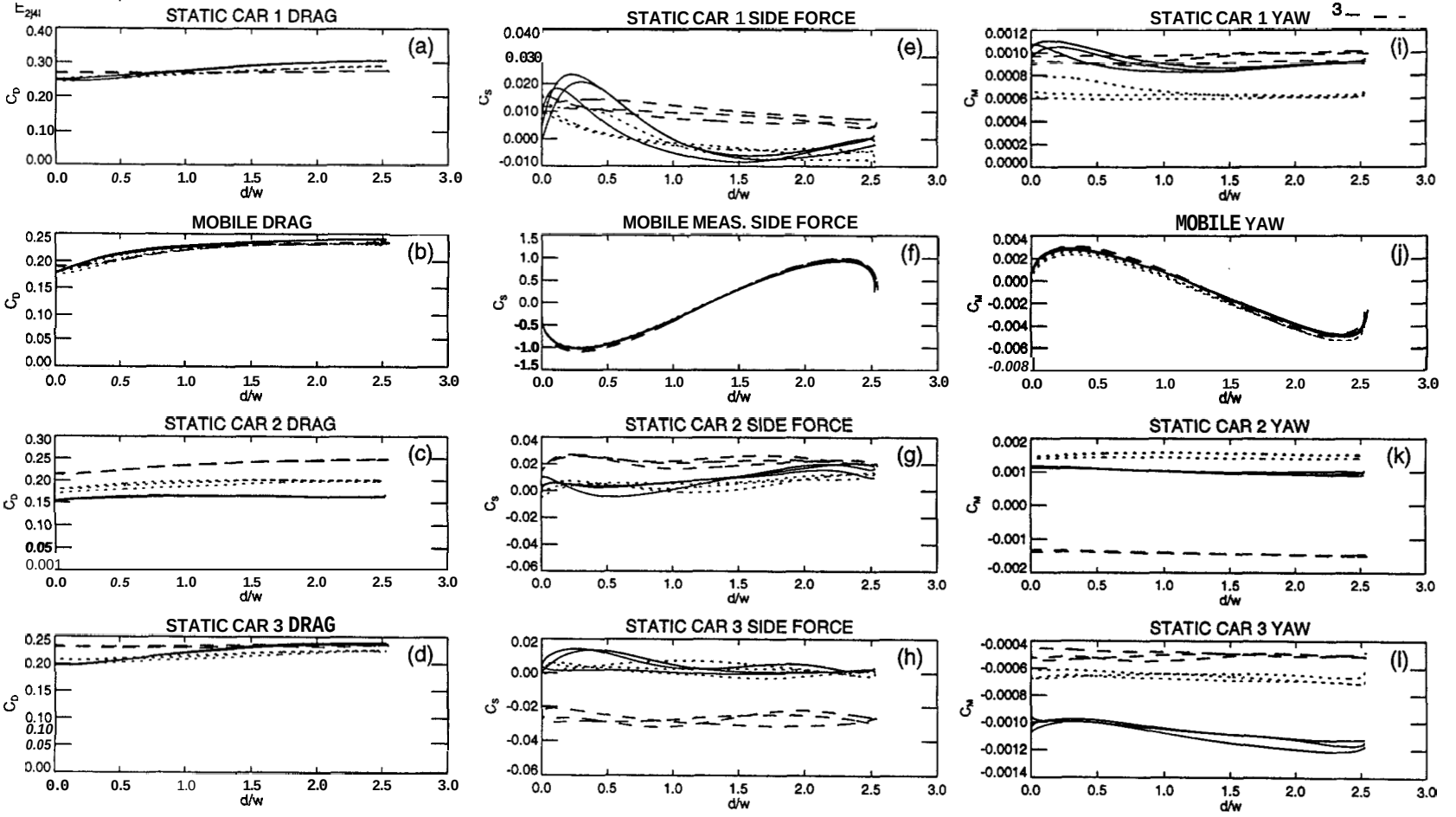
separation: 1(0.2l), 2(0.4l), 3(l)




moving car position= 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 3
motion: into platoon
separation: 1(0.2l), 2(0.4l), 3(l)
1
2
3
STATIC CAR 1 DRAG
(a)
STATIC CAR 1 SIDE FORCE
(e)
STATIC CAR 1 YAW
(i)
MOBILE DRAG
(b)
MOBILE MEAS. SIDE FORCE
(f)
MOBILE YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
d/w

moving car position= **2**
acceleration profile: **1**(static), **2**($2t_d$), **3**($1.5t_d$), **4**(t_d), **5**($0.67t_d$), **6**($0.50t_d$)= **4**
motion: out of platoon

separation: **1**(0.2l), **2**(0.4l), **3**(l)
1 ——
2 .....
3 — — -

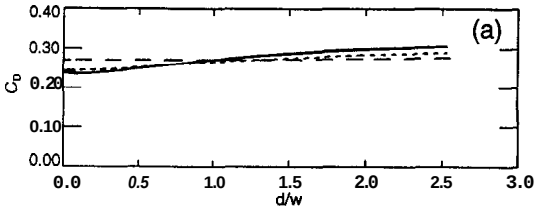


moving car position= 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon

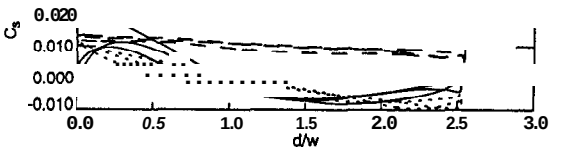
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

$E_{2|4|}$

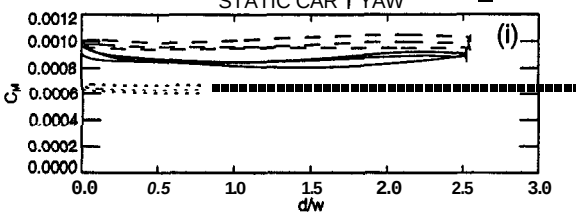
STATIC CAR 1 DRAG



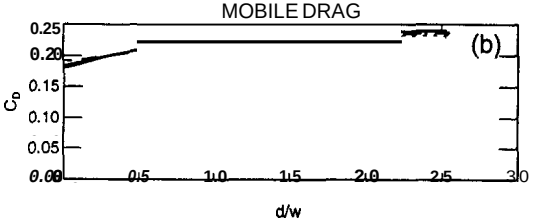
STATIC CAR 1 SIDE FORCE



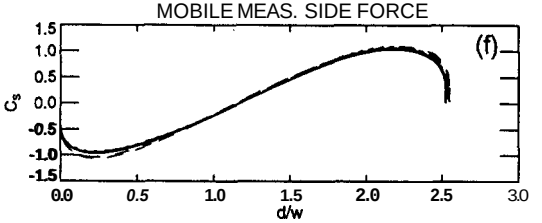
STATIC CAR 1 YAW



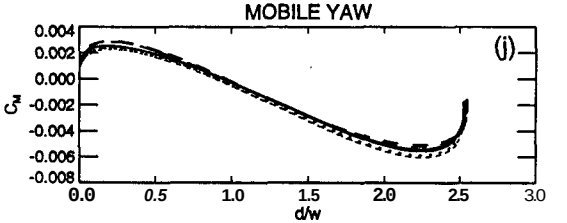
MOBILE DRAG



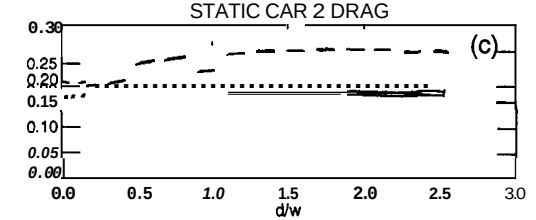
MOBILE MEAS. SIDE FORCE



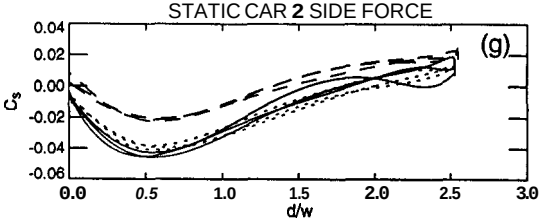
MOBILE YAW



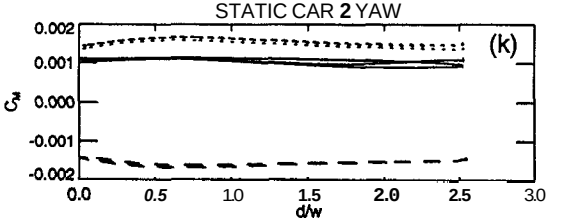
STATIC CAR 2 DRAG



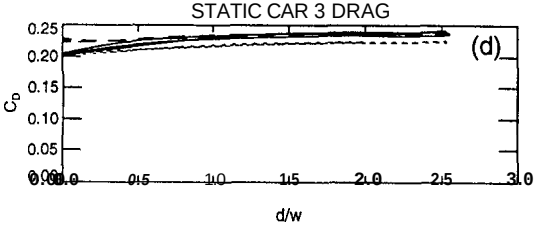
STATIC CAR 2 SIDE FORCE



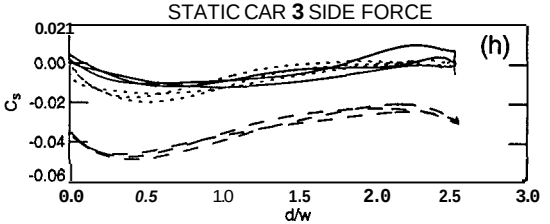
STATIC CAR 2 YAW



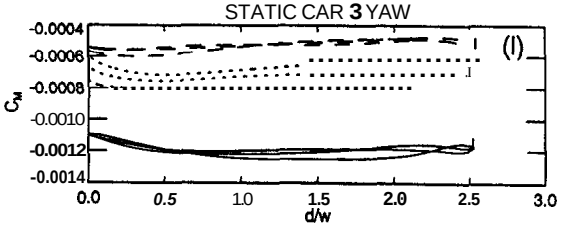
STATIC CAR 3 DRAG

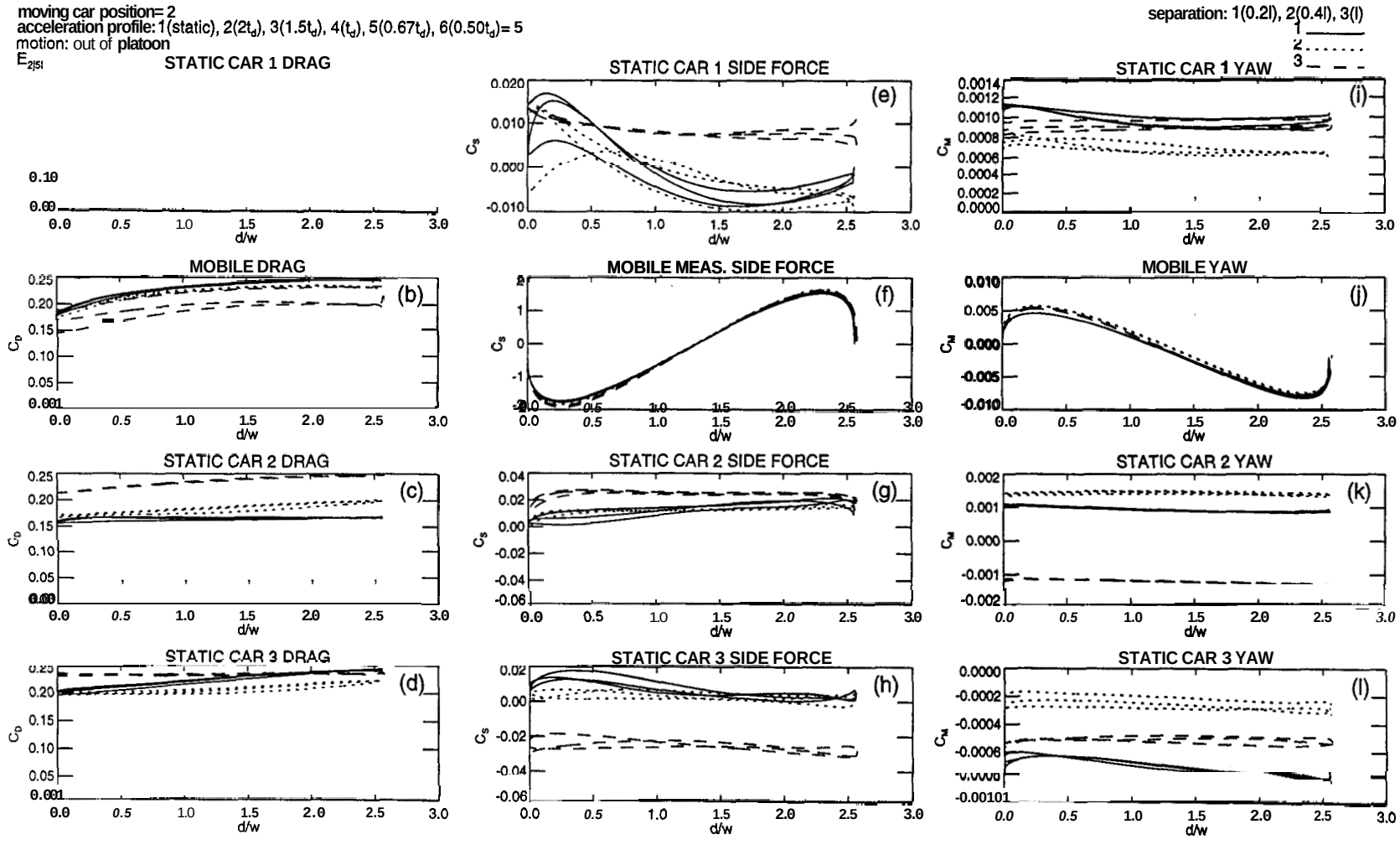


STATIC CAR 3 SIDE FORCE

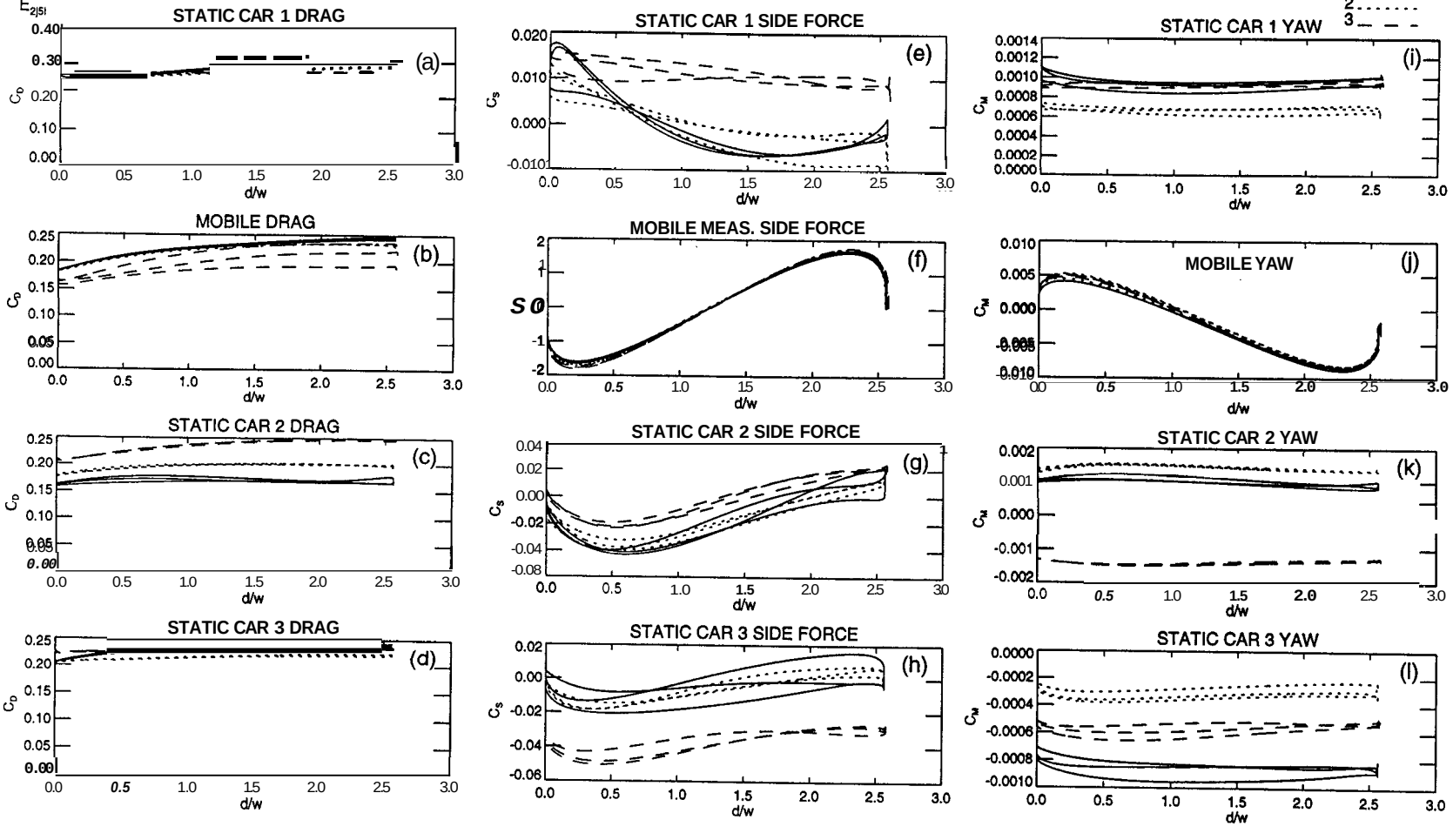


STATIC CAR 3 YAW



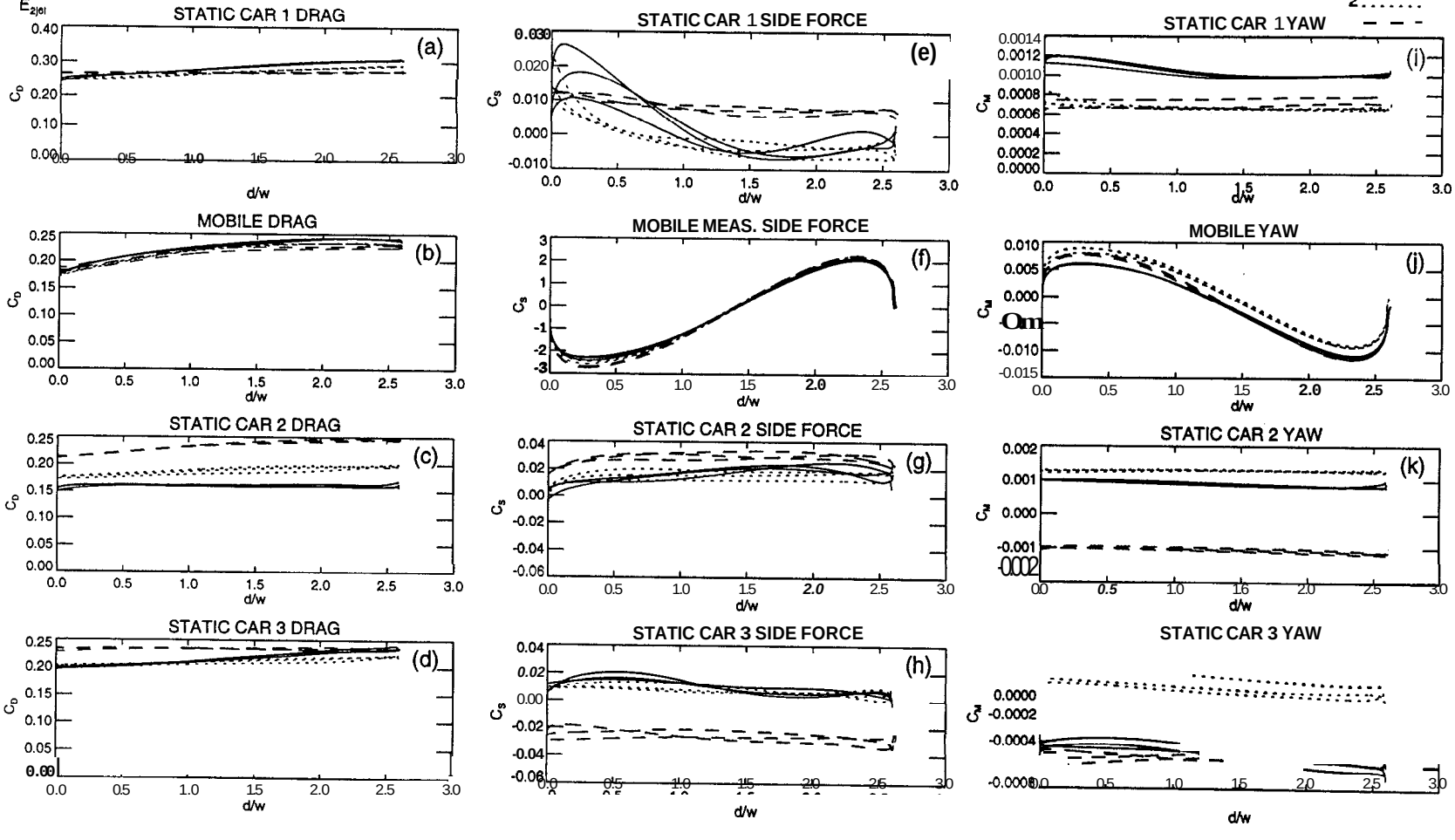

moving car position= 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: out of platoon
E_2jsl
separation: 1(0.2l), 2(0.4l), 3(l)
1
2
3
STATIC CAR 1 DRAG
STATIC CAR 1 SIDE FORCE
STATIC CAR 1 YAW
(e)
(i)
MOBILE DRAG
MOBILE MEAS. SIDE FORCE
MOBILE YAW
(b)
(f)
(j)
STATIC CAR 2 DRAG
STATIC CAR 2 SIDE FORCE
STATIC CAR 2 YAW
(c)
(g)
(k)
STATIC CAR 3 DRAG
STATIC CAR 3 SIDE FORCE
STATIC CAR 3 YAW
(d)
(h)
(l)
C_D
C_S
C_M
d/w

moving car position=2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: into platoon
separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= **2**
acceleration profile: **1**(static), **2**($2t_d$), **3**($1.5t_d$), **4**(t_d), **5**($0.67t_d$), **6**($0.50t_d$)= **6**
motion: out of platoon

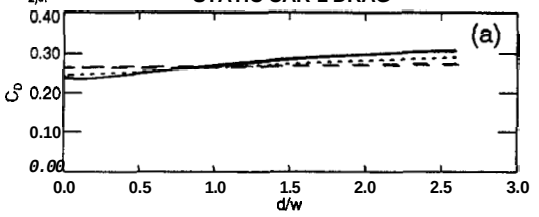
separation: **1**(0.2l), **2**(0.4l), **3**(l)
1 ——
2 . . . . . .
— — —



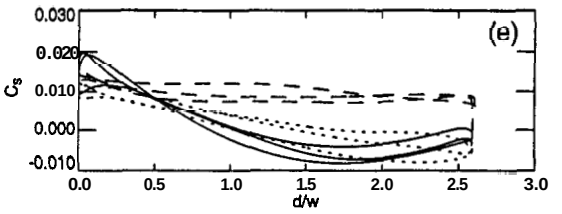
moving car position= 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: into platoon
$E_{2|6|}$

separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

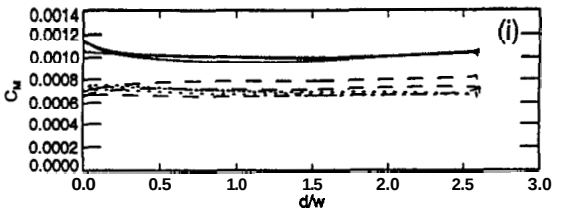
STATIC CAR 1 DRAG



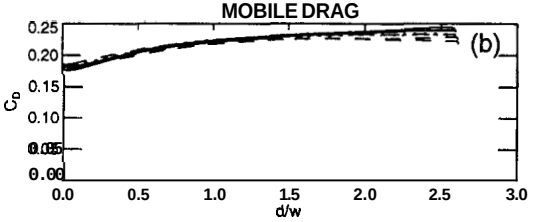
STATIC CAR 1 SIDE FORCE



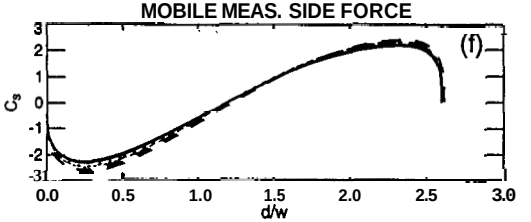
STATIC CAR 1 YAW



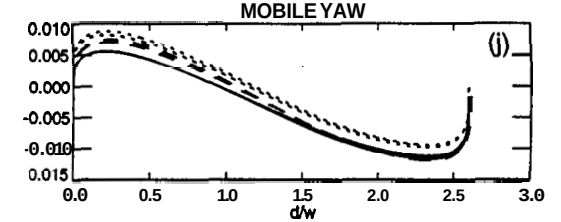
MOBILE DRAG



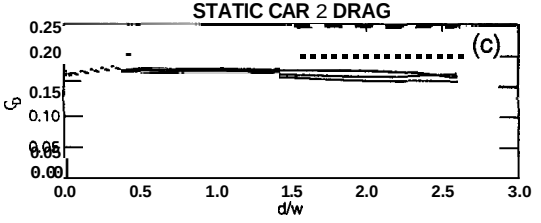
MOBILE MEAS. SIDE FORCE



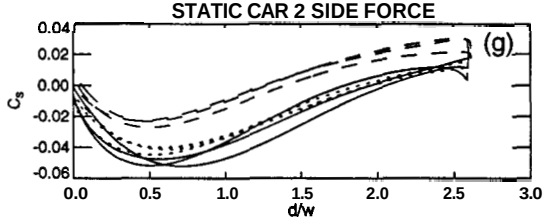
MOBILE YAW



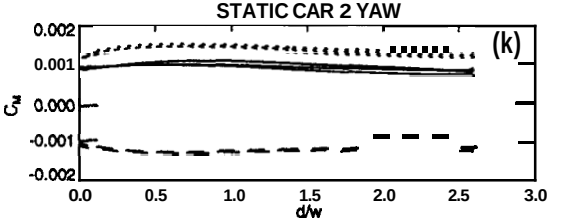
STATIC CAR 2 DRAG



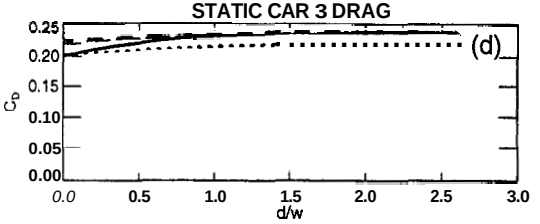
STATIC CAR 2 SIDE FORCE



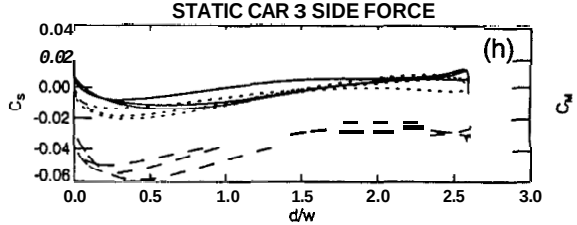
STATIC CAR 2 YAW



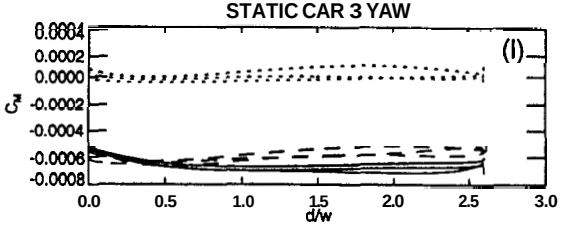
STATIC CAR 3 DRAG



STATIC CAR 3 SIDE FORCE

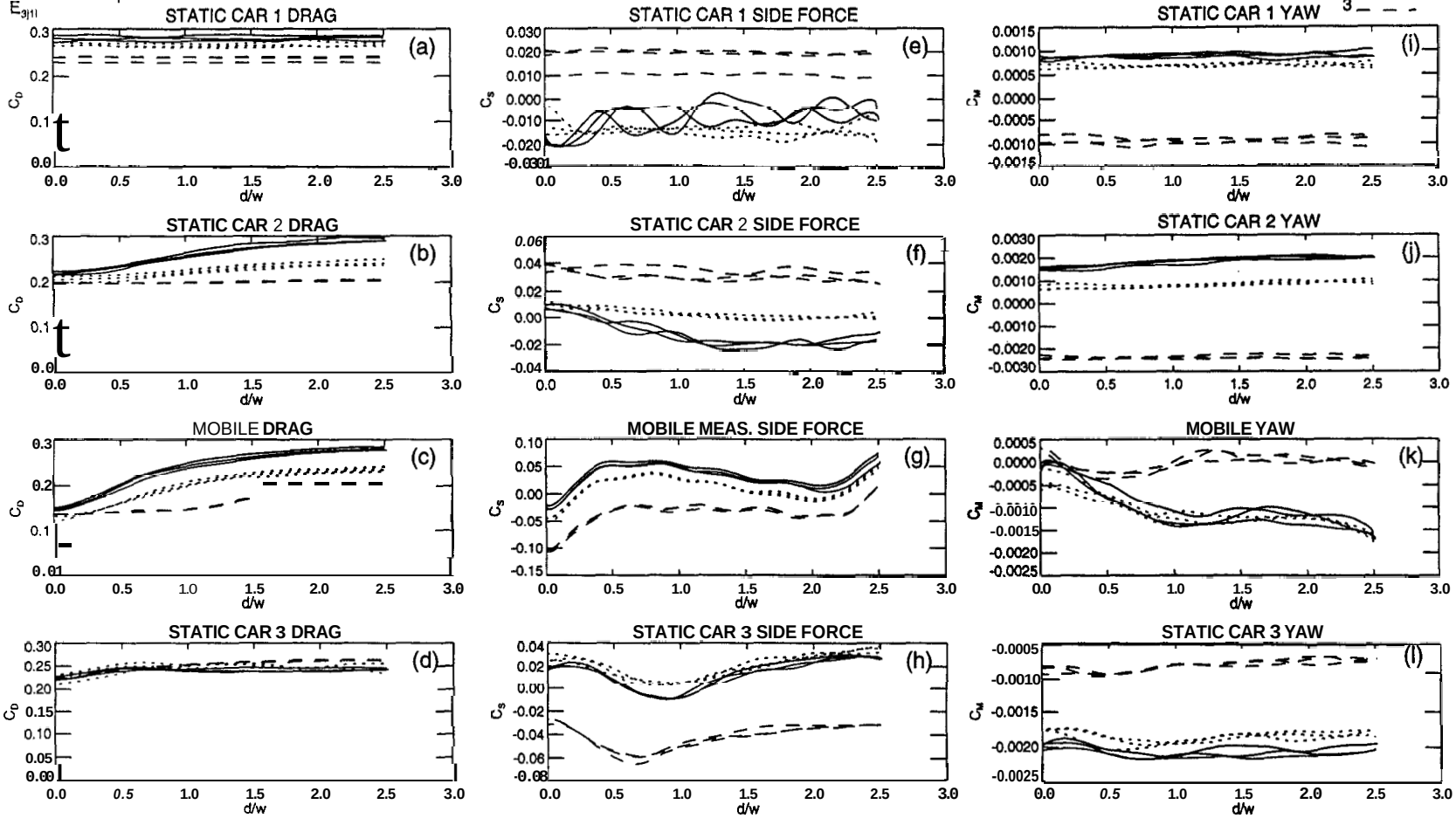


STATIC CAR 3 YAW



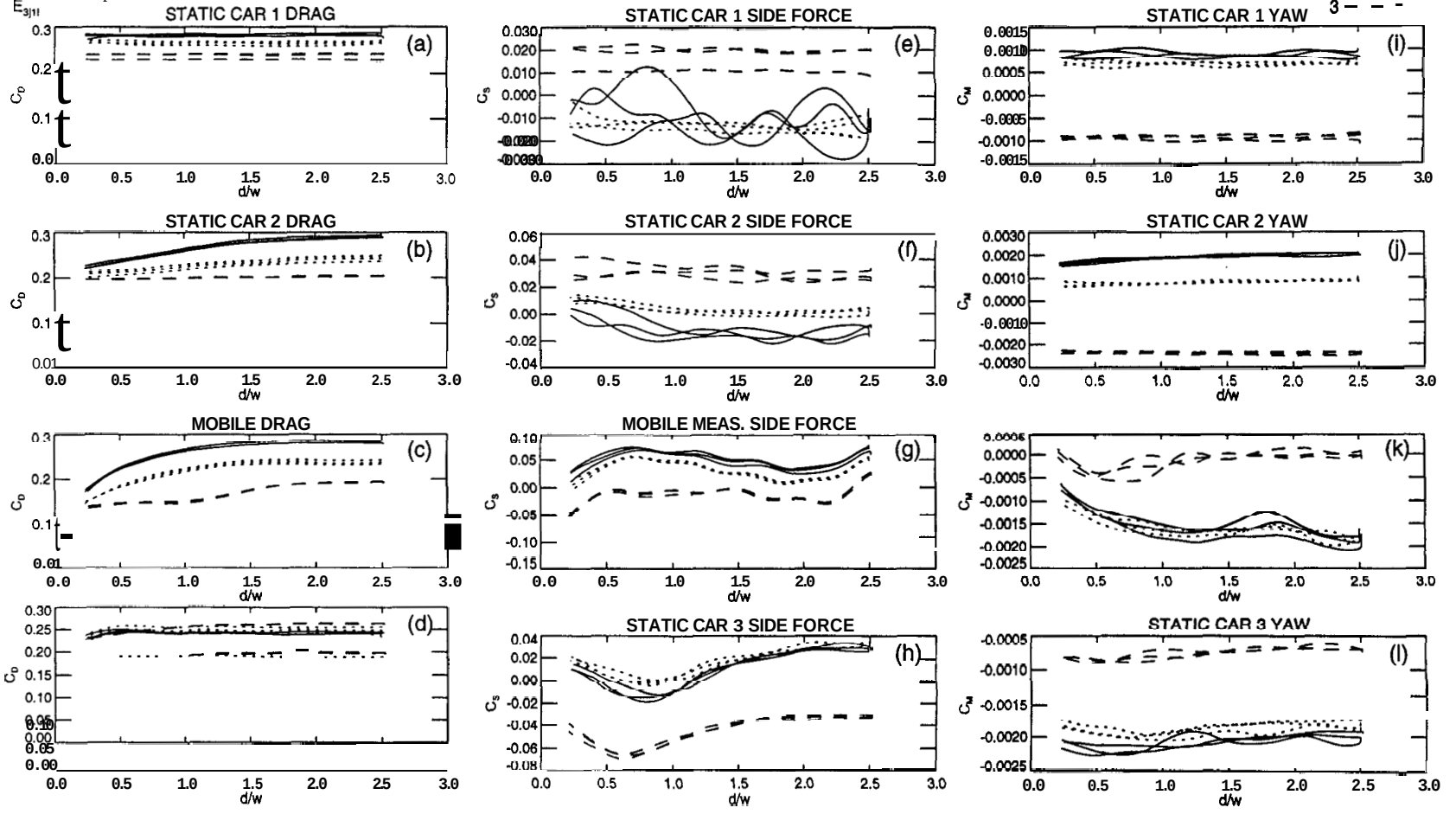
moving car position=3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
potion: into platoon

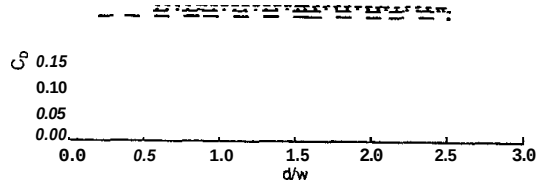
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 — — -



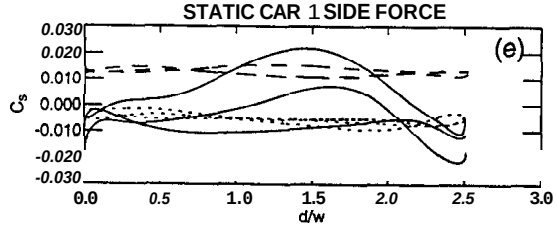
moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon
$E_{3|2|}$

separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

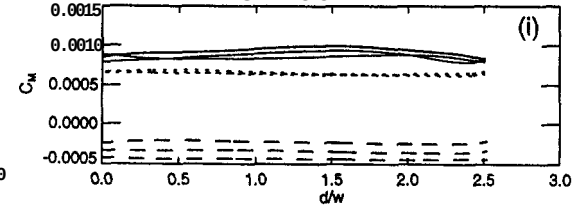
STATIC CAR 1 DRAG



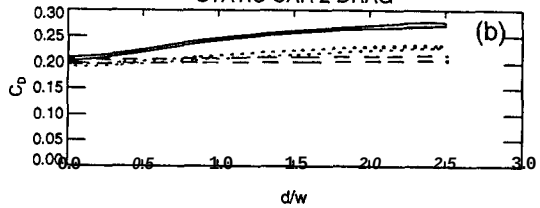
STATIC CAR 1 SIDE FORCE



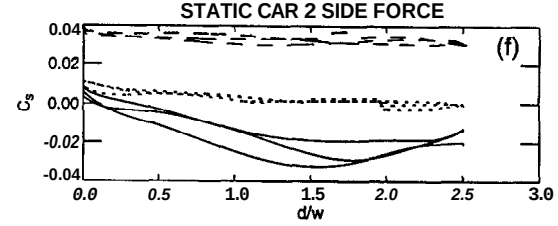
STATIC CAR 1 YAW



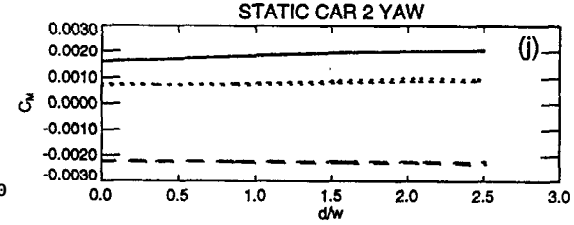
STATIC CAR 2 DRAG



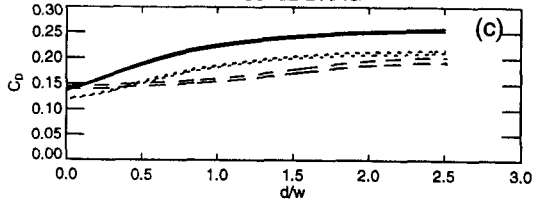
STATIC CAR 2 SIDE FORCE



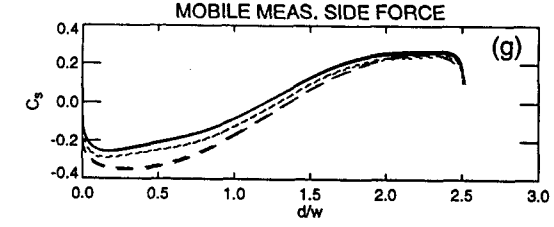
STATIC CAR 2 YAW



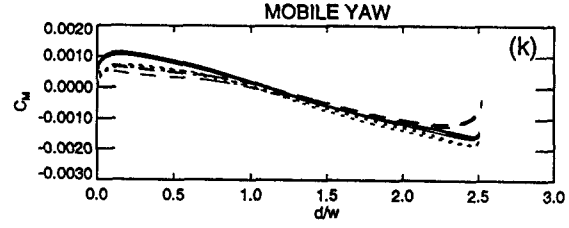
MOBILE DRAG



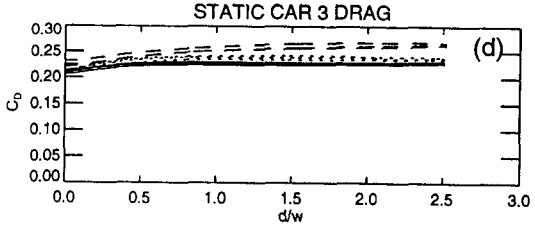
MOBILE MEAS. SIDE FORCE



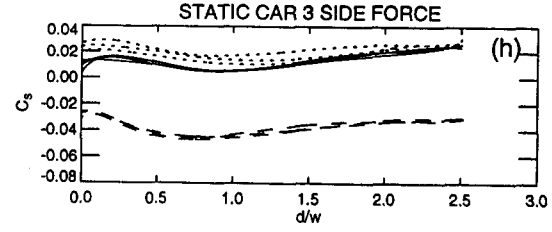
MOBILE YAW



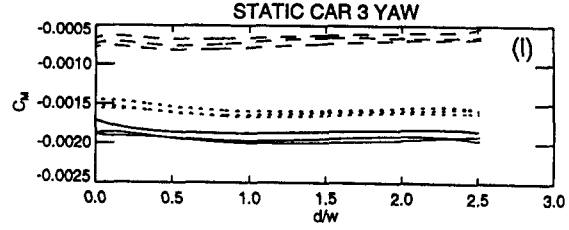
STATIC CAR 3 DRAG



STATIC CAR 3 SIDE FORCE



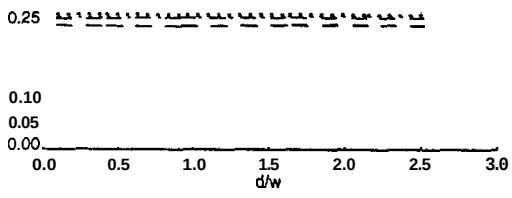
STATIC CAR 3 YAW



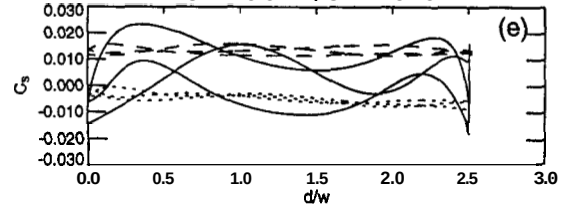
moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: into platoon
$E_{3|2l}$

separation: 1(0.2l), 2(**0.4l**), **3(l)**
1 ——
2 ·····
3 – – –

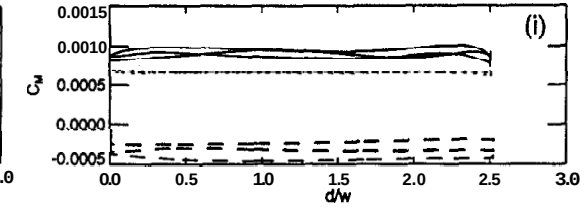
STATIC CAR 1 DRAG



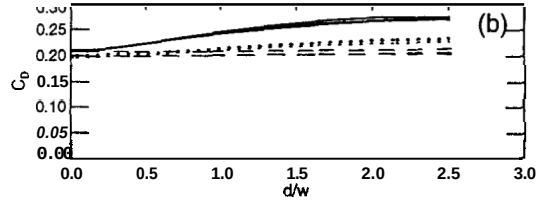
STATIC CAR **1** SIDE FORCE



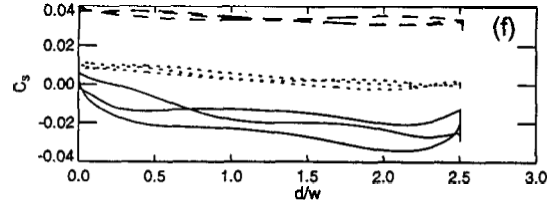
STATIC CAR **1** YAW



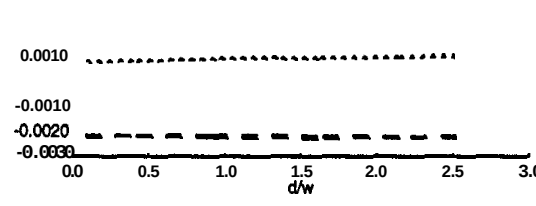
STATIC CAR **2** DRAG



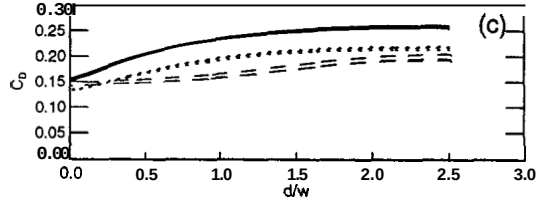
STATIC CAR 2 SIDE FORCE



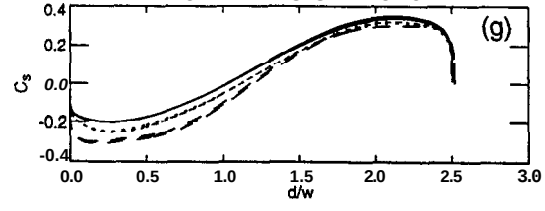
STATIC CAR **2** YAW



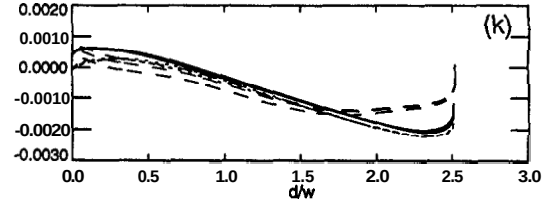
MOBILE DRAG



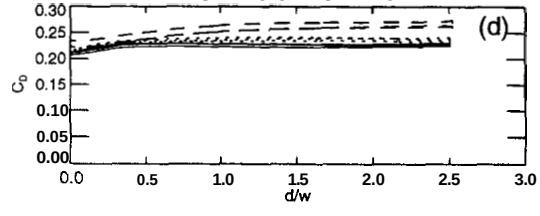
MOBILE MEAS. SIDE FORCE



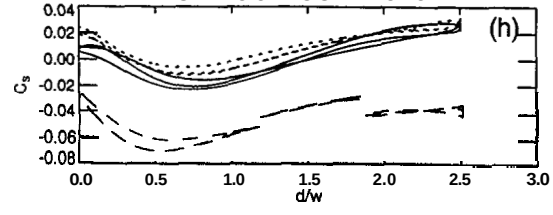
MOBILE YAW



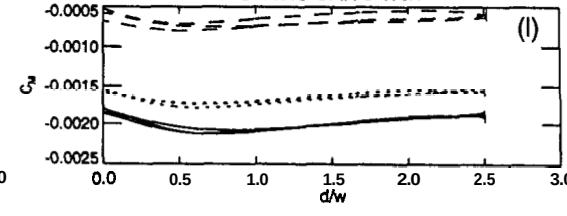
STATIC CAR **3** DRAG



STATIC CAR 3 SIDE FORCE



STATIC CAR 3 YAW

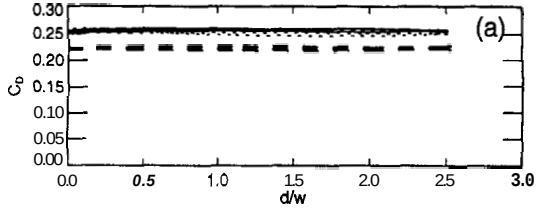


moving car position=3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: out of platoon

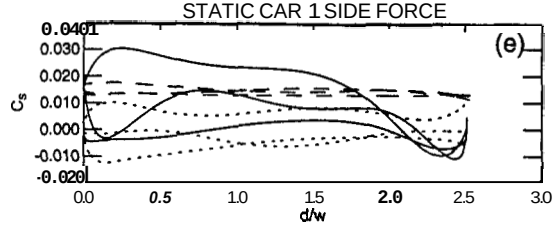
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

$E_{3|3|}$

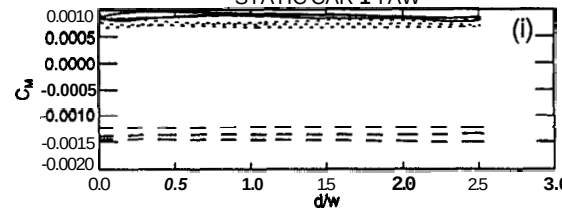
STATIC CAR 1 DRAG



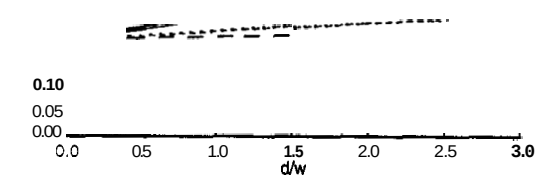
STATIC CAR 1 SIDE FORCE



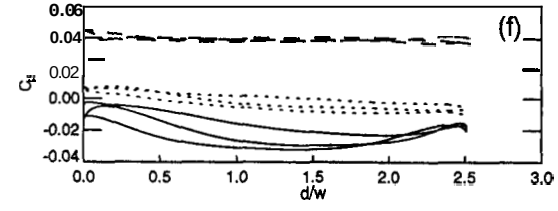
STATIC CAR 1 YAW



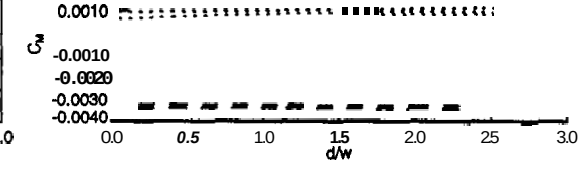
STATIC CAR 2 DRAG



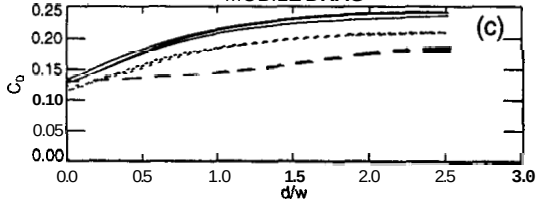
STATIC CAR 2 SIDE FORCE



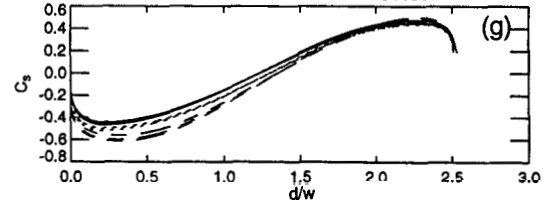
STATIC CAR 2 YAW



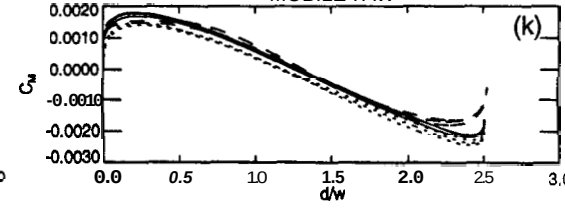
MOBILE **DRAG**



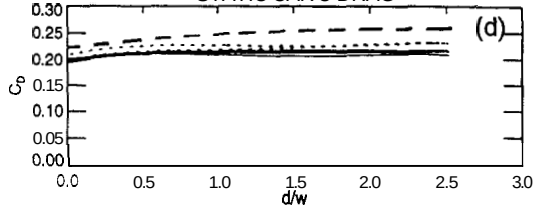
MOBILE MEAS. SIDE FORCE



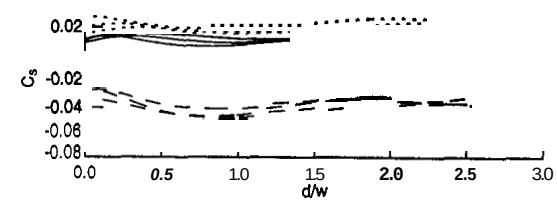
MOBILE YAW



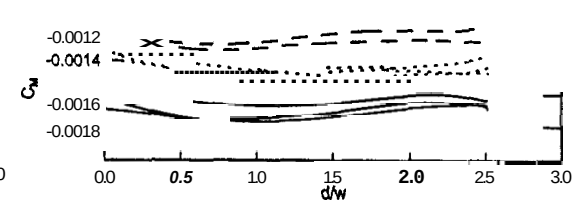
STATIC CAR 3 DRAG



STATIC CAR 3 SIDE FORCE



STATIC CAR 3 YAW

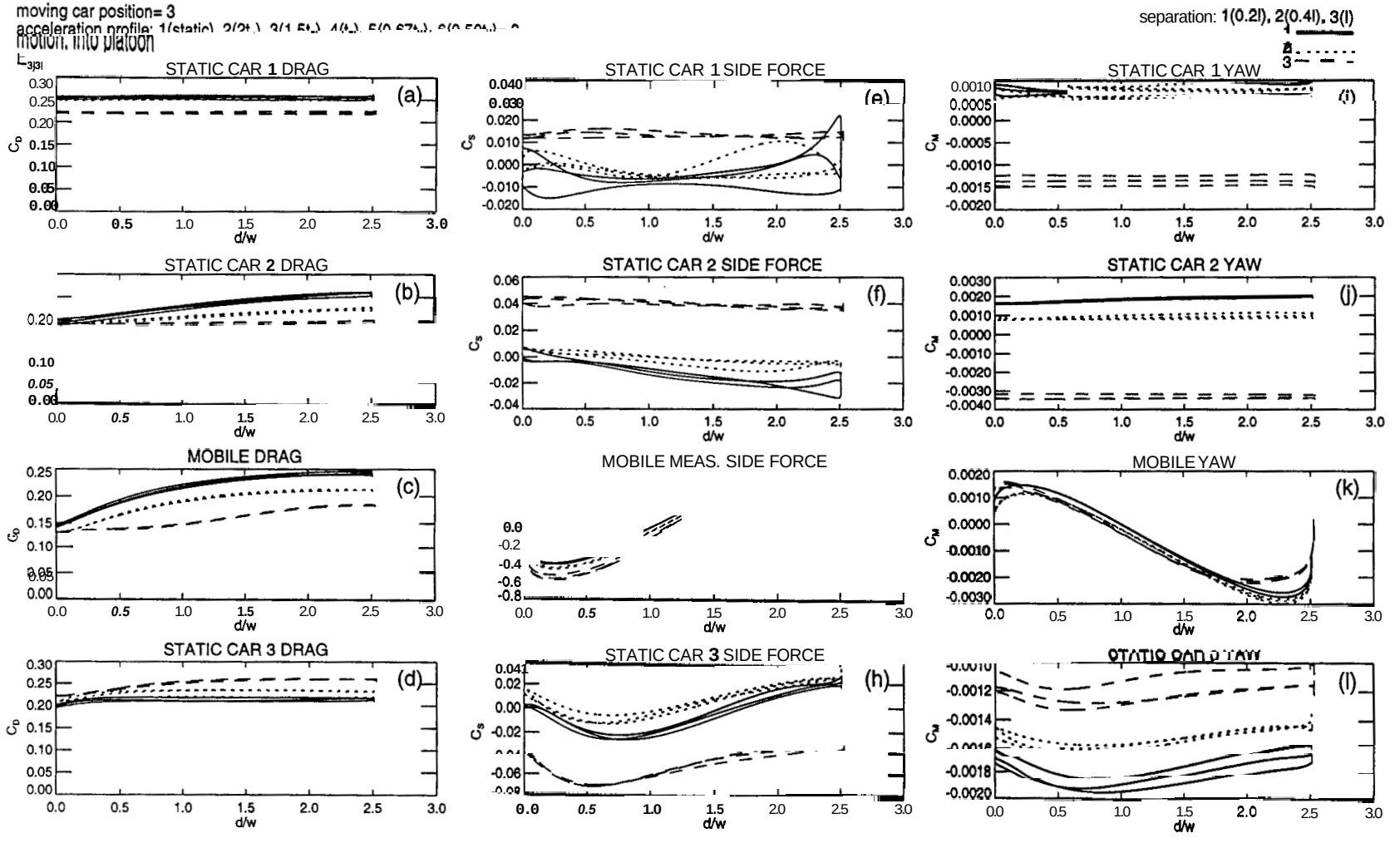


moving car position= 3

acceleration profile: 1(static), 2(2t), 3(1.5t), 4(t), 5(0.67t), 6(0.50t)

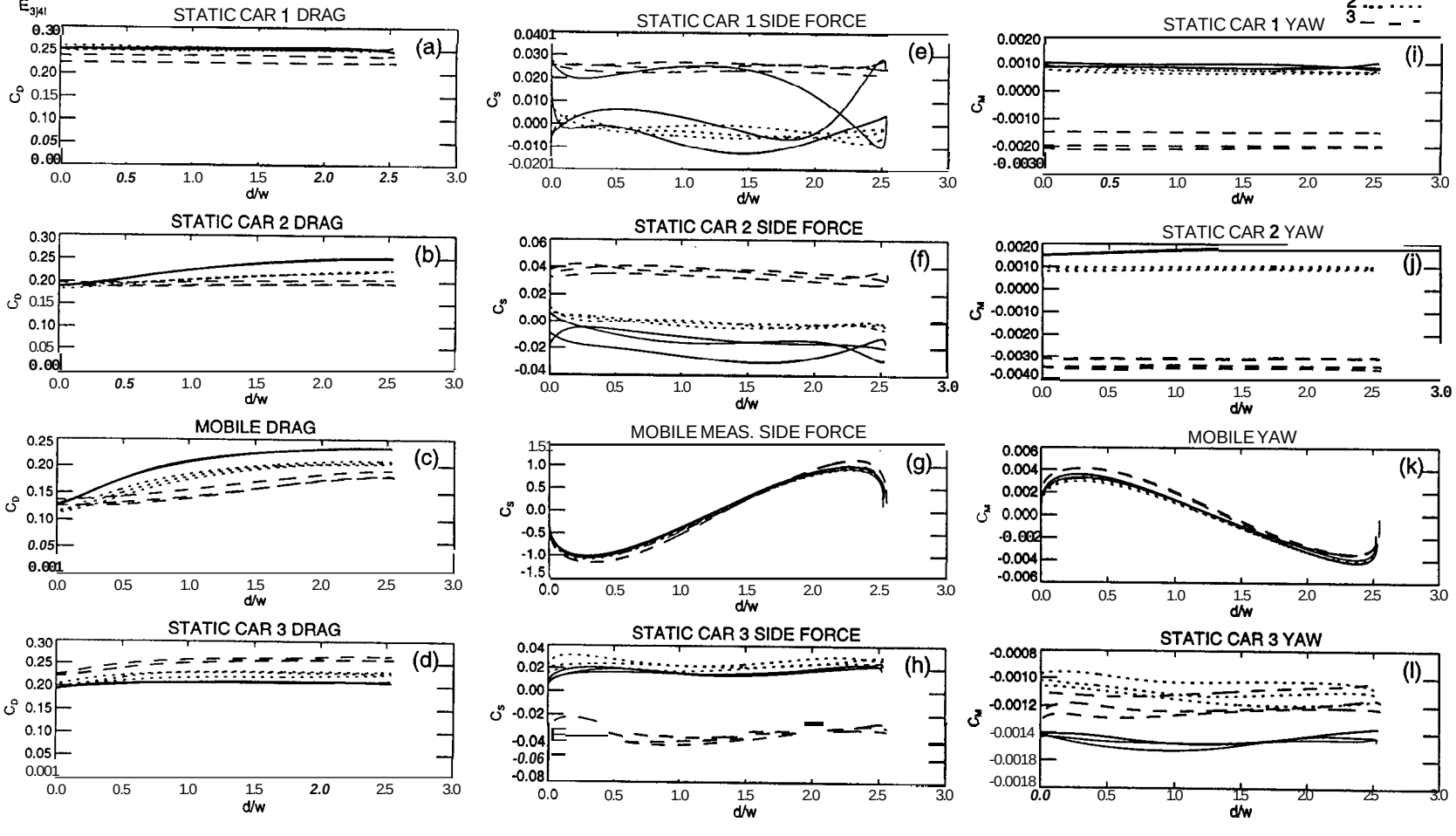
motion: into platoon

separation: 1(0.2l), 2(0.4l), 3(l)



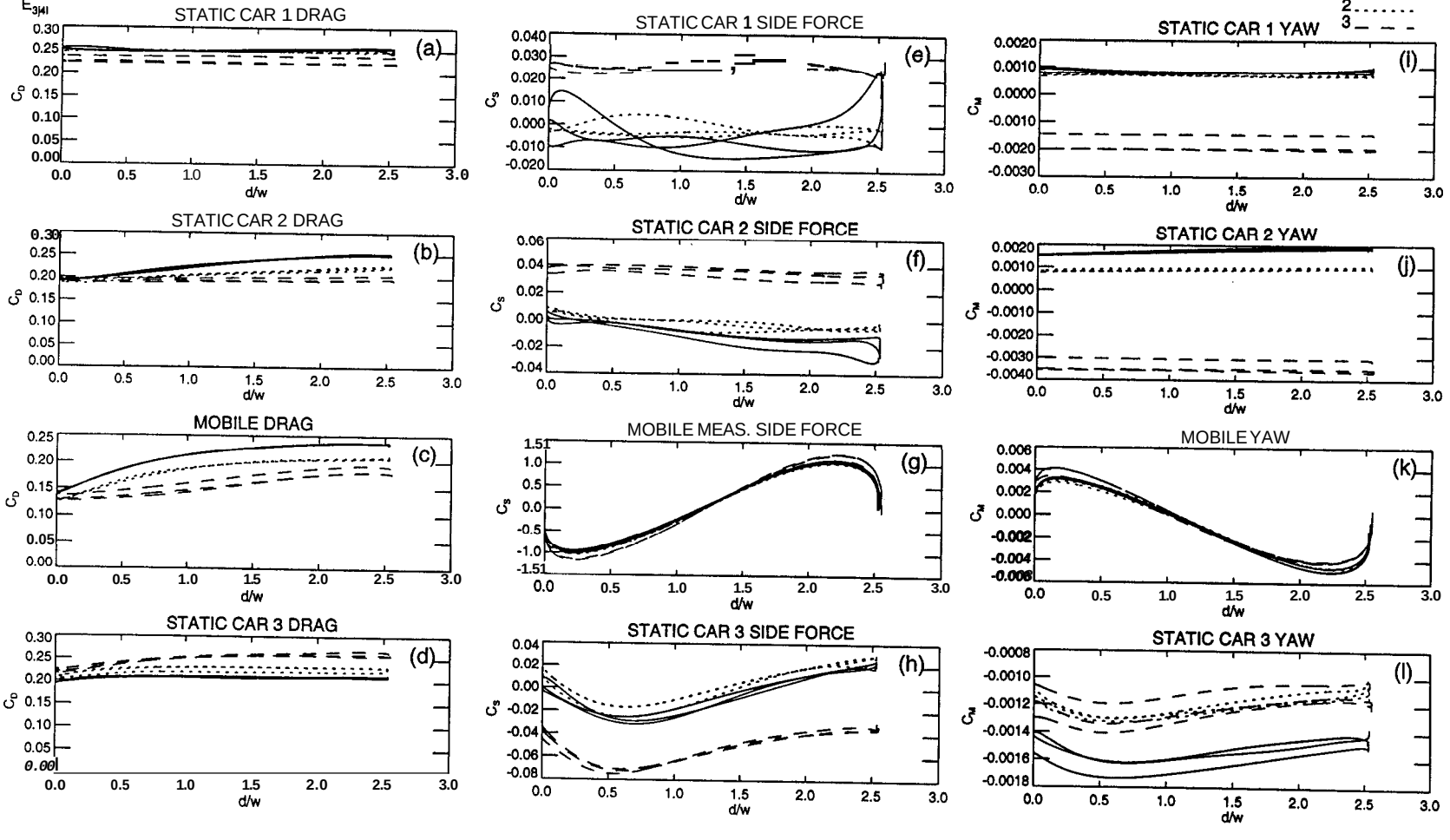
moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: out of platoon
$E_{3|4|}$

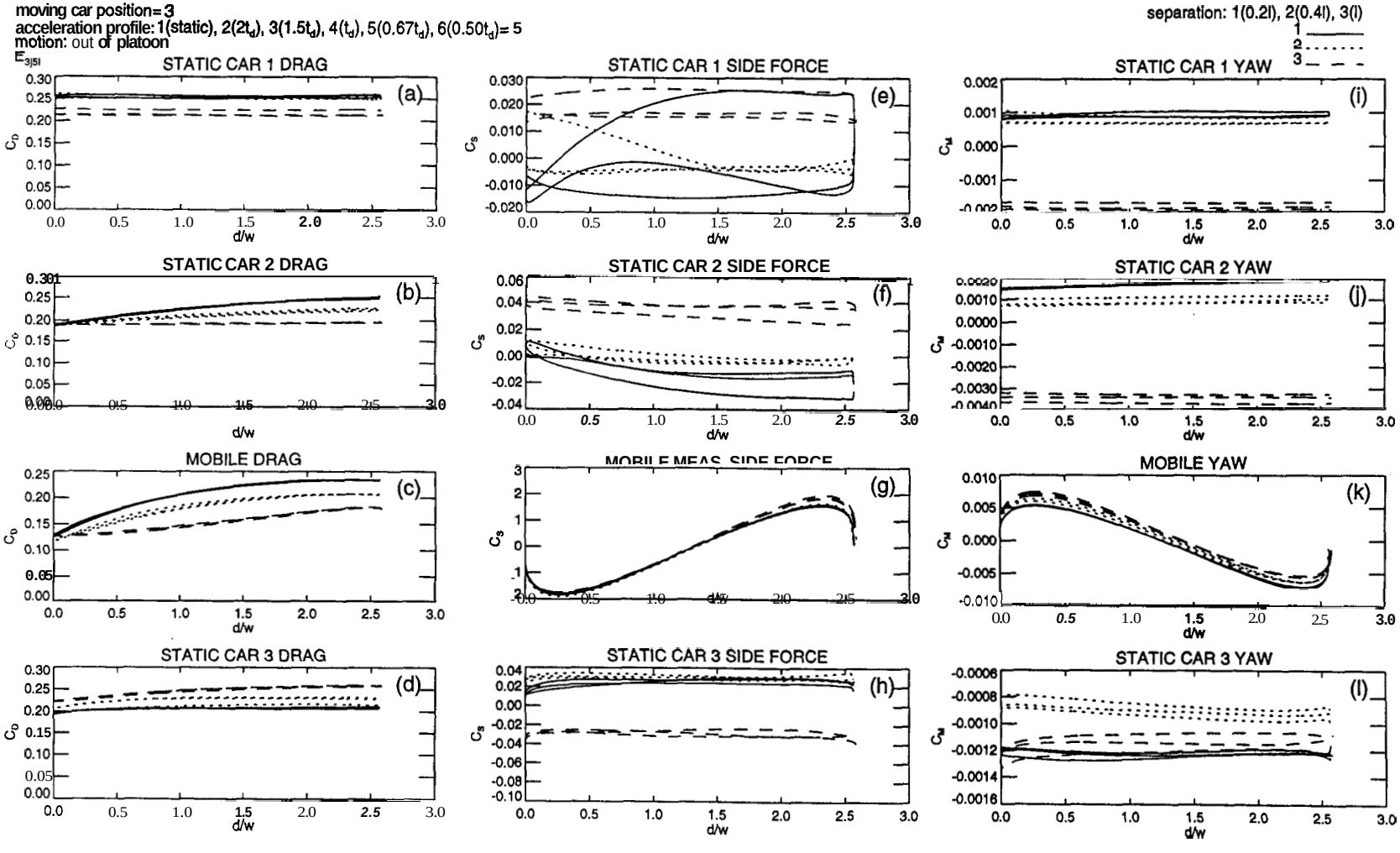
separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon
$E_{3|4|}$

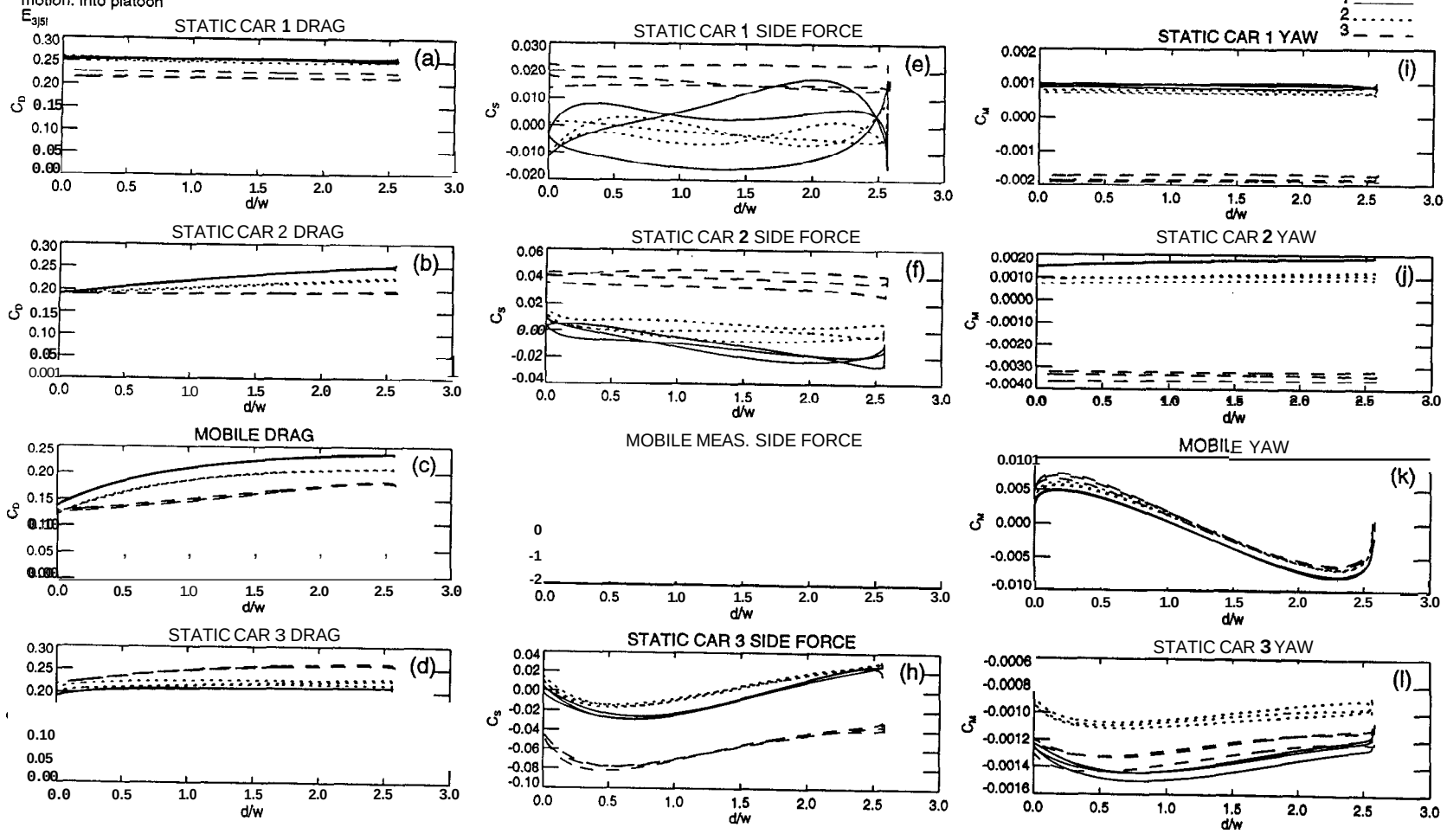
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 — — —




moving car position= 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: out of platoon
separation: 1(0.2l), 2(0.4l), 3(l)
1
2
3
STATIC CAR 1 DRAG
(a)
C_D
d/w
STATIC CAR 1 SIDE FORCE
(e)
C_S
d/w
STATIC CAR 1 YAW
(i)
C_M
d/w
STATIC CAR 2 DRAG
(b)
C_D
d/w
STATIC CAR 2 SIDE FORCE
(f)
C_S
d/w
STATIC CAR 2 YAW
(j)
C_M
d/w
MOBILE DRAG
(c)
C_D
d/w
MOBILE MEAS. SIDE FORCE
(g)
C_S
MOBILE YAW
(k)
C_M
d/w
STATIC CAR 3 DRAG
(d)
C_D
d/w
STATIC CAR 3 SIDE FORCE
(h)
C_S
d/w
STATIC CAR 3 YAW
(l)
C_M
d/w

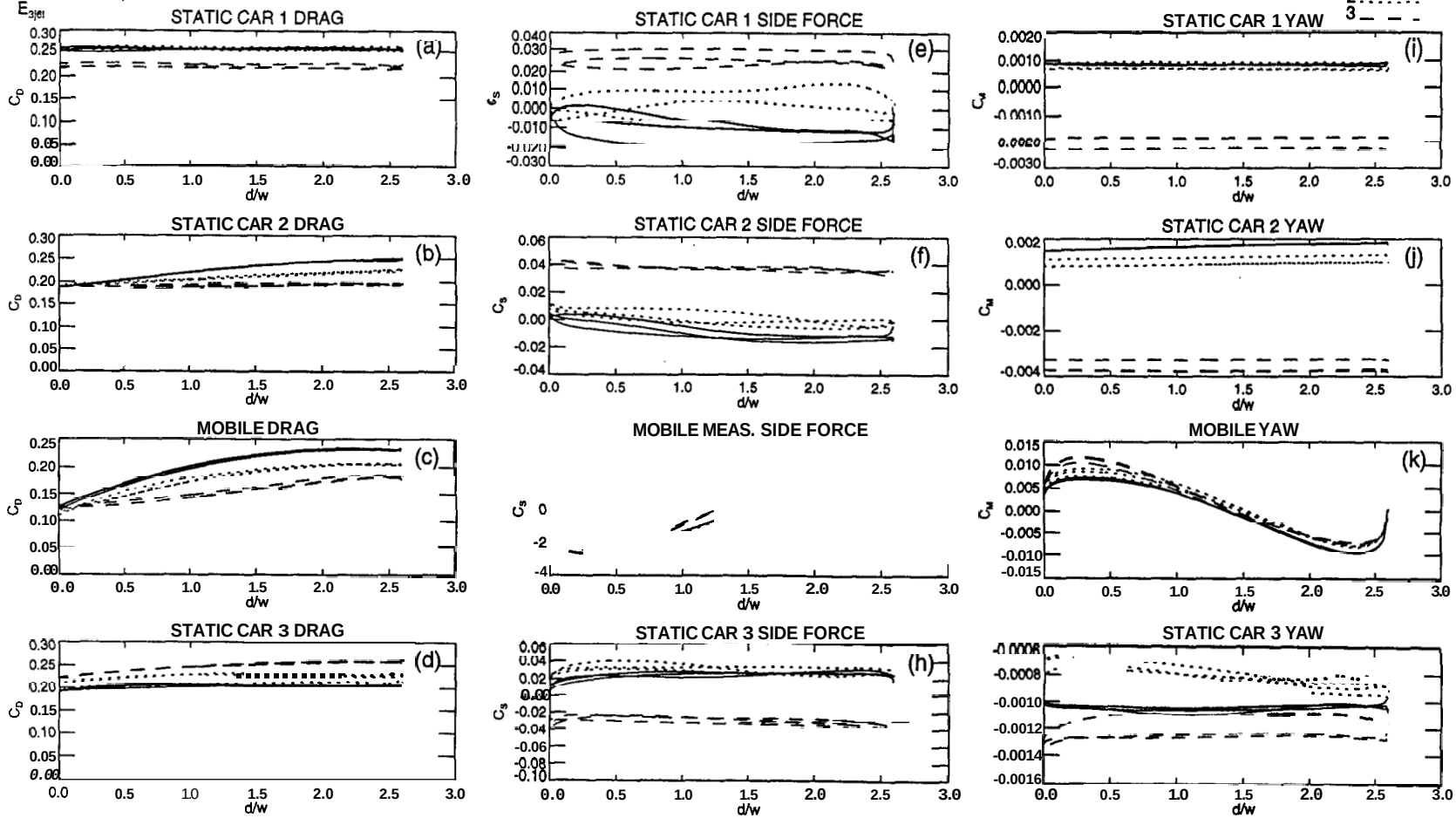
moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: into platoon
$E_{3|5|}$

separation: 1(0.2l), 2(0.4l), 3(l)



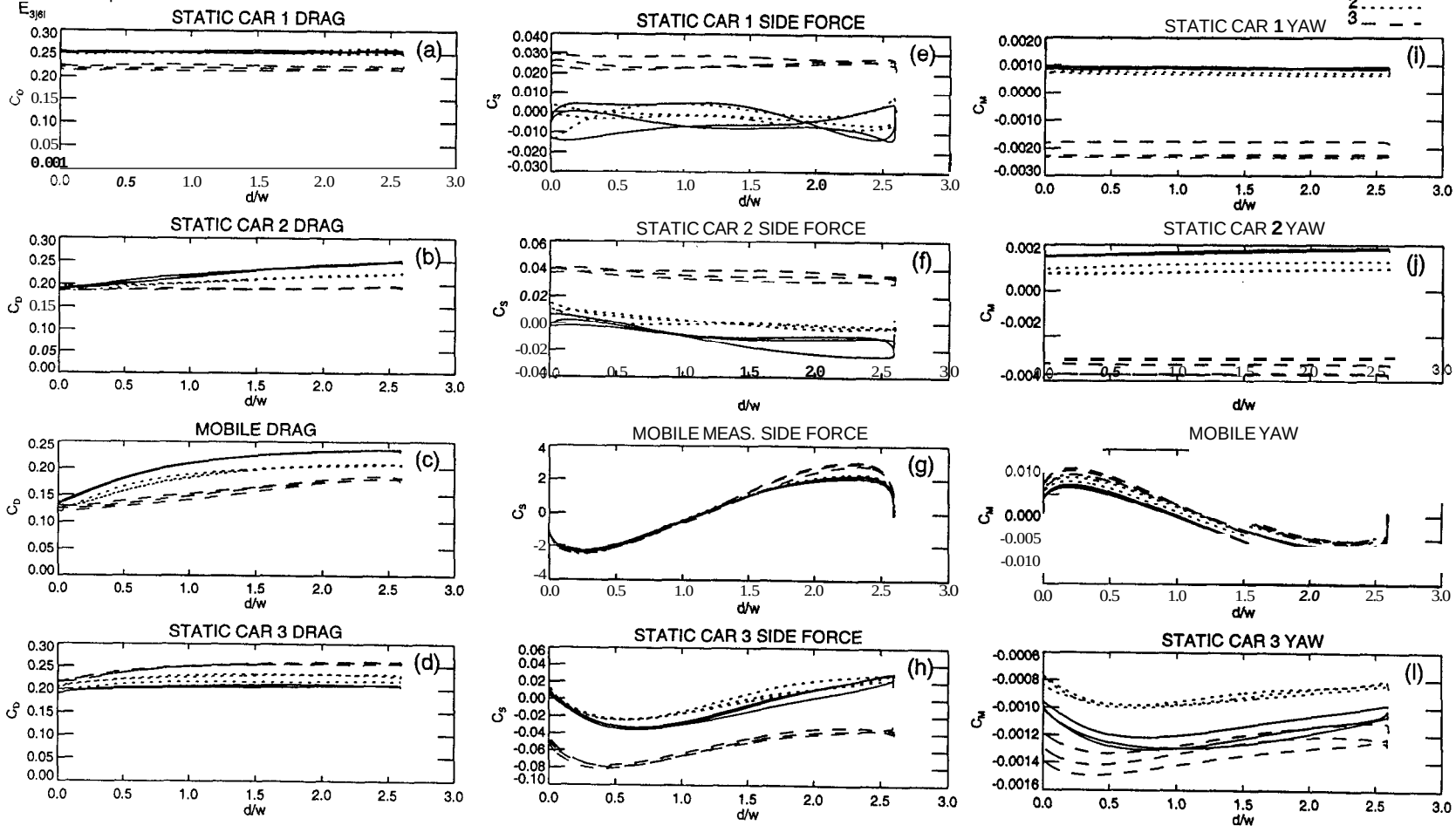
moving car position= 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



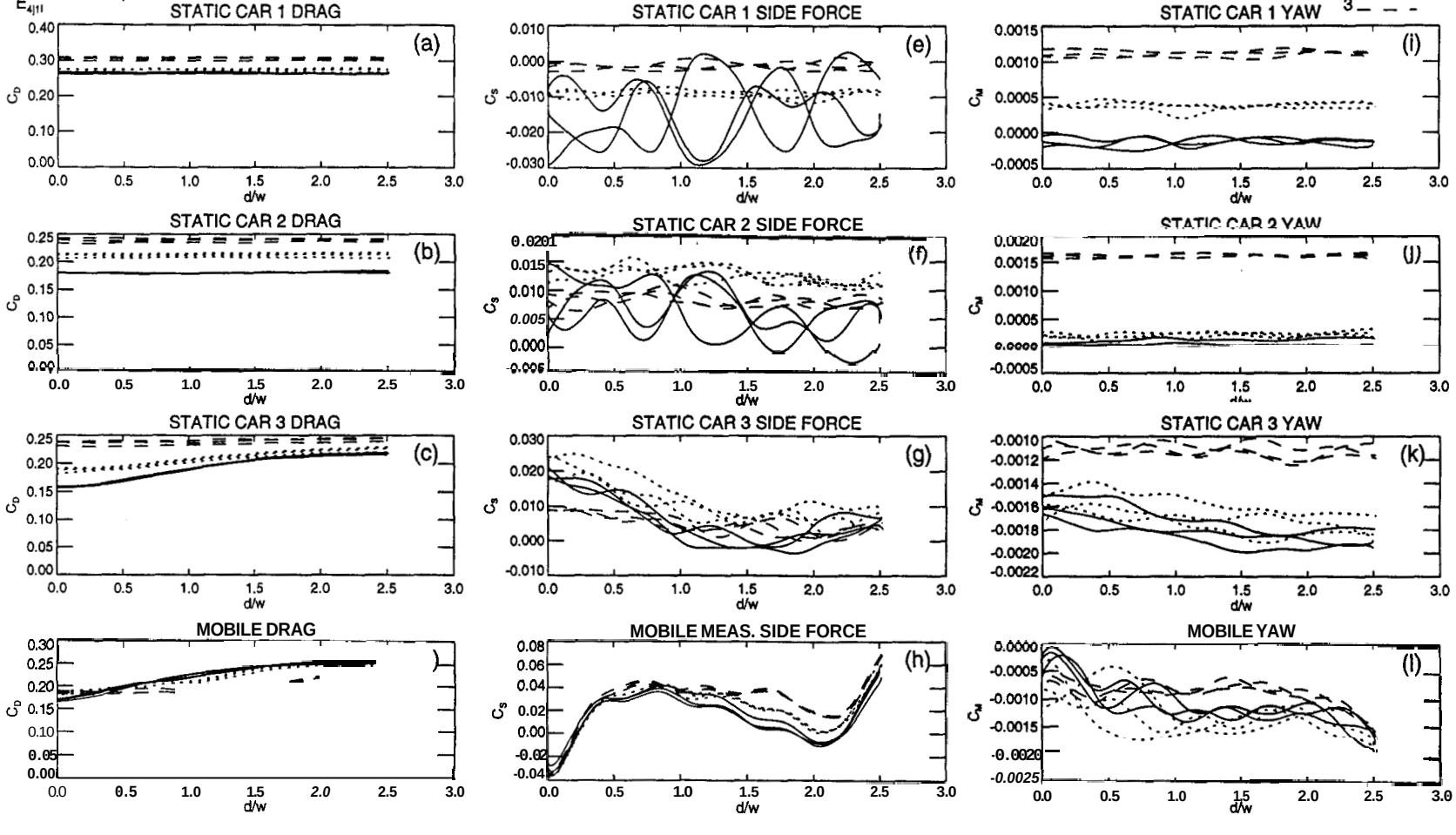
moving car position=3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: Into platoon

separation: 1(0.2l), 2(0.4l), 3(l)



moving car position=4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)

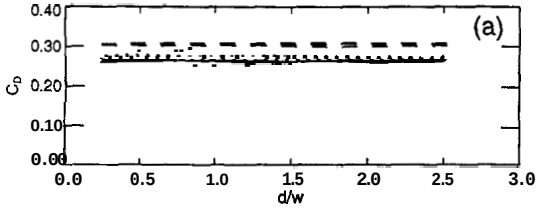


moving car position= 4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: into platoon

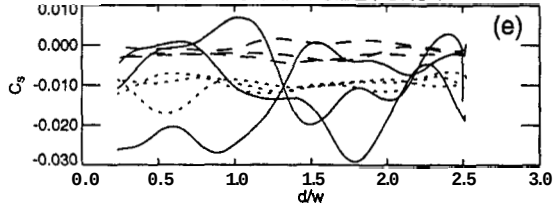
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 – – –

$E_{4|1|}$

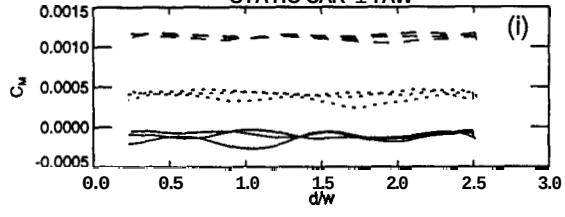
STATIC CAR 1 DRAG



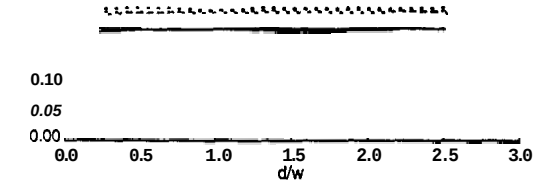
STATIC CAR 1 SIDE FORCE



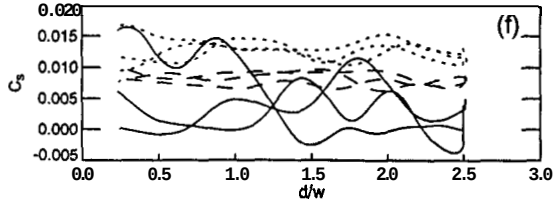
STATIC CAR 1 YAW



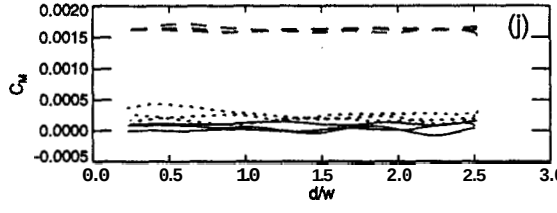
STATIC CAR 2 DRAG



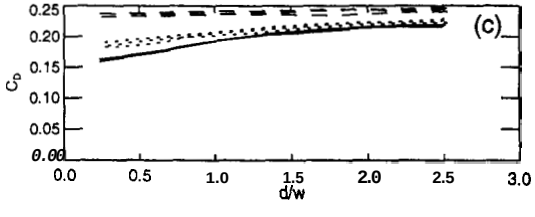
STATIC CAR 2 SIDE FORCE



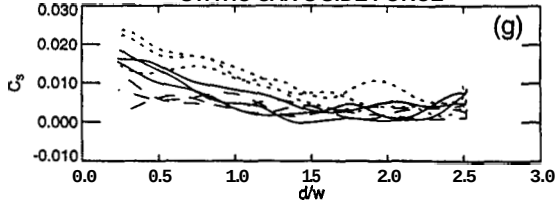
STATIC CAR 2 YAW



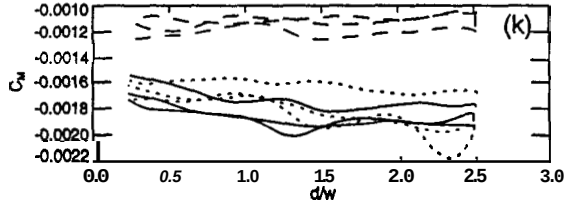
STATIC CAR 3 DRAG



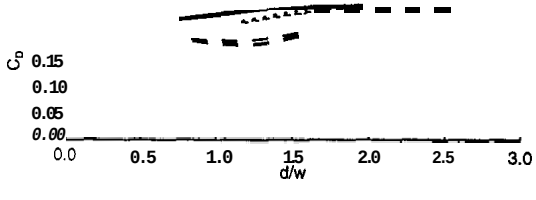
STATIC CAR 3 SIDE FORCE



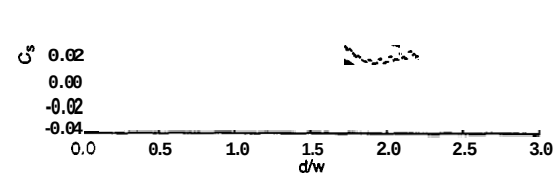
STATIC CAR 3 YAW



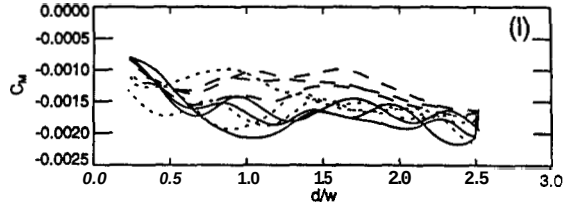
MOBILE DRAG



MOBILE MEAS. SIDE FORCE

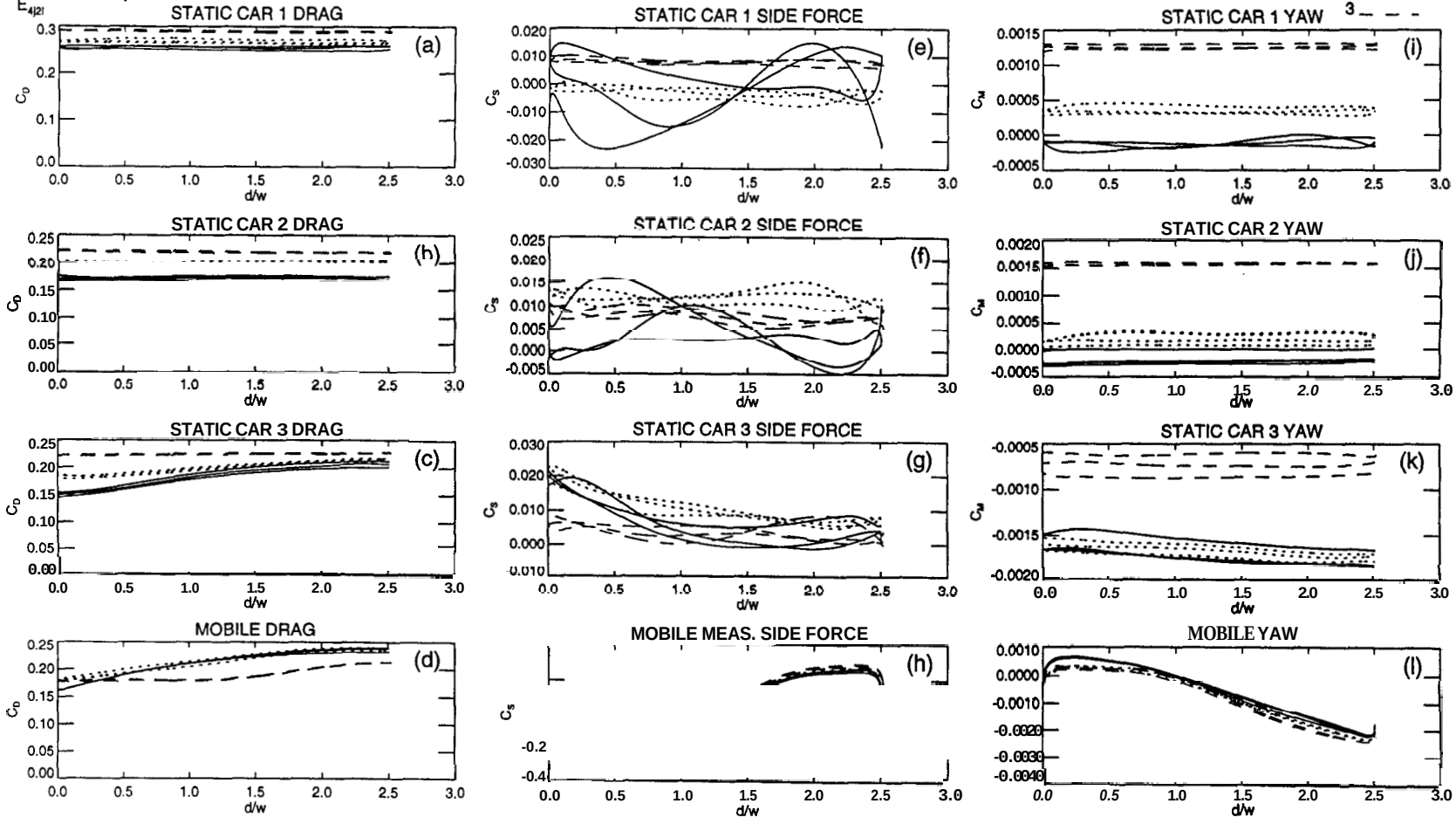


MOBILE YAW



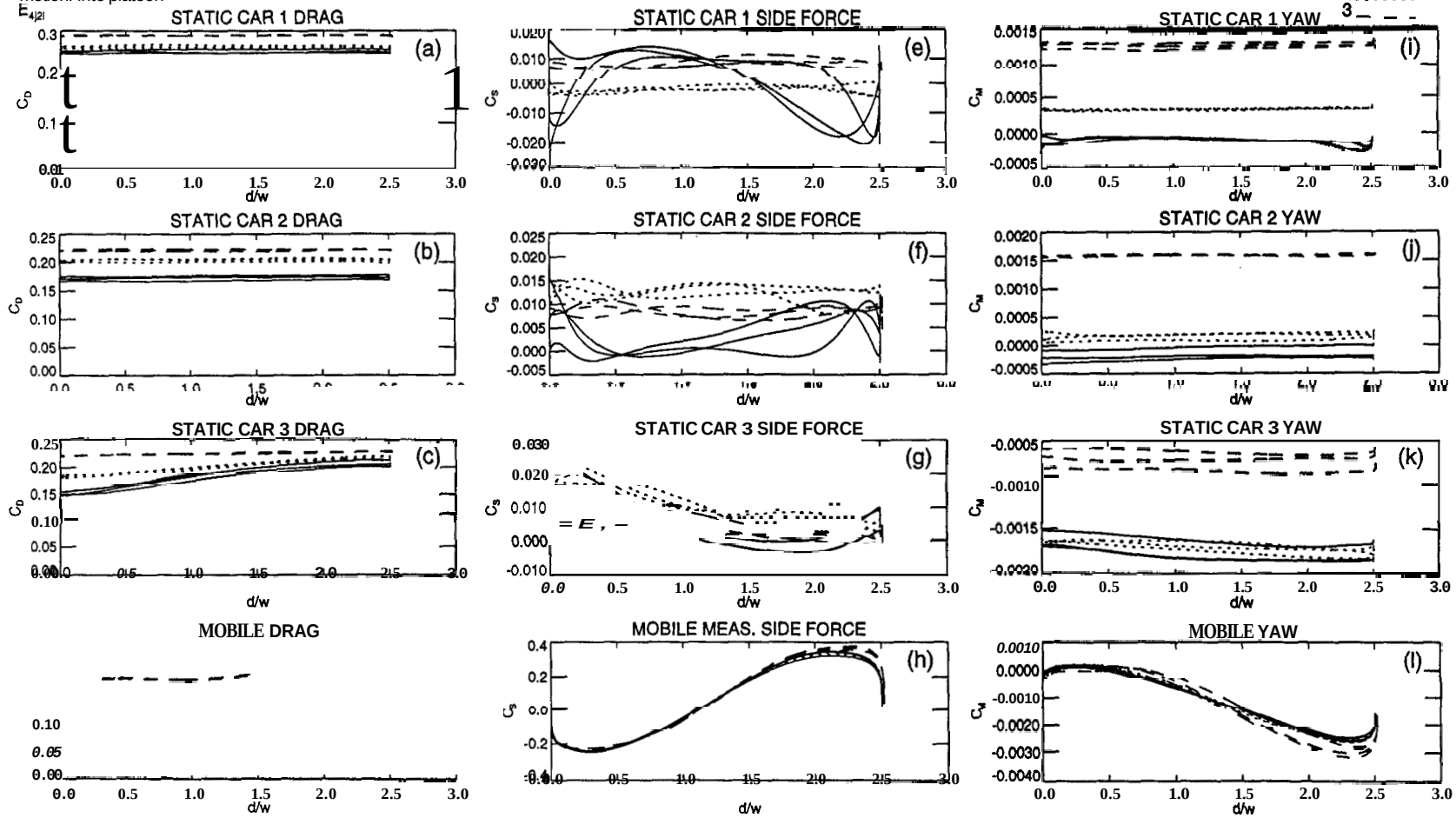
moving car **position=4**
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of **platoon**

separation: 1(0.2l), 2(0.4l), 3(l)



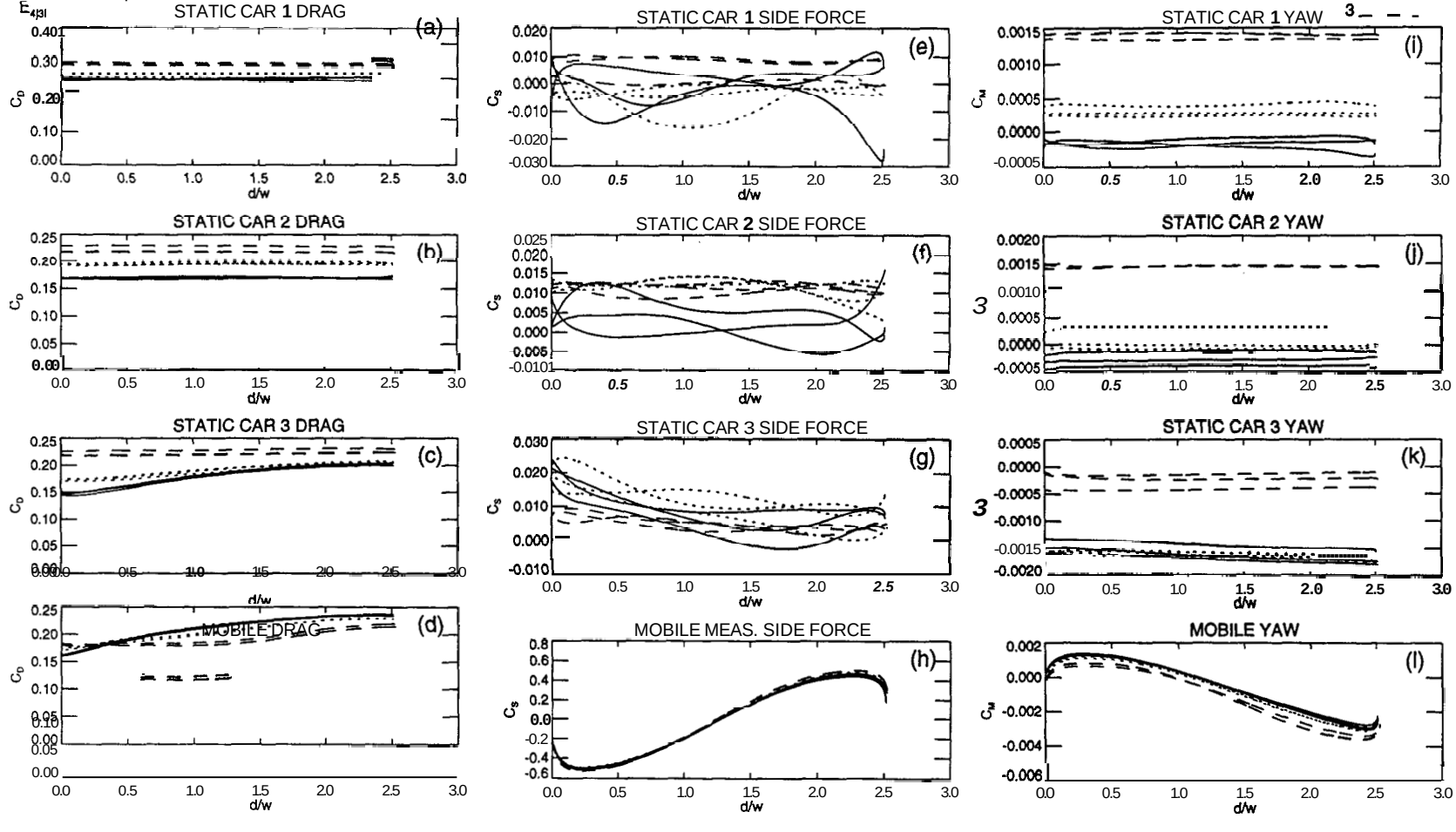
moving car position=4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: into platoon

separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 .....
3 — — —



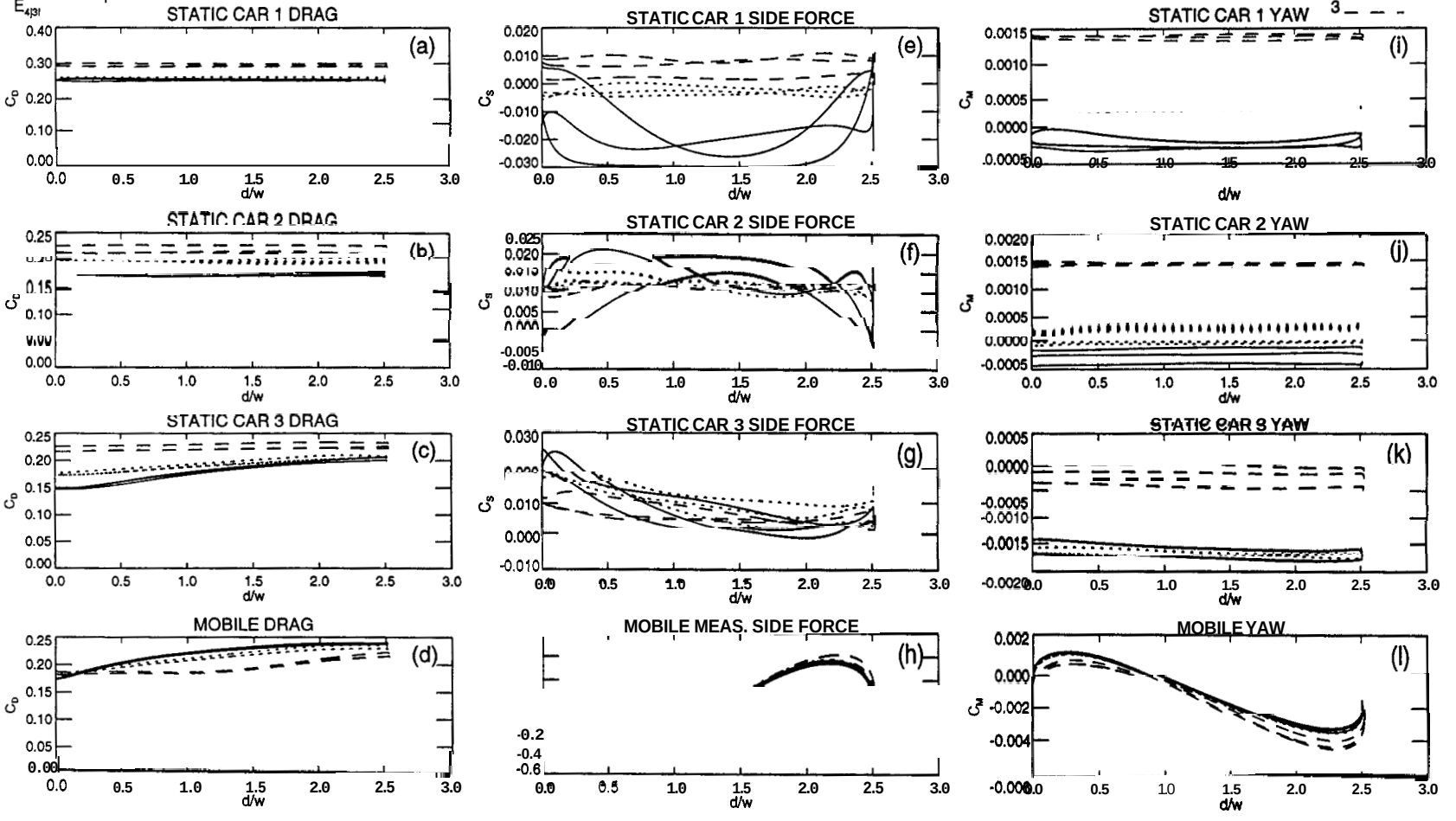
moving car position= 4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: out of platoon

separation: 1(0.2l), 2(0.4l), 3(l)



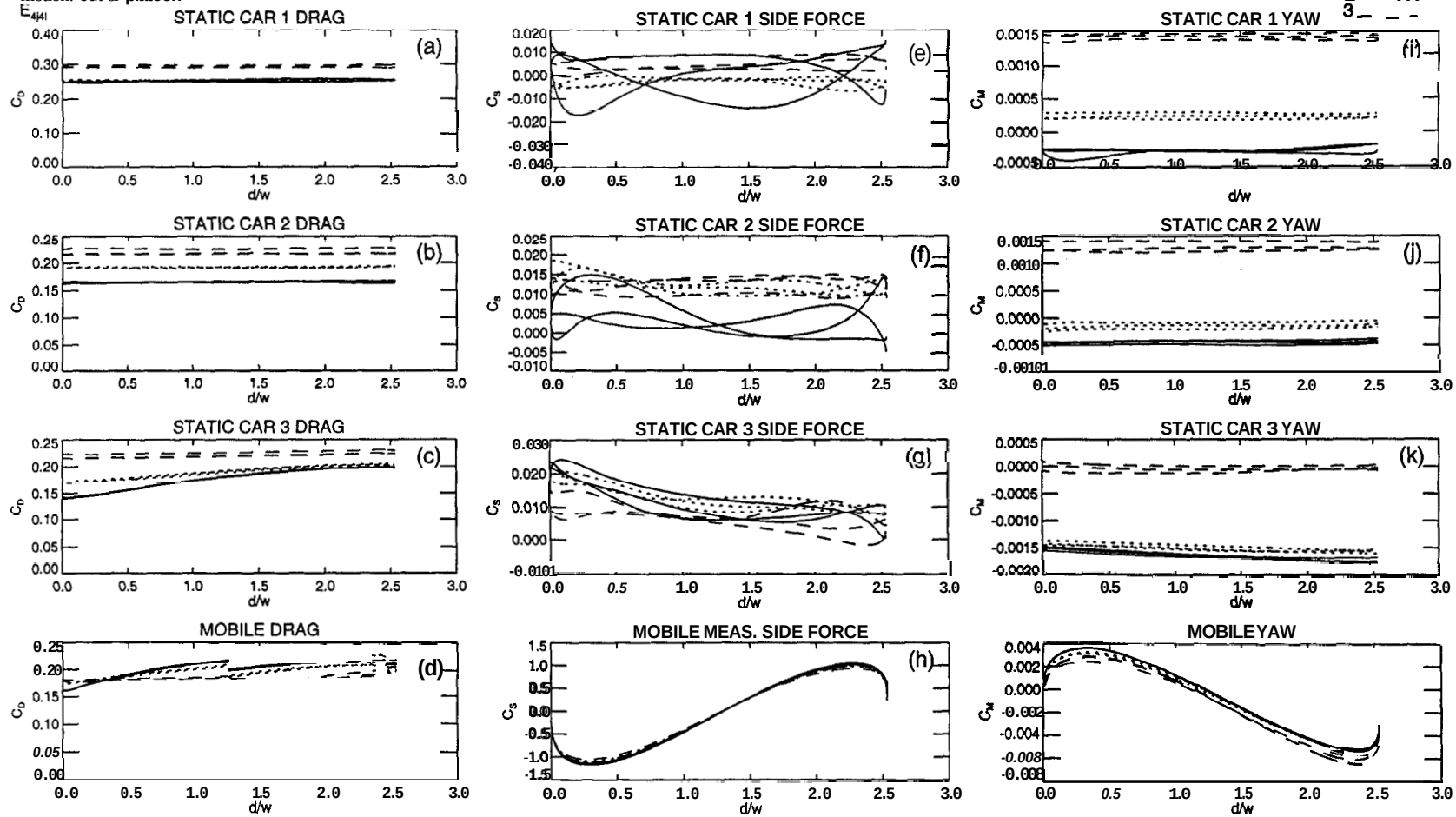
moving car position= 4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: Into platoon

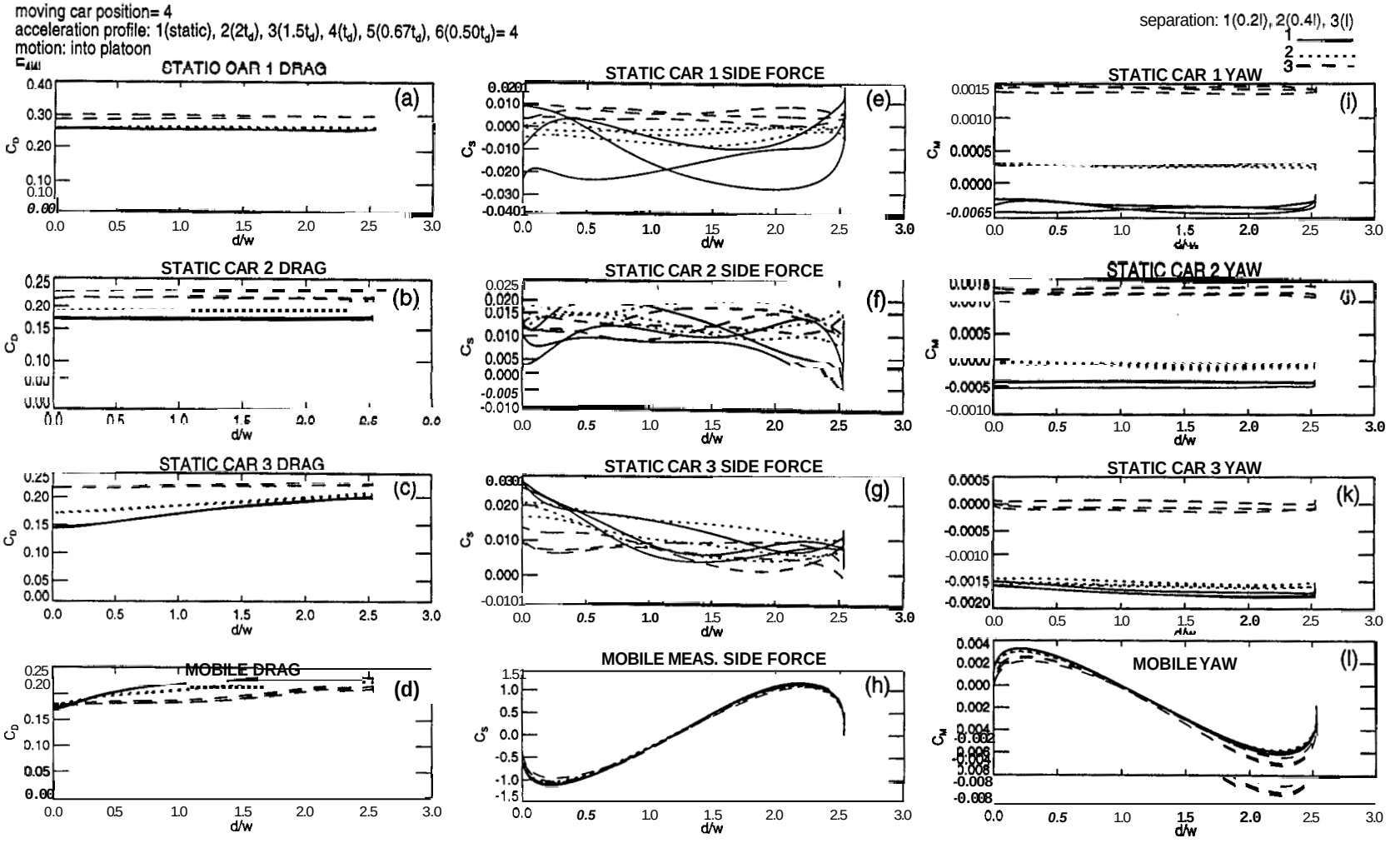
separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= 4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: out of platoon

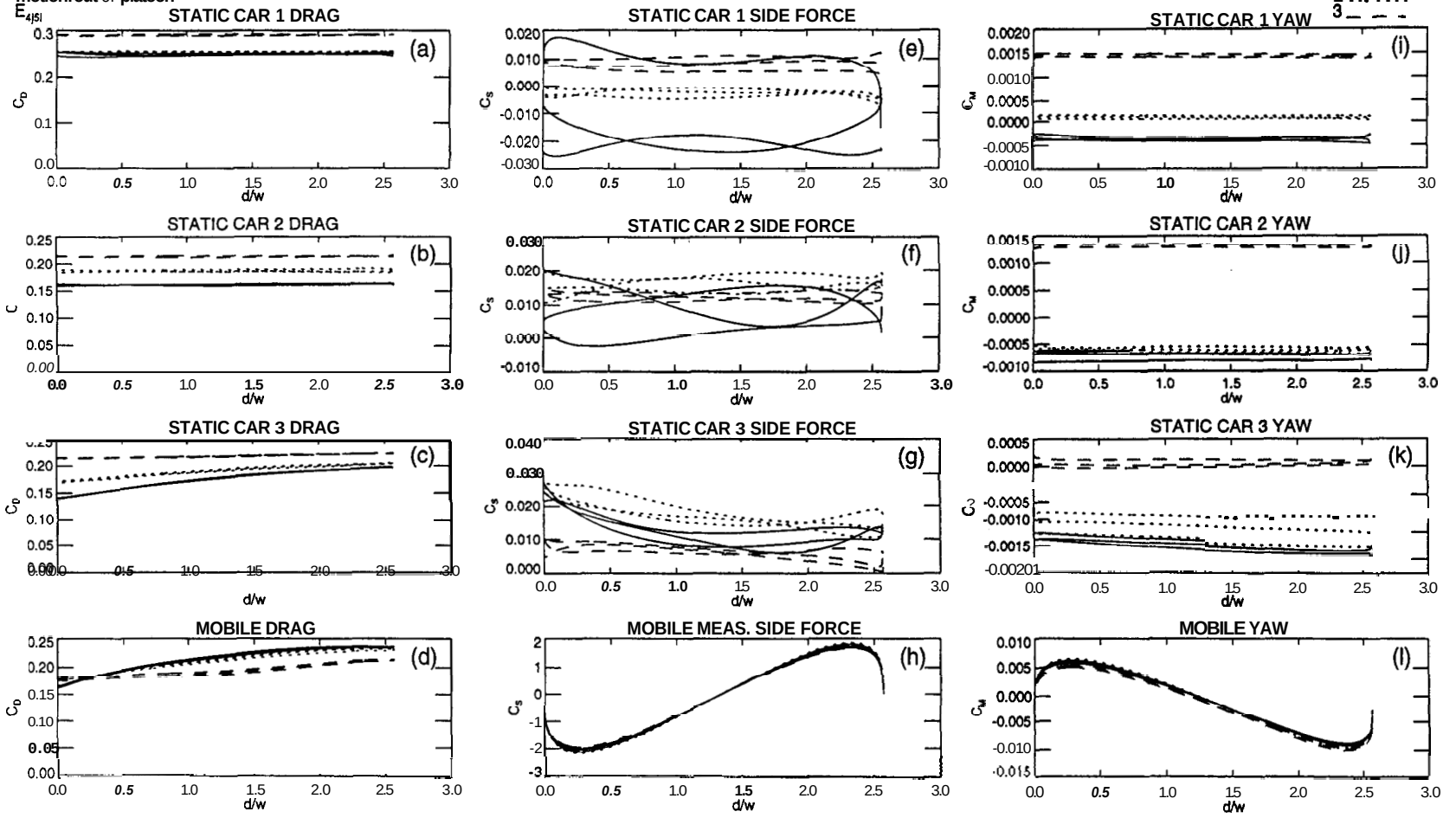
separation: 1(0.2l), 2(0.4l), 3(l)




moving car position= 4
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 4
motion: into platoon
separation: 1(0.2l), 2(0.4l), 3(l)
1
2
3
STATIC CAR 1 DRAG
(a)
STATIC CAR 1 SIDE FORCE
(e)
STATIC CAR 1 YAW
(i)
STATIC CAR 2 DRAG
(b)
STATIC CAR 2 SIDE FORCE
(f)
STATIC CAR 2 YAW
(j)
STATIC CAR 3 DRAG
(c)
STATIC CAR 3 SIDE FORCE
(g)
STATIC CAR 3 YAW
(k)
MOBILE DRAG
(d)
MOBILE MEAS. SIDE FORCE
(h)
MOBILE YAW
(l)
C_D
C_S
C_M
d/w

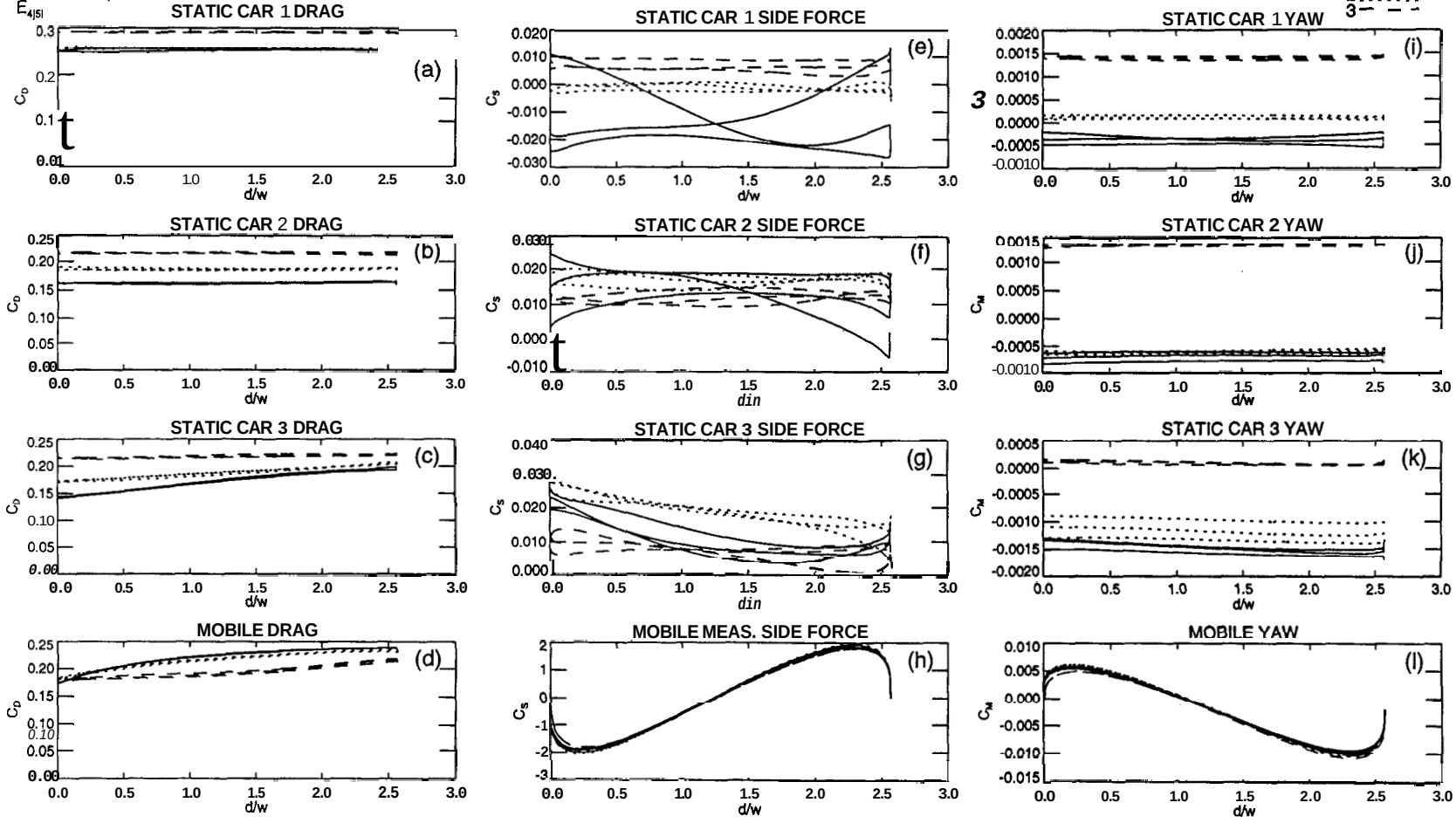
moving car position= 4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: out of platoon

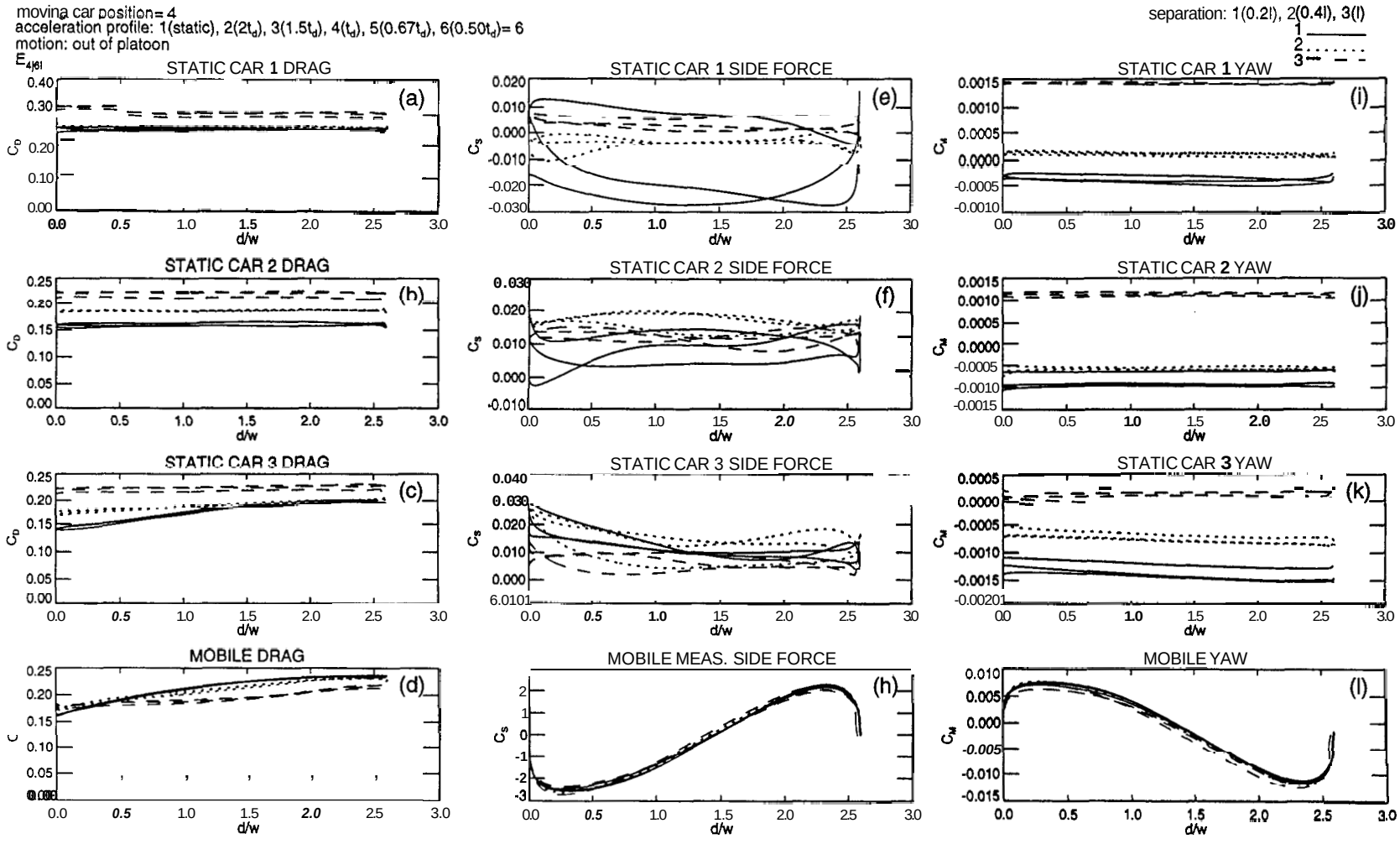
separation: 1(0.2l), 2(0.4l), 3(l)



moving car position= *4*
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: Into platoon

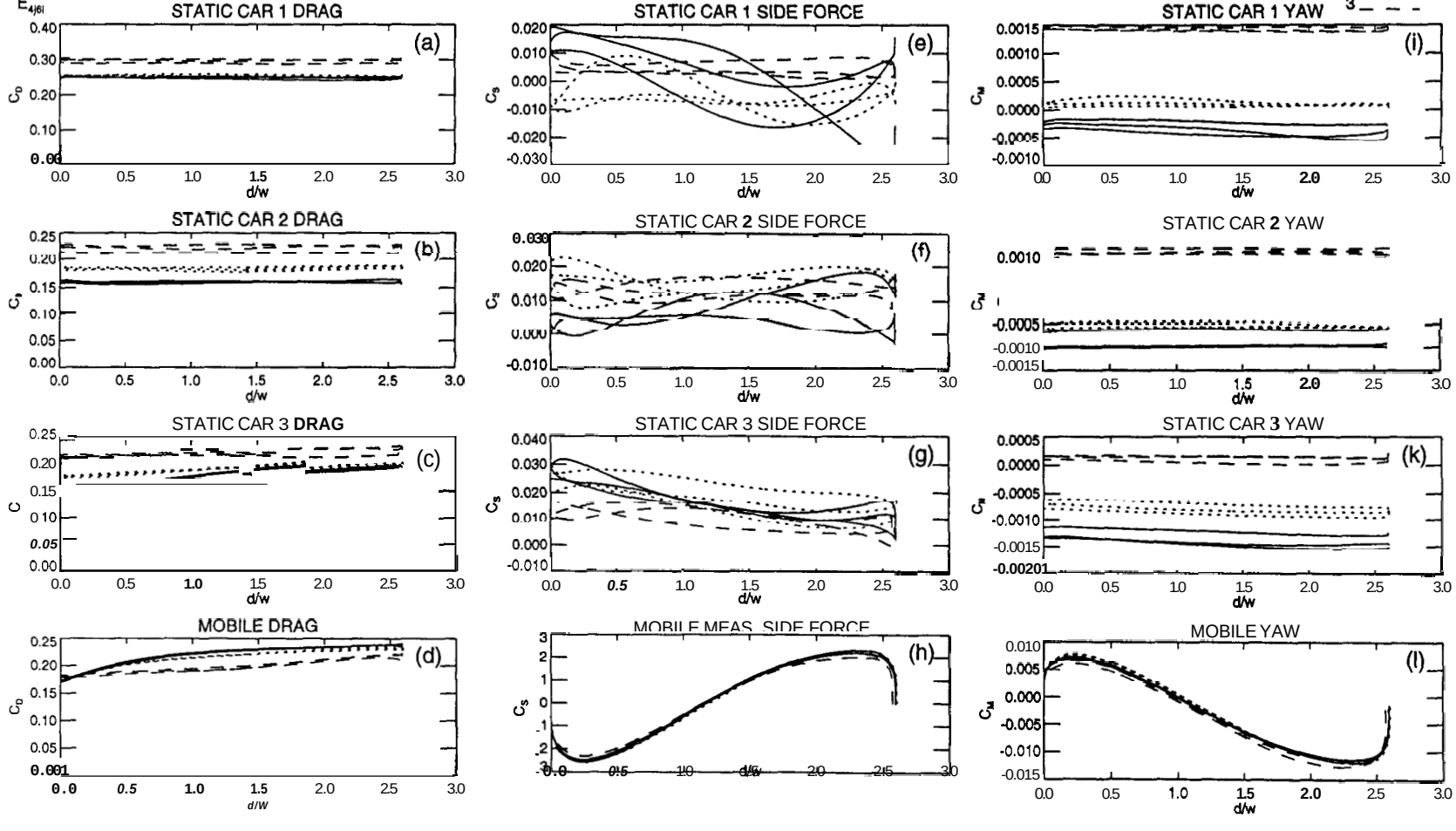
separation: 1(0.2l), 2(0.4l), 3(l)
1 ——
2 ·····
3 – – –




moving car position= 4
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: out of platoon
separation: 1(0.2l), 2(0.4l), 3(l)
1
2
3
STATIC CAR 1 DRAG
(a)
STATIC CAR 1 SIDE FORCE
(e)
STATIC CAR 1 YAW
(i)
STATIC CAR 2 DRAG
(b)
STATIC CAR 2 SIDE FORCE
(f)
STATIC CAR 2 YAW
(j)
STATIC CAR 3 DRAG
(c)
STATIC CAR 3 SIDE FORCE
(g)
STATIC CAR 3 YAW
(k)
MOBILE DRAG
(d)
MOBILE MEAS. SIDE FORCE
(h)
MOBILE YAW
(l)
d/w

moving car position=4
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: Into platoon

separation: 1(0.2l), 2(0.4l), 3(l)



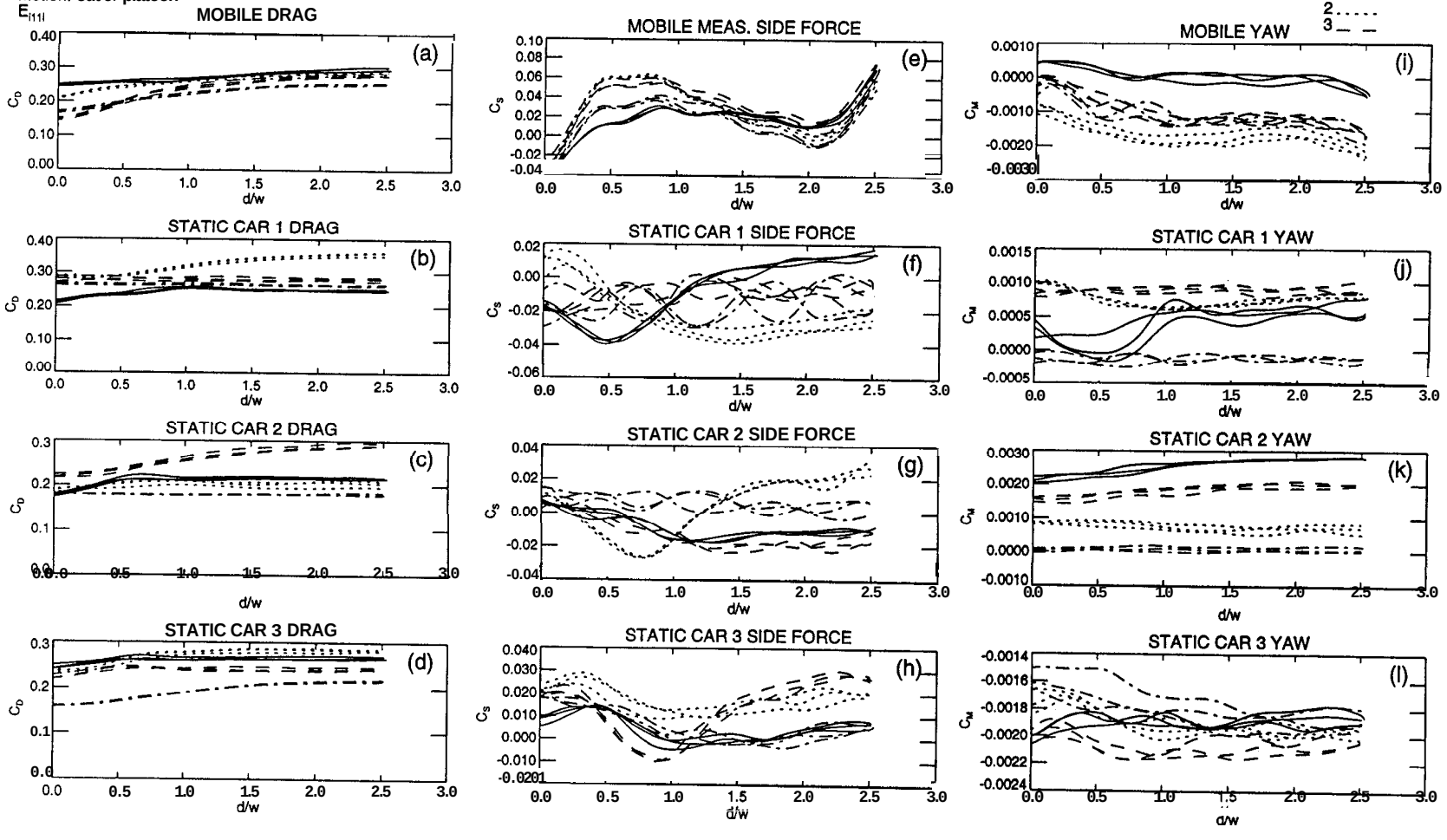
Chapter 4

Location Profiles - Cars

The drag, side force, and yawing moment coefficients measured on each of the **four** cars in a platoon during a simulated lane change are shown in the following figures. One of the cars moves out **of** the platoon, and after a pause, returns into the platoon. The coefficients are plotted with respect to the nondimensional lateral displacement of the maneuvering car d/w, where the displacement d is scaled with the car width w. The measurements made during movement out **of** the platoon for one platoon configuration are shown first. The measurements made during movement into the platoon for the same configuration are shown in the next figure. This arrangement of the figures for motion out of the platoon and into the platoon is used for **all** of the platoon configurations. Each figure represents one of the three possible inter-vehicle spacings in the platoon and one acceleration profile used by the maneuvering car. The different linetypes in each figure represent the four possible locations of the mobile car. The three experimental runs performed with each platoon configuration are shown.

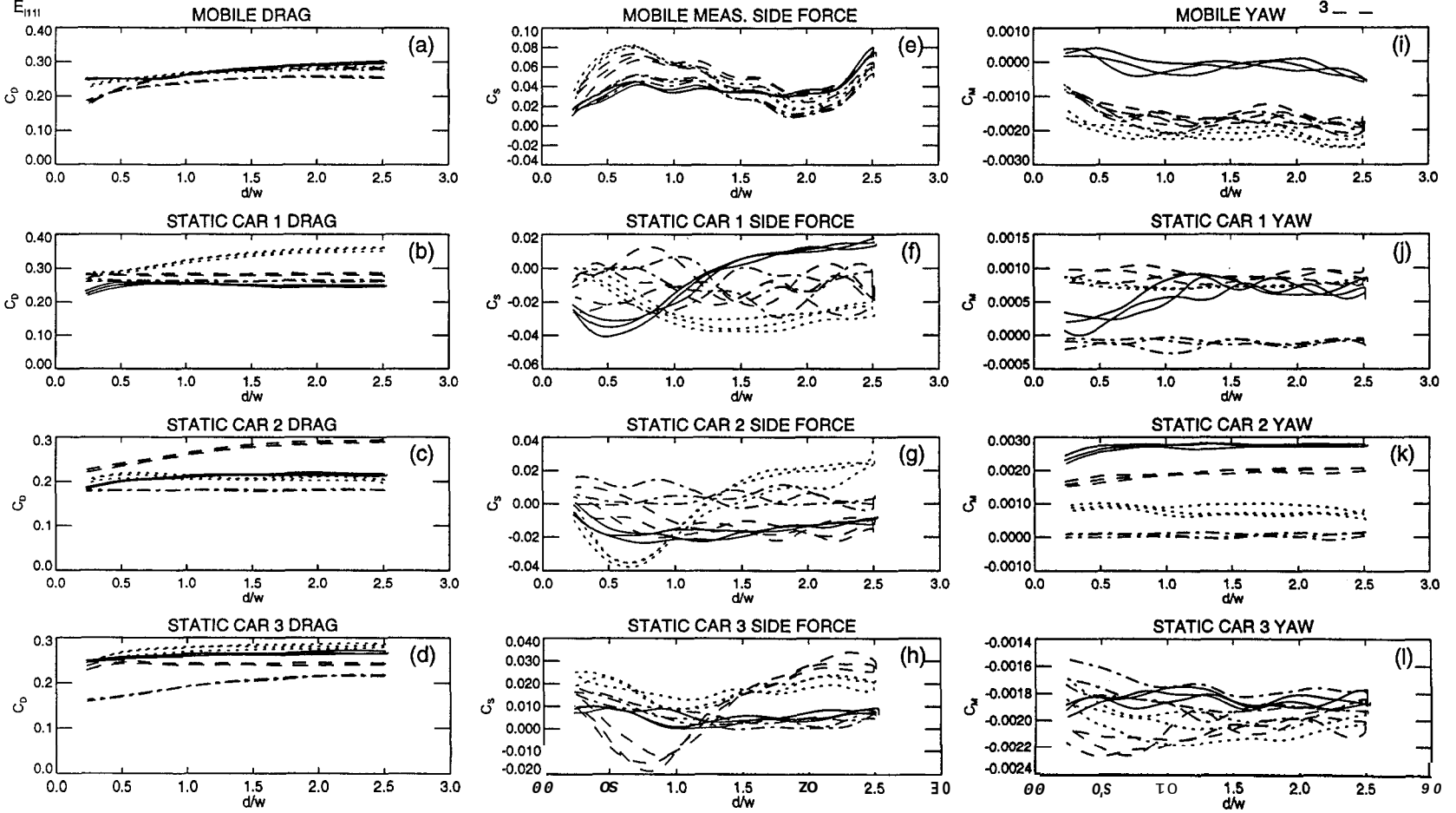
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of platoon

moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —



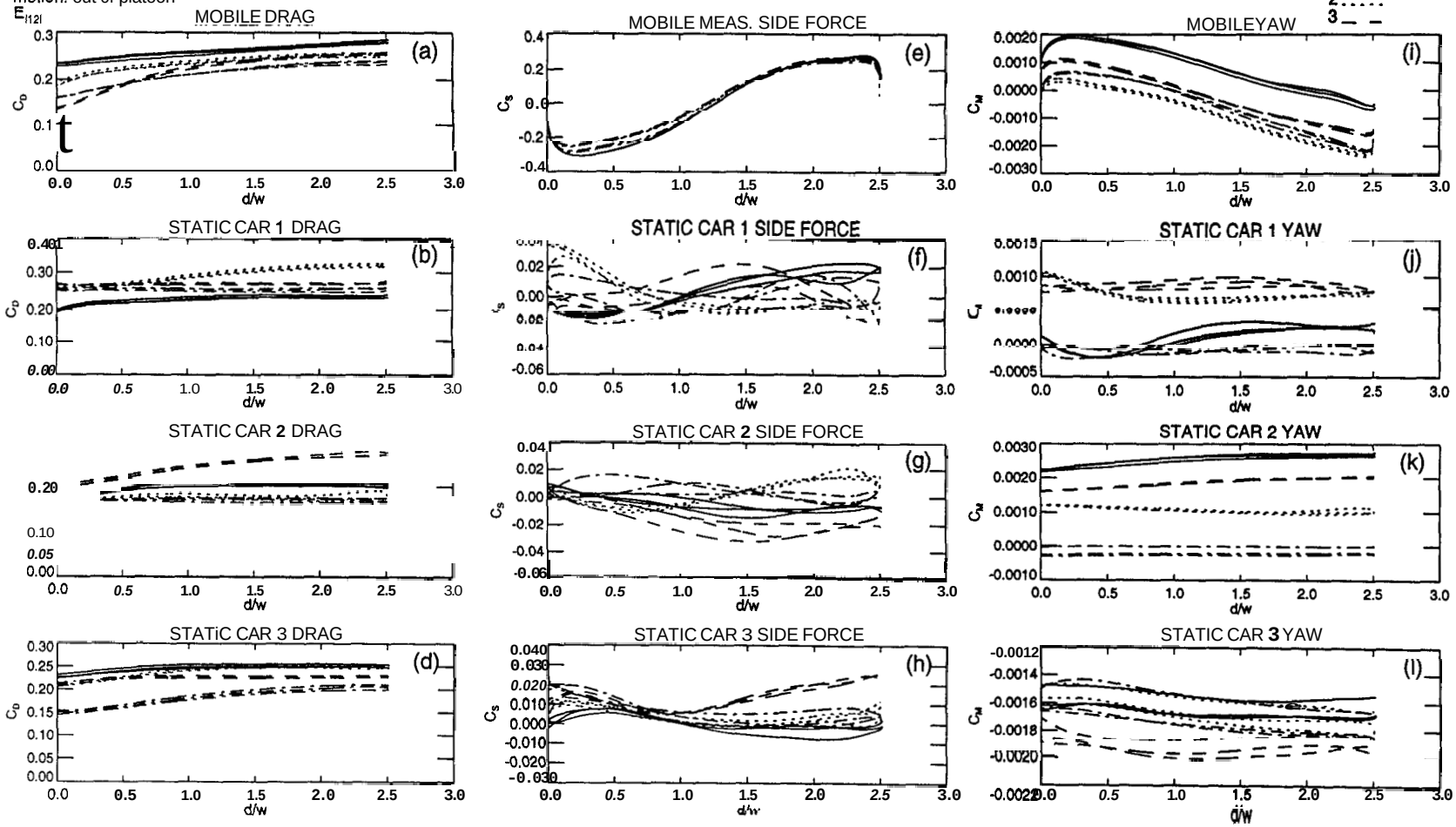
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: into platoon
E_{1111}

moving car position:
1 ——— 4 — - —
2 - - - - -
3 — —



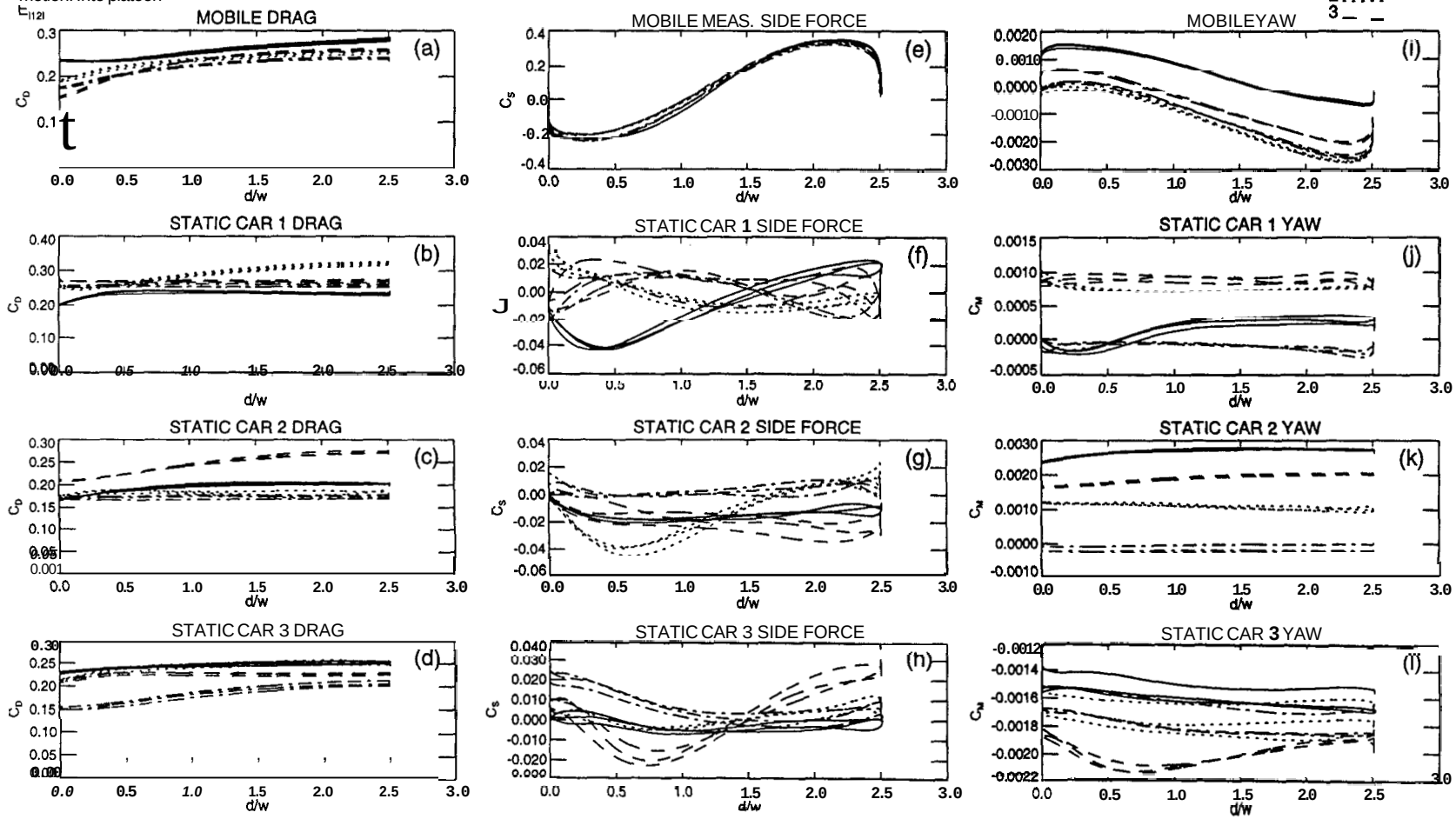
separation: 1(0.2l , 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon

moving car position:
1 —— 4 – · –
2 · · · · ·
3 – – –



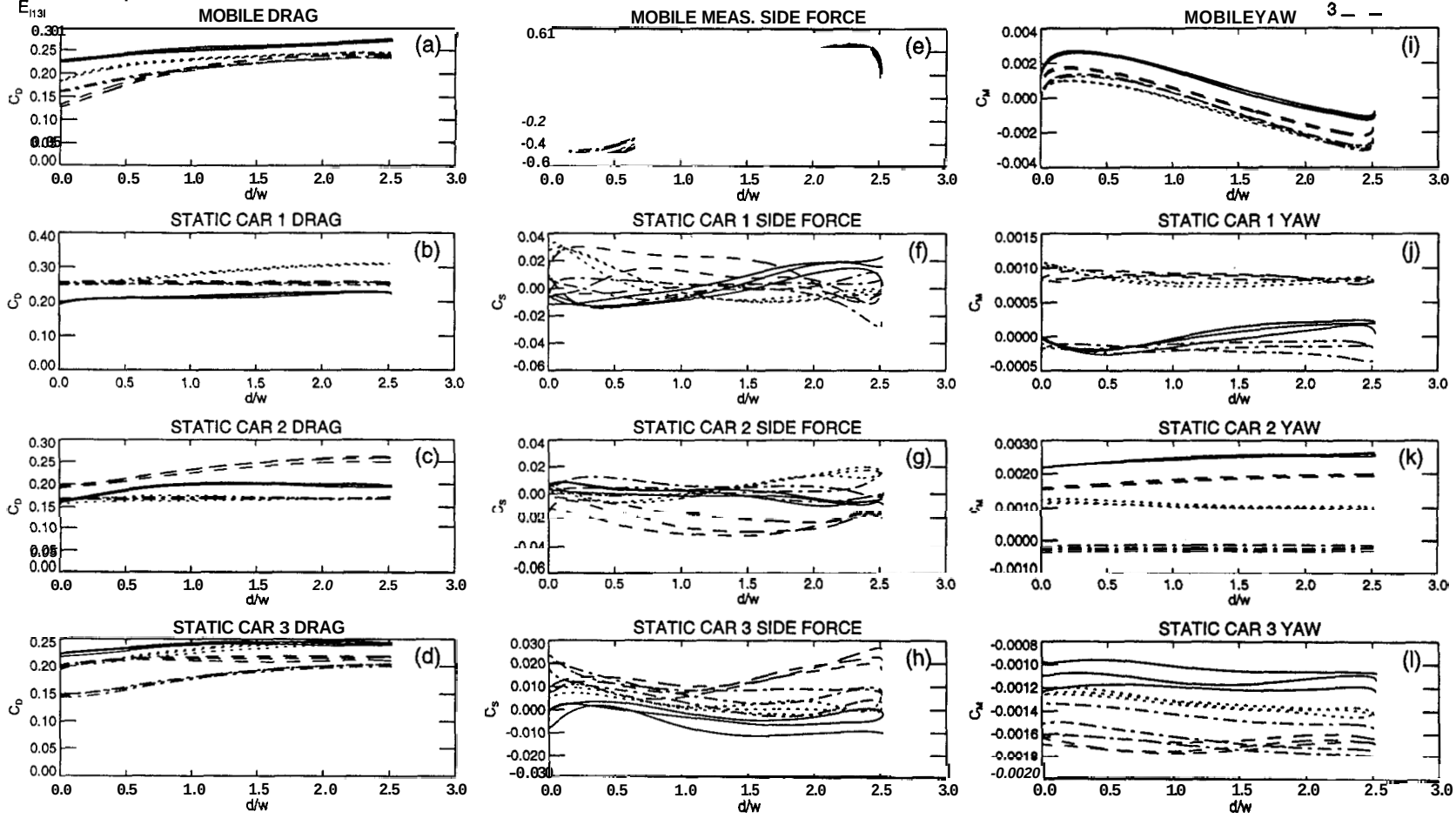
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: Into platoon

moving car position:
1 ——— 4 — · —
2 ·····
3 — —



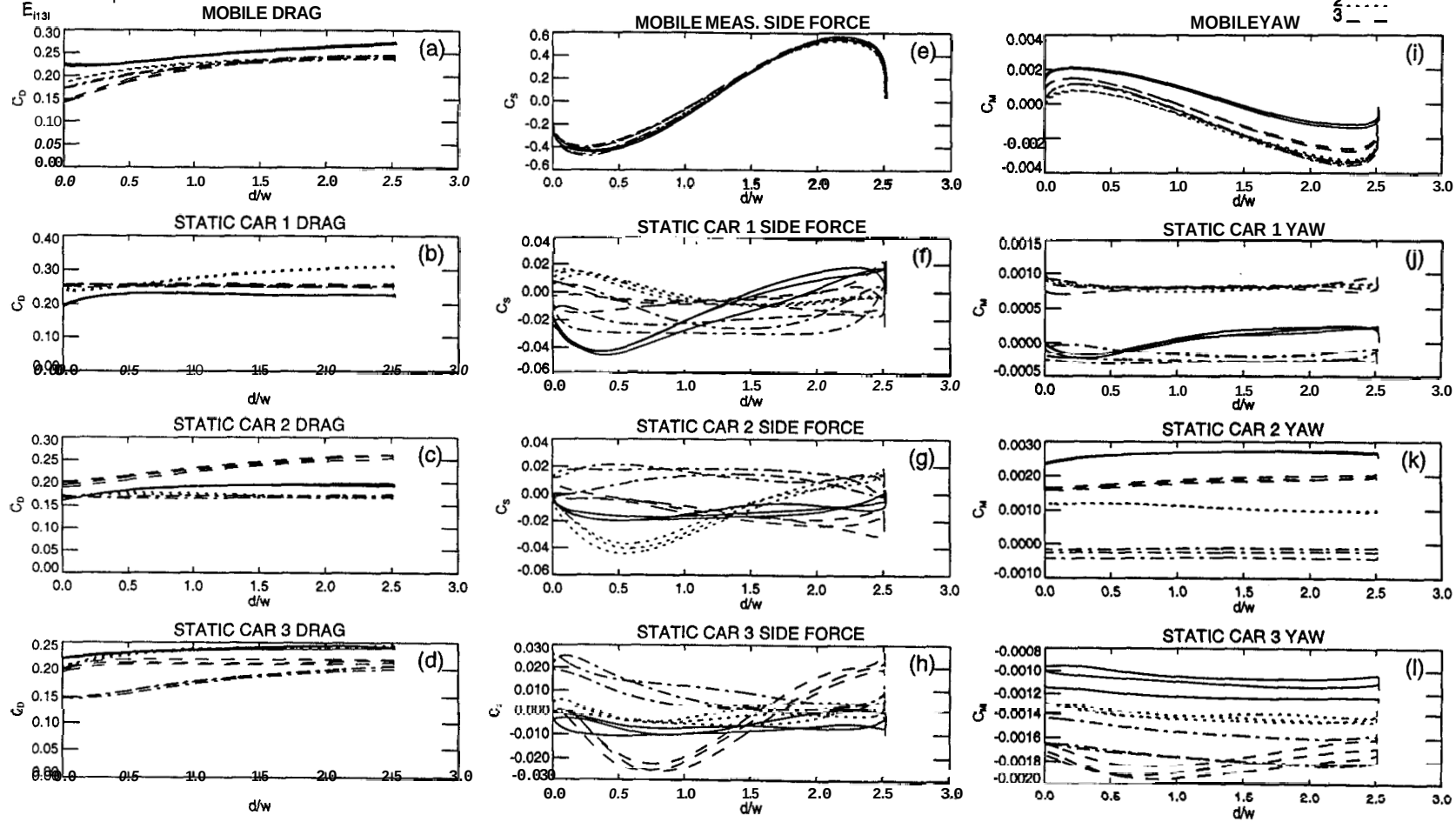
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: out of platoon
E_{i13l}

moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —



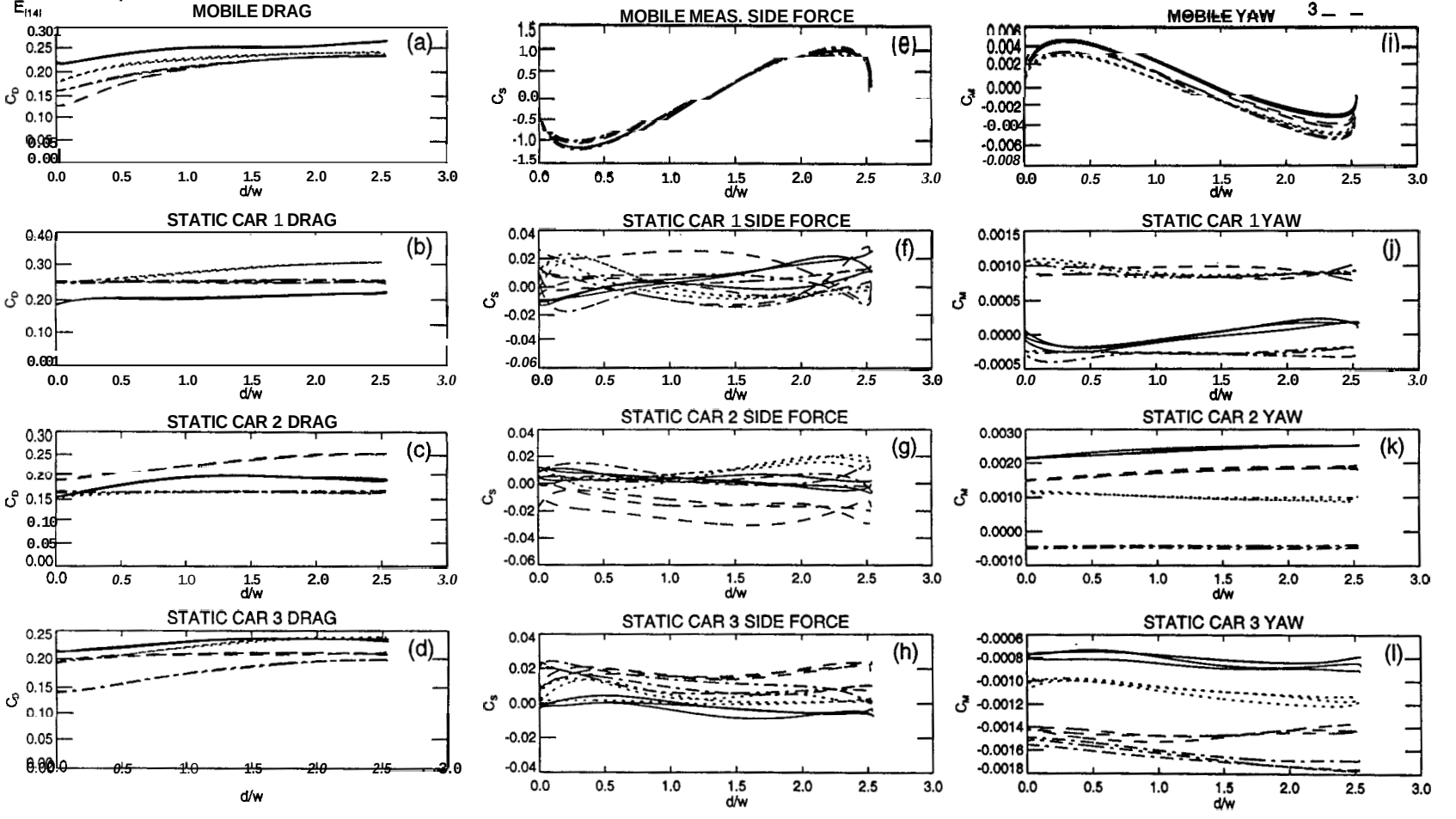
separation: 1(0.2l , 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: into platoon

moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —



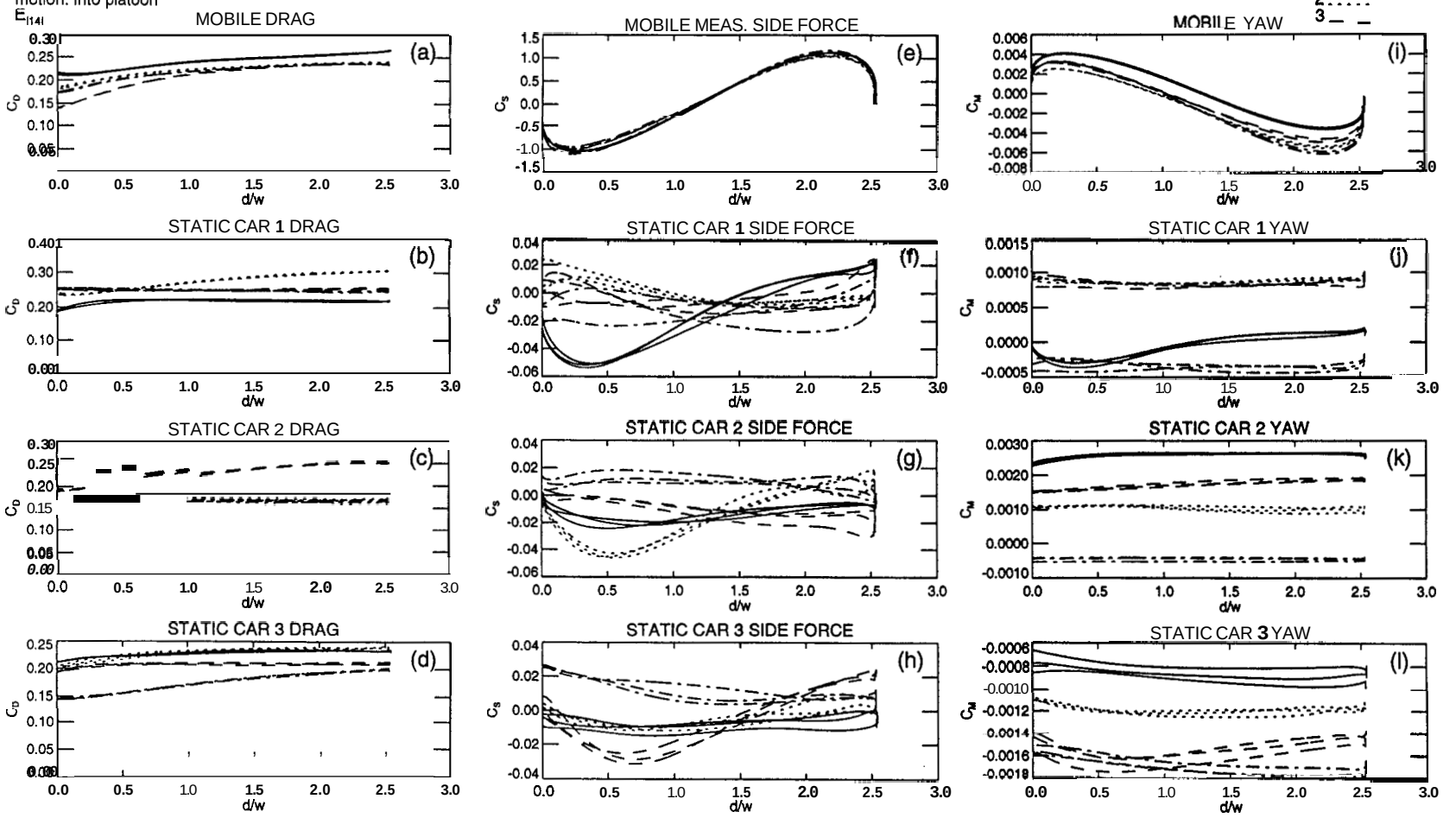
separation: 1(0.2l 2(0.4l), 3(l) = 1
acceleration profik: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: out of platoon

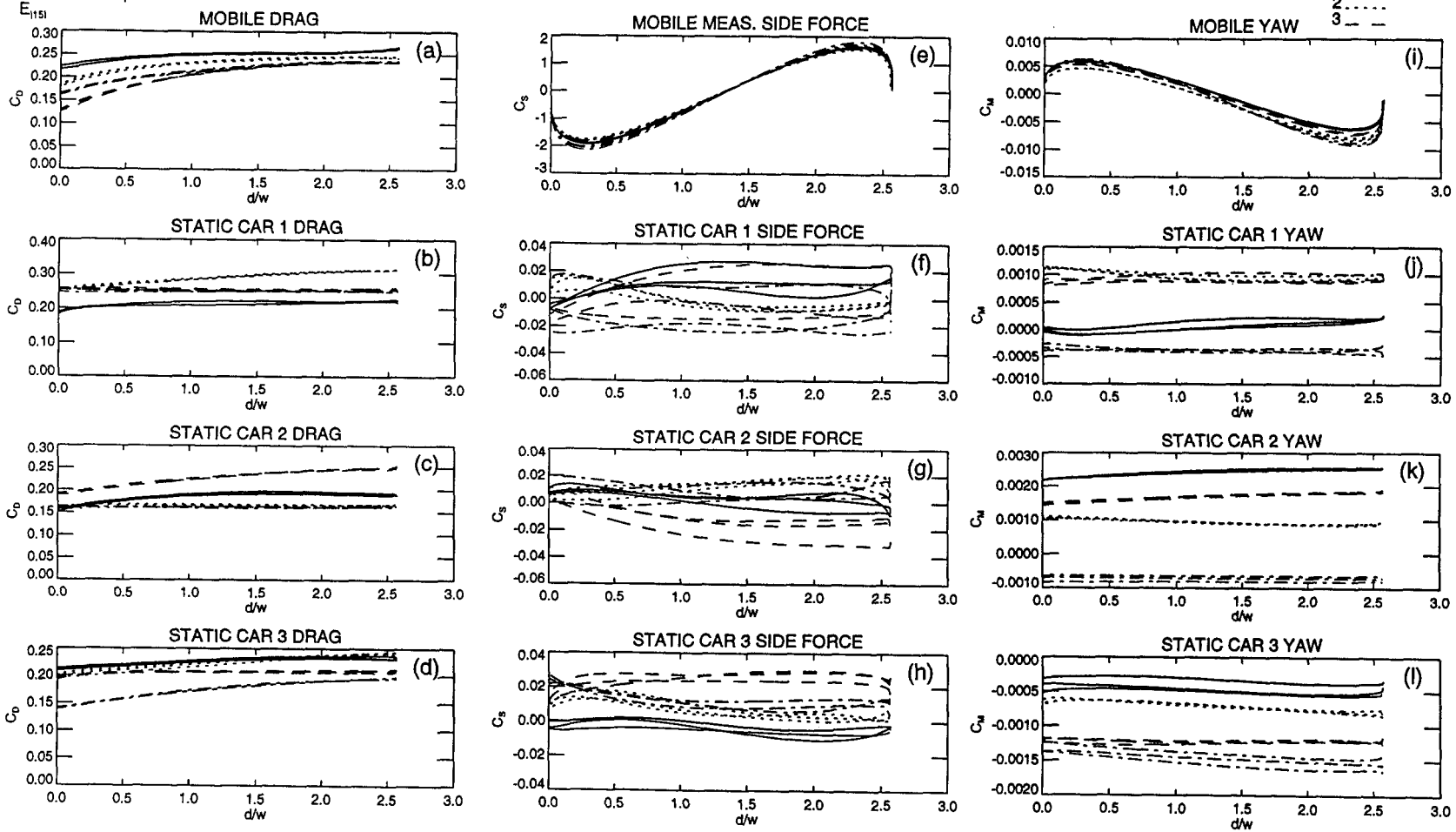
moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — — —



separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon
E_{i14l}

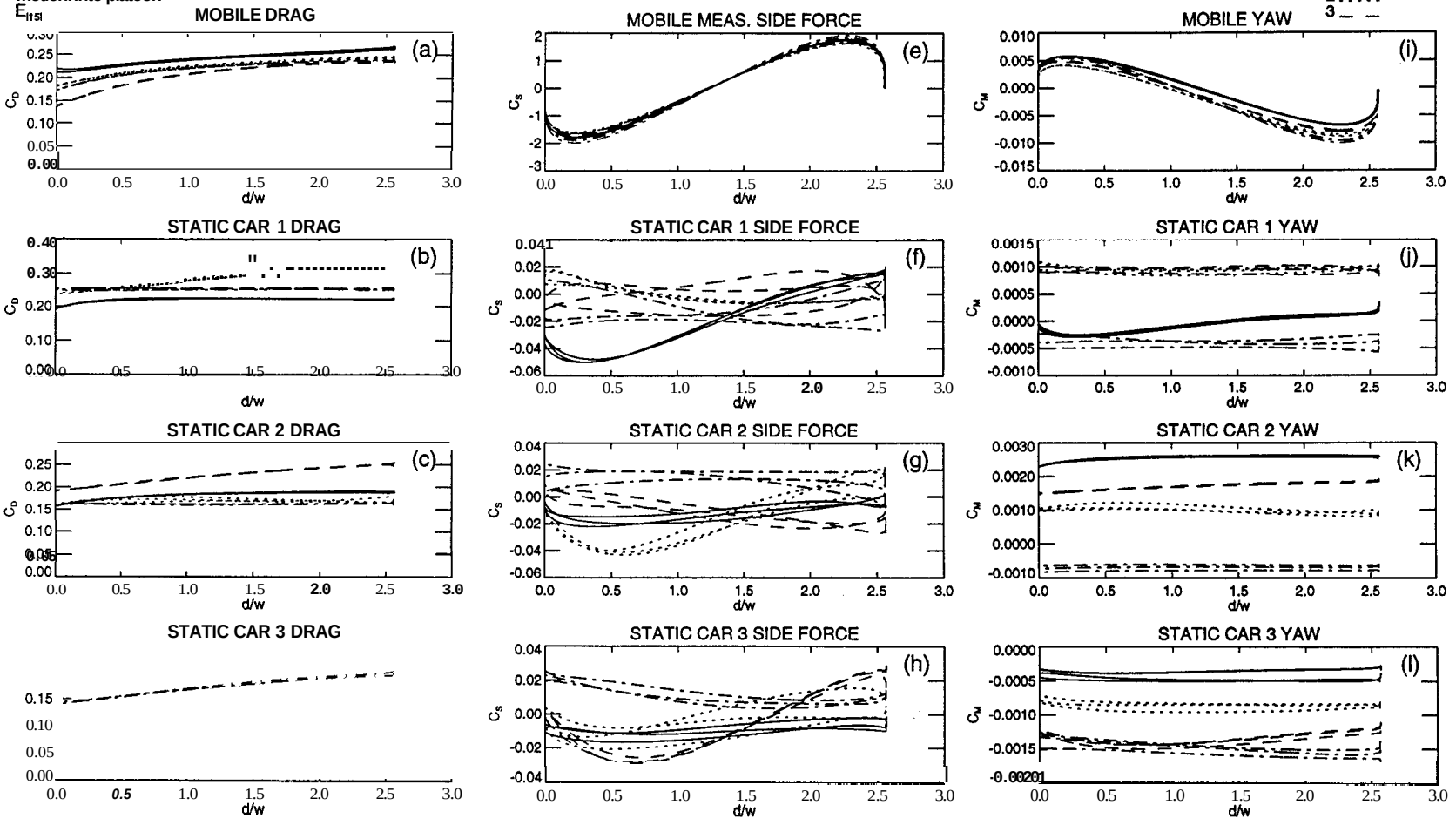
moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — —




separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: out of platoon
E_l15l
moving car position:
1
2
3
4
MOBILE DRAG
(a)
STATIC CAR 1 DRAG
(b)
STATIC CAR 2 DRAG
(c)
STATIC CAR 3 DRAG
(d)
MOBILE MEAS. SIDE FORCE
(e)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 3 SIDE FORCE
(h)
MOBILE YAW
(i)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

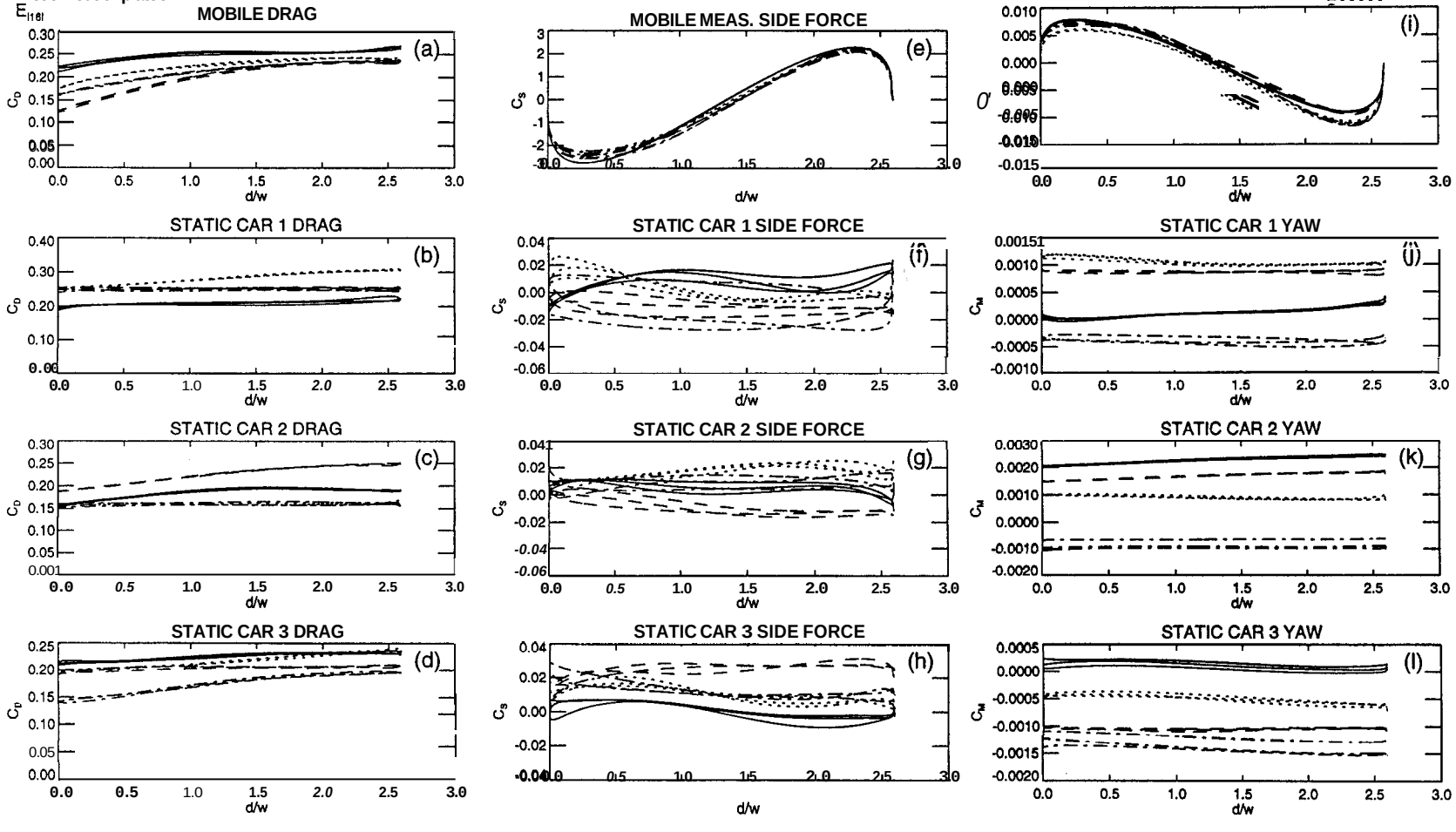
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: Into platoon

moving car position:
1 —— 4 — · —
2 · · · · ·
3 — — —



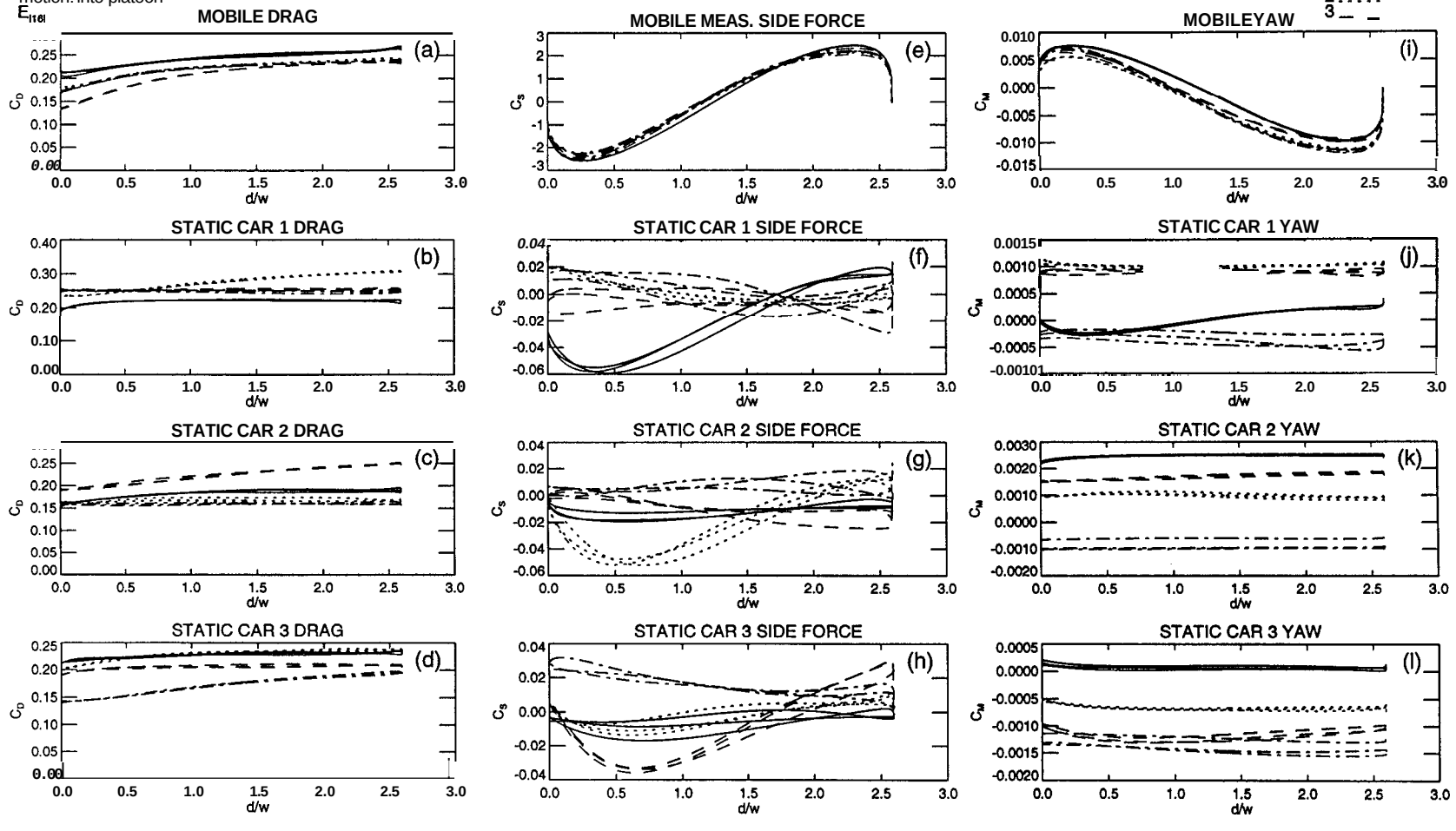
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$) = 6
motion: out of platoon

moving car position:
1 —— 4 — · —
2 · · · · ·



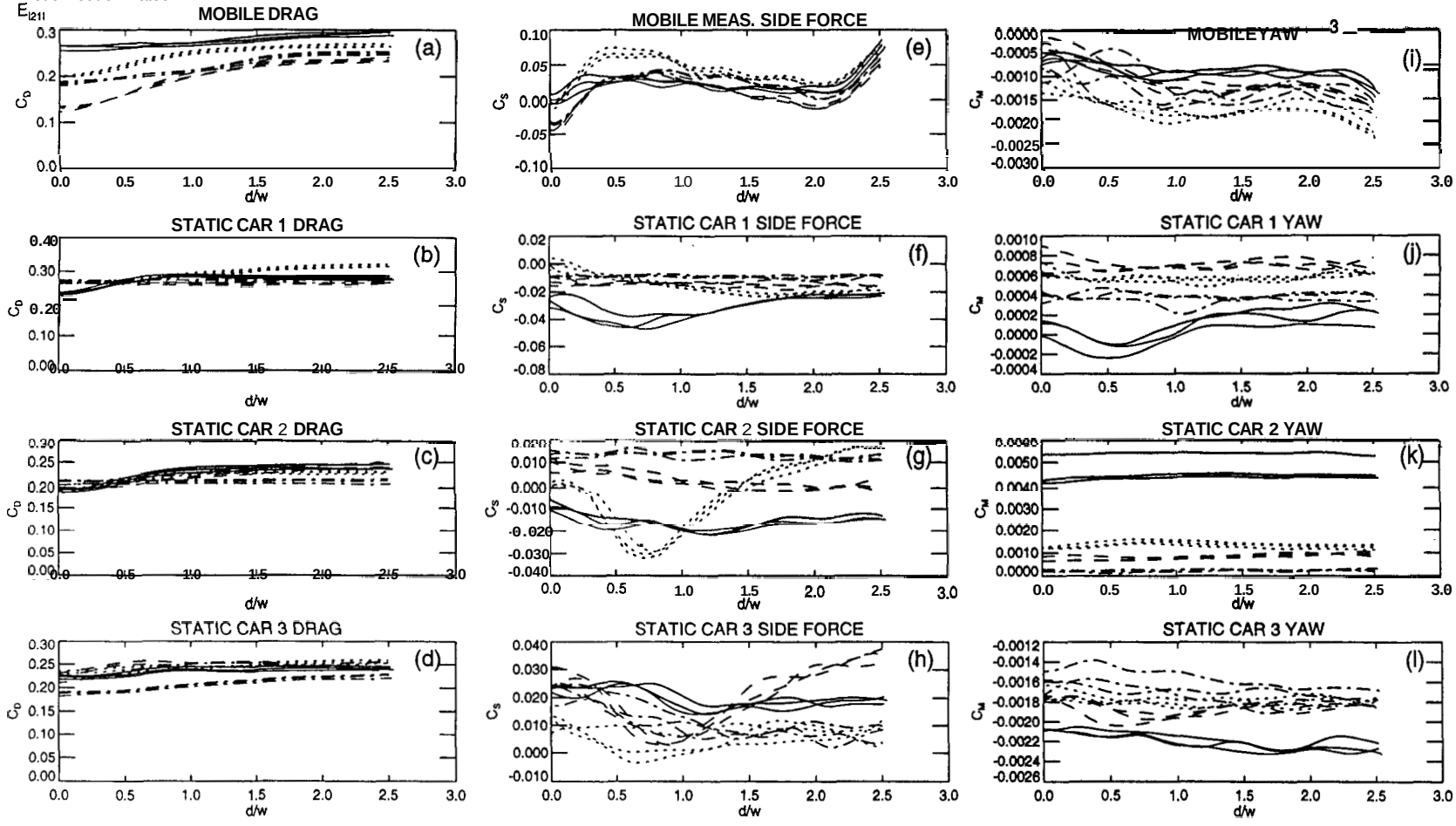
separation: 1(0.2l), 2(0.4l), 3(l) = 1
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: into platoon

moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — — —



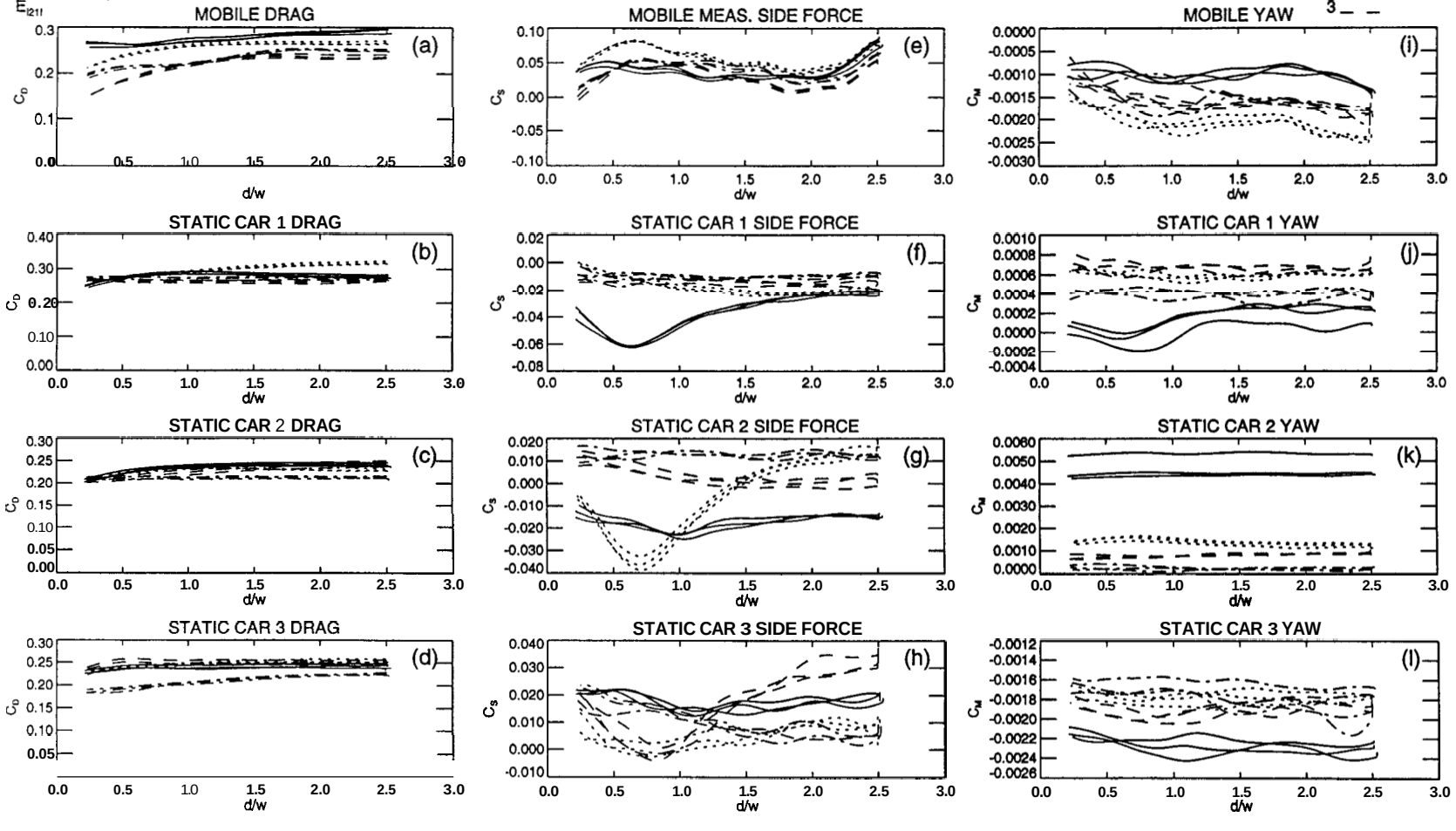
separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of Dlatoon

moving car position:
1 —— 4 — · —
2 · · · · ·
3 ——



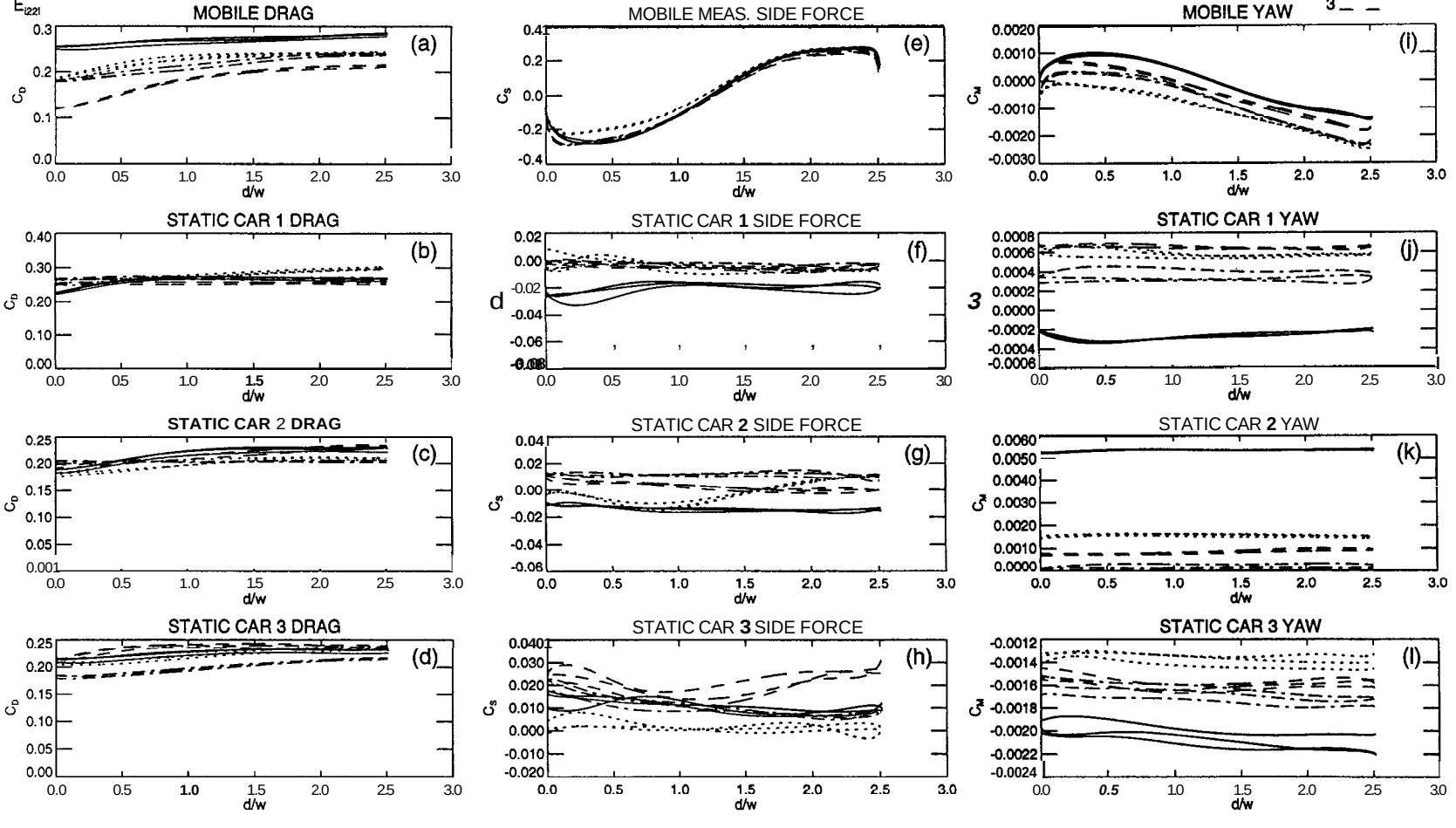
separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: into platoon

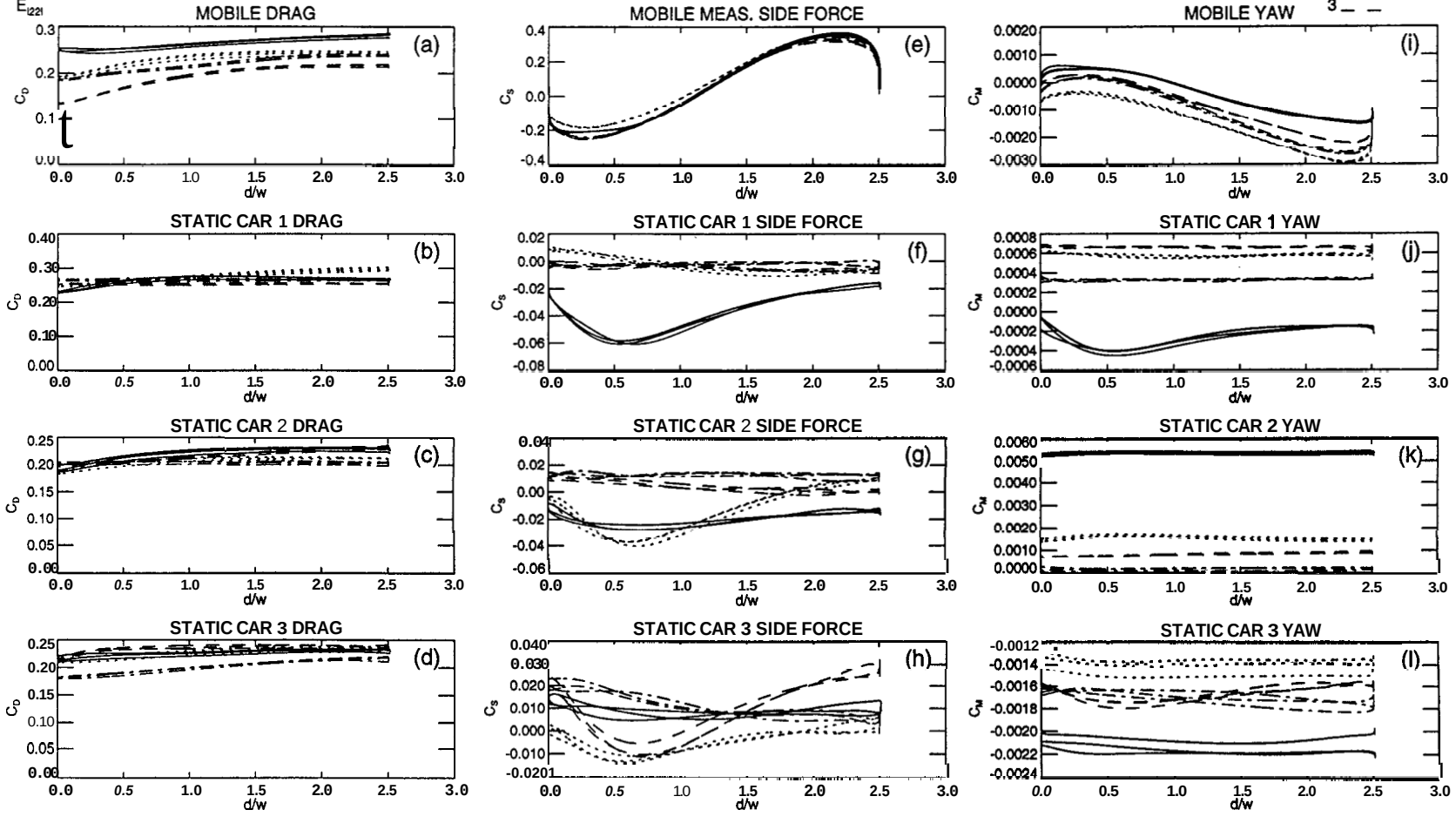
moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — —



separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon

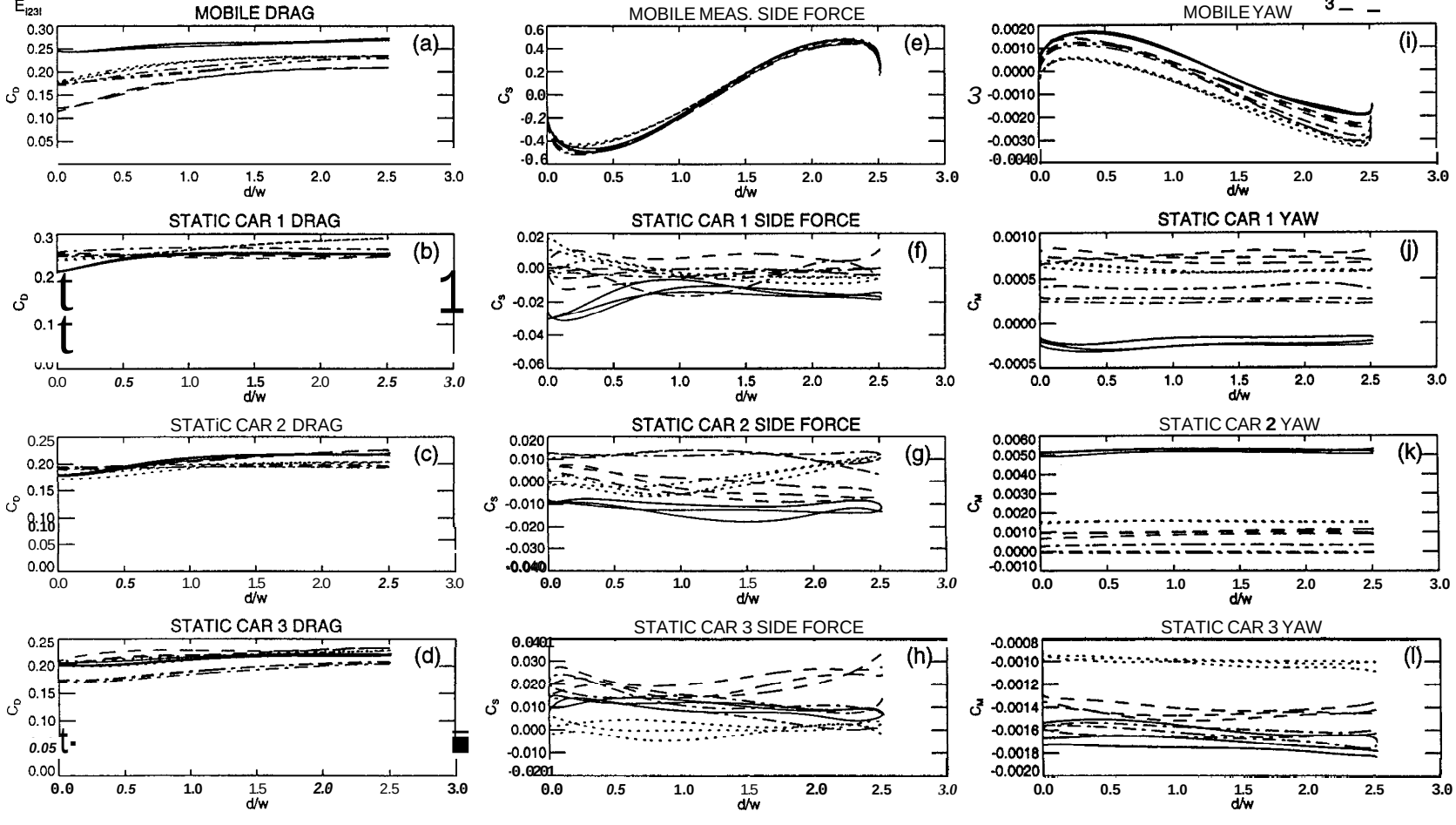
moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —

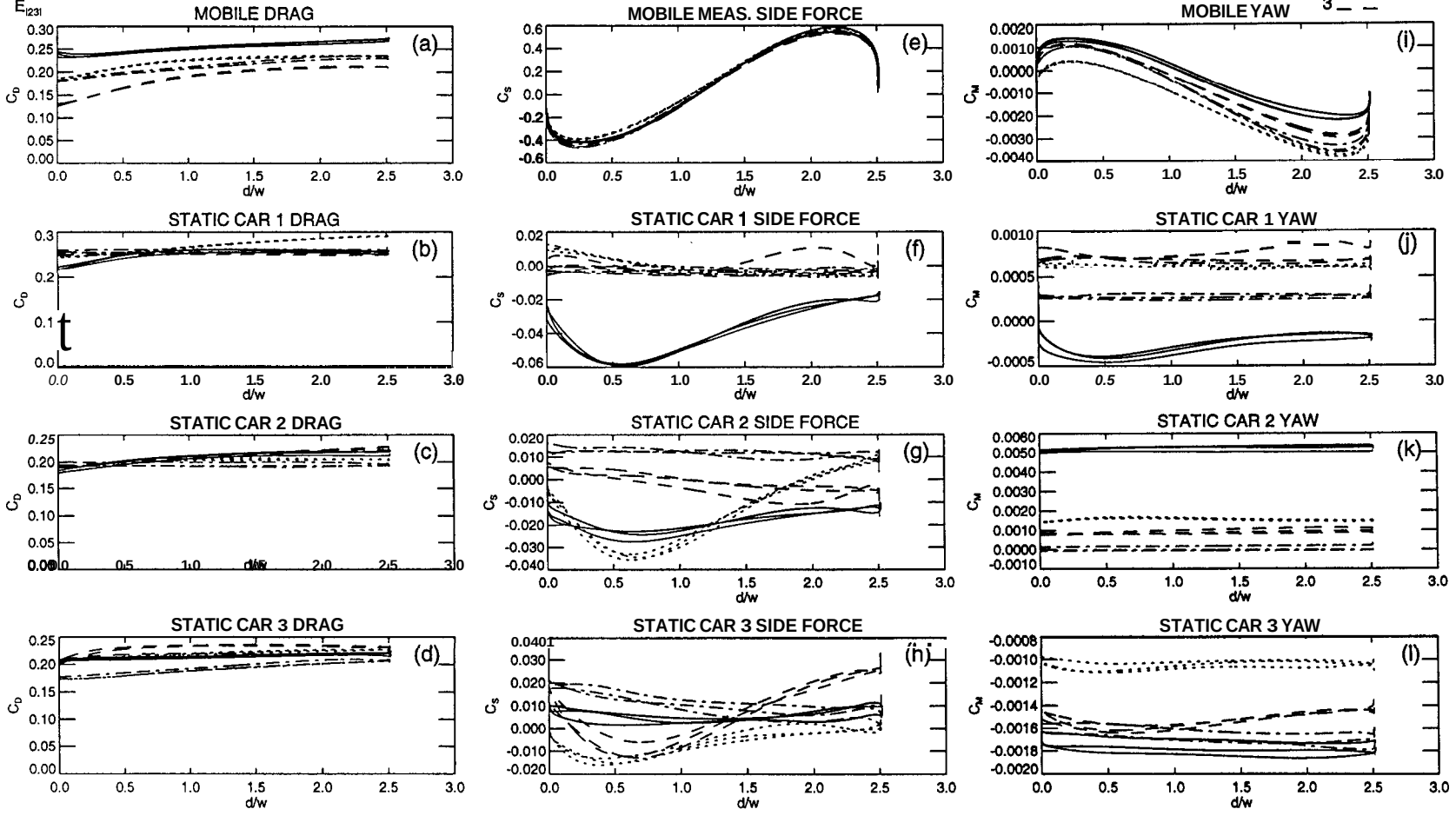


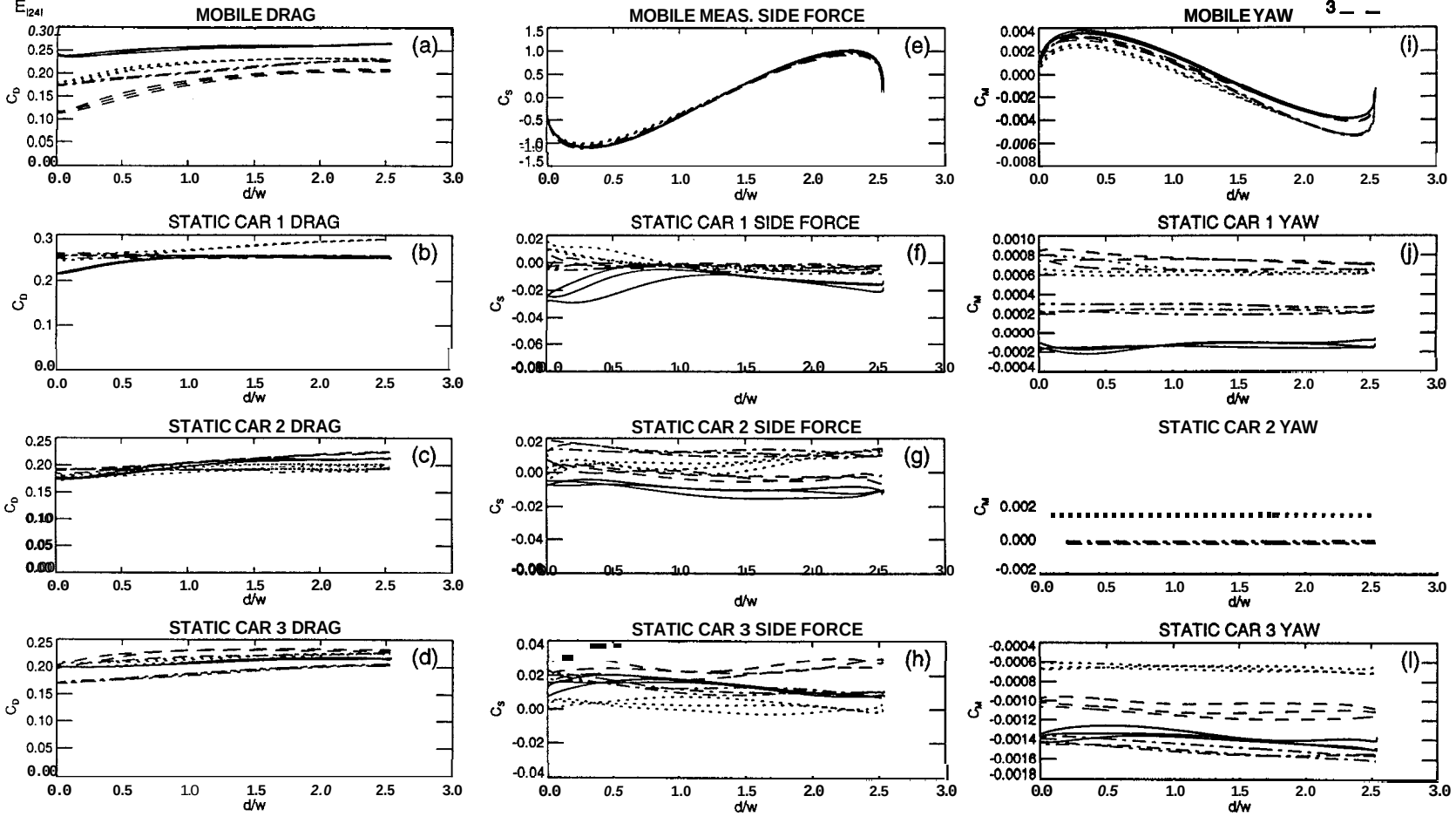

separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d) = 2
motion: into platoon
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: out of platoon
E_{l23l}

moving car position: 1 2 3 4

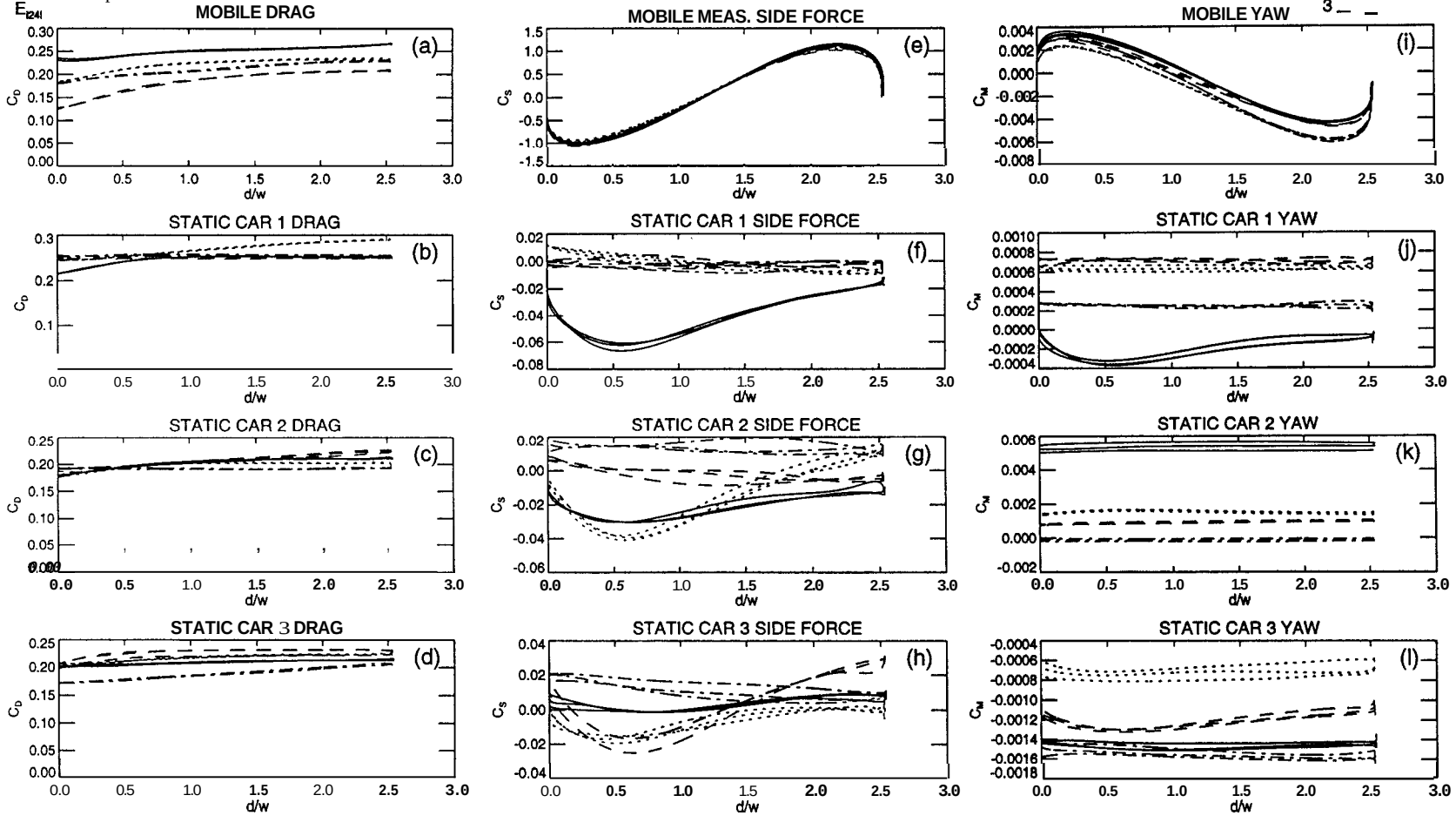



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 3
motion: into platoon
E_i231
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w


separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 4
motion: out of platoon
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

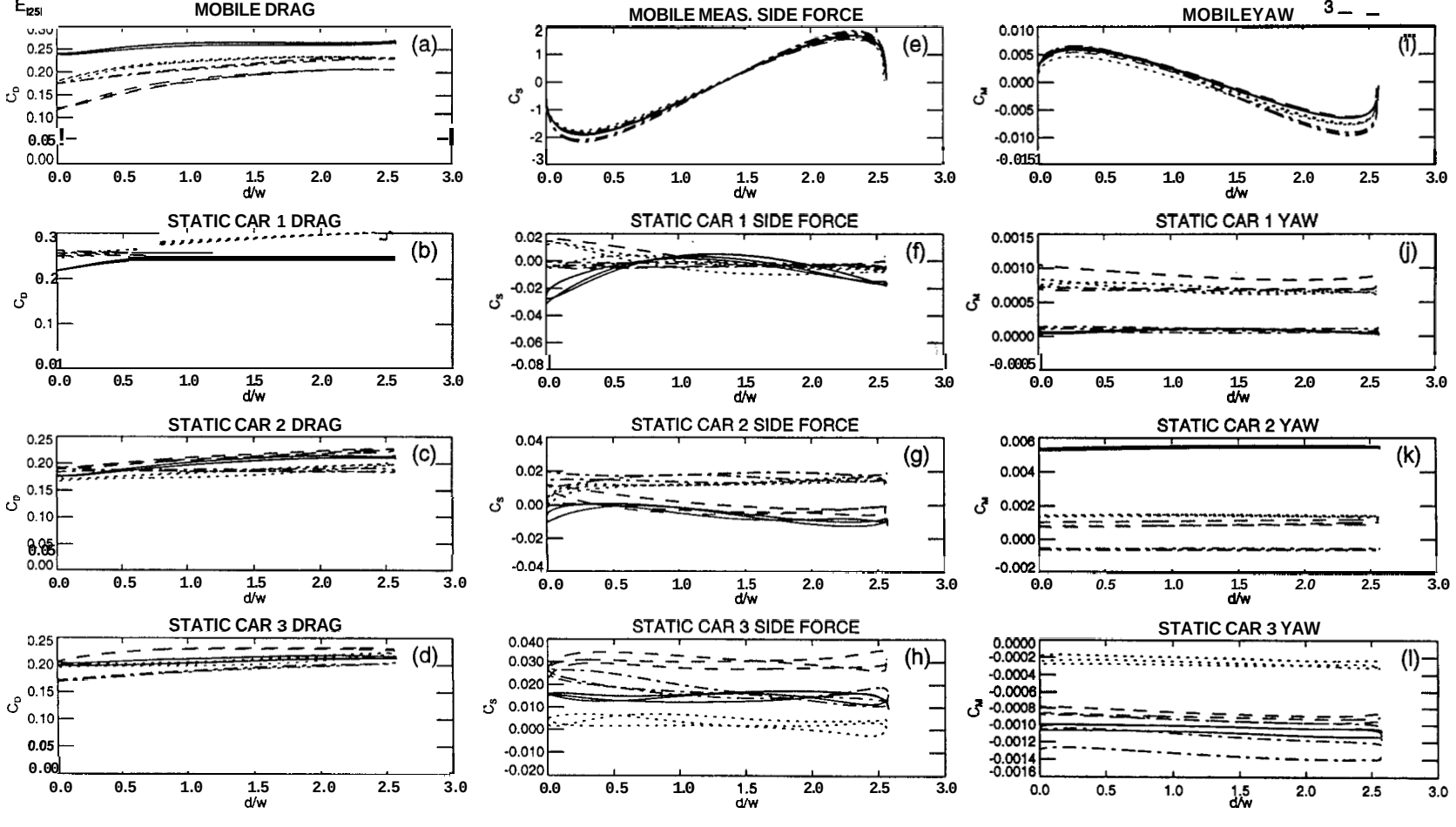
separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon

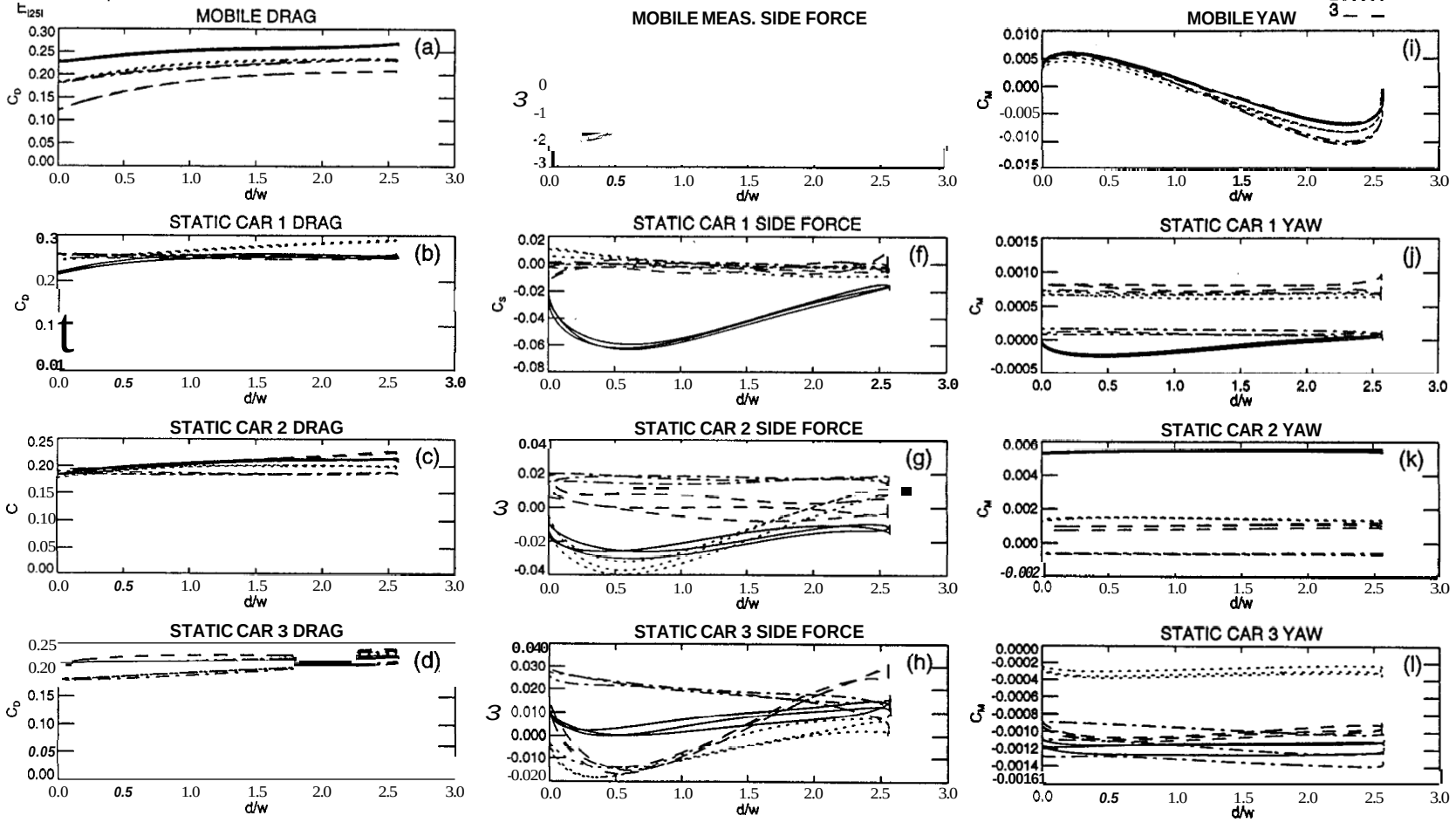
moving car position: 1 —— 4 — · — 2 ····· 3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: out of platoon

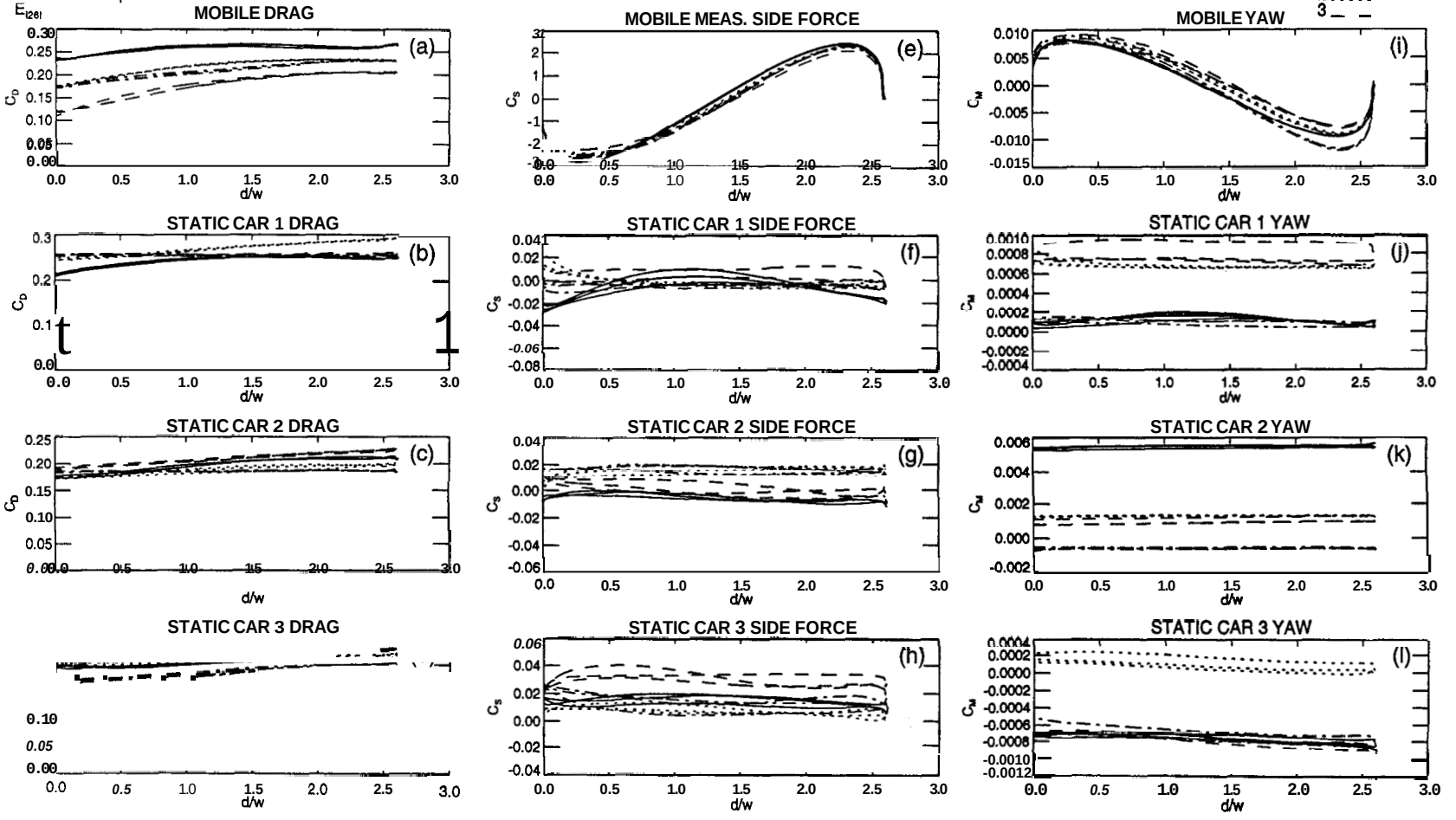
moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — — —

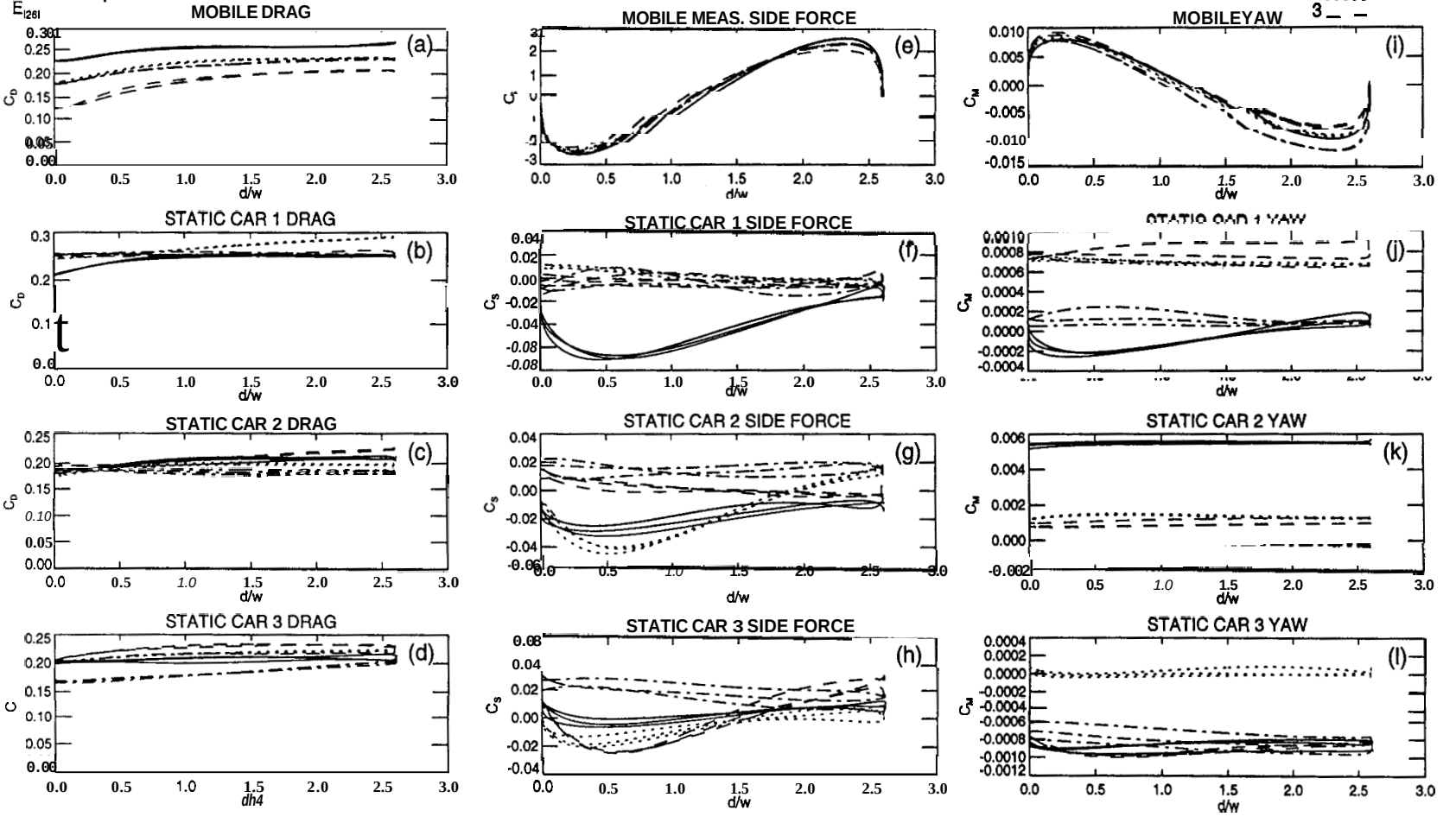



separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: into platoon
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
d/w

separation: i(0.21 , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: out of platoon

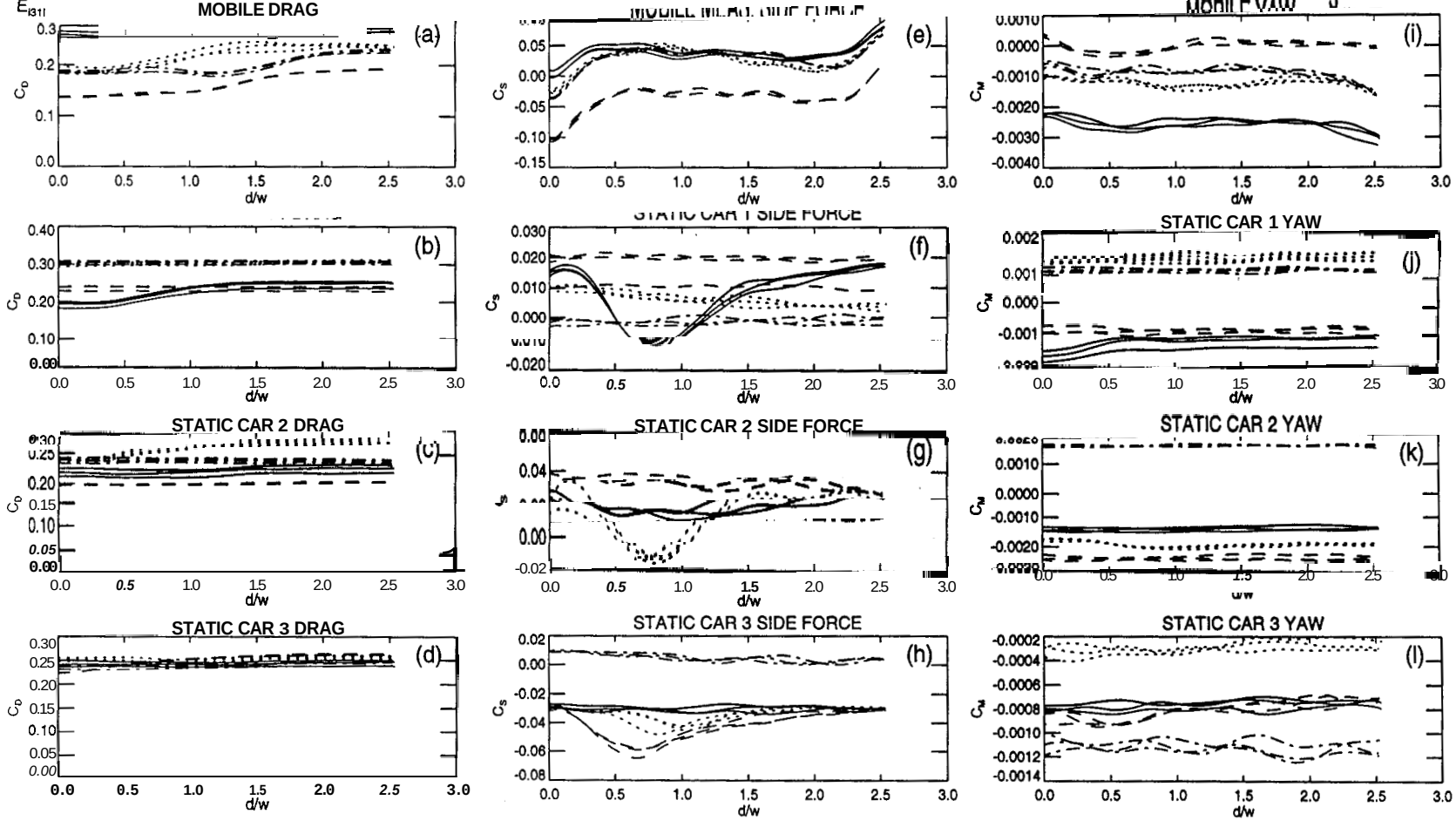
moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —




separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: Into platoon
moving car position:
MOBILE DRAG
MOBILE MEAS. SIDE FORCE
MOBILEYAW
STATIC CAR 1 DRAG
STATIC CAR 1 SIDE FORCE
STATIC CAR 2 DRAG
STATIC CAR 2 SIDE FORCE
STATIC CAR 2 YAW
STATIC CAR 3 DRAG
STATIC CAR 3 SIDE FORCE
STATIC CAR 3 YAW
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
d/w
dh4

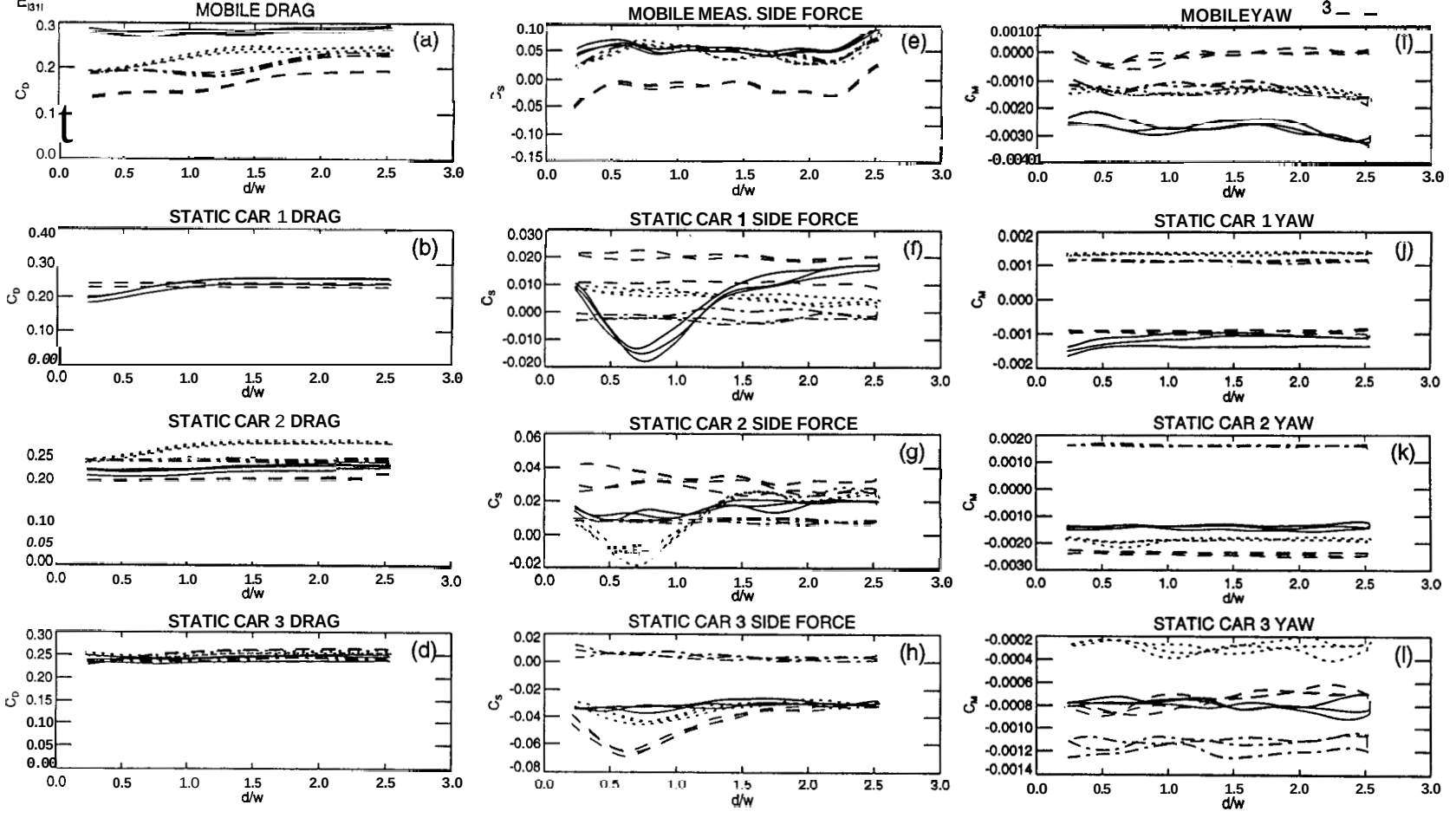
separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$) = 1
motion: out of platoon

moving car position: 1 2 4



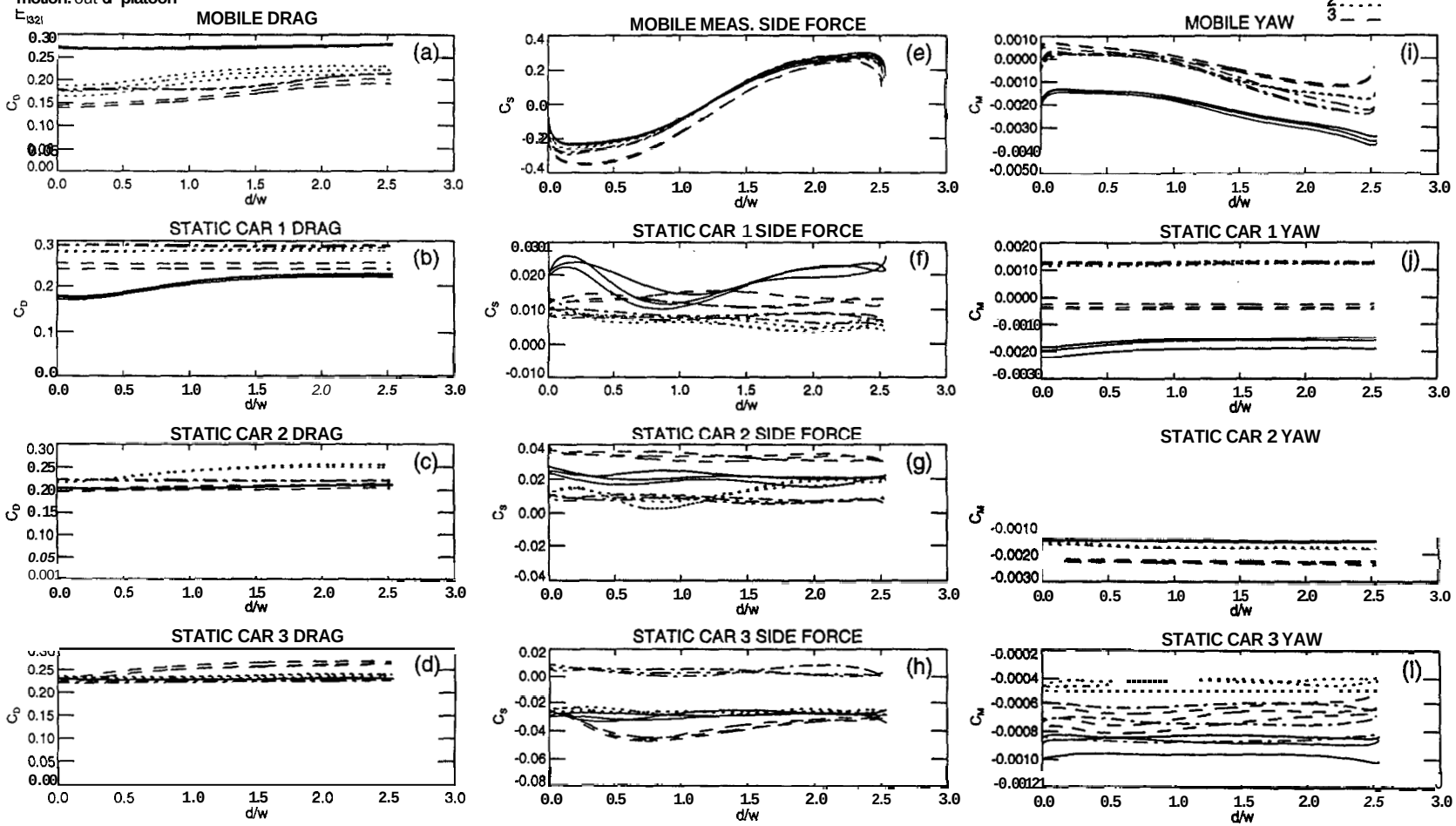
separation: 1(0.2l , 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motton: Into platoon
E_{131}

moving car position:
1 ——— 4 — · —
2 · · · · ·
3 — —



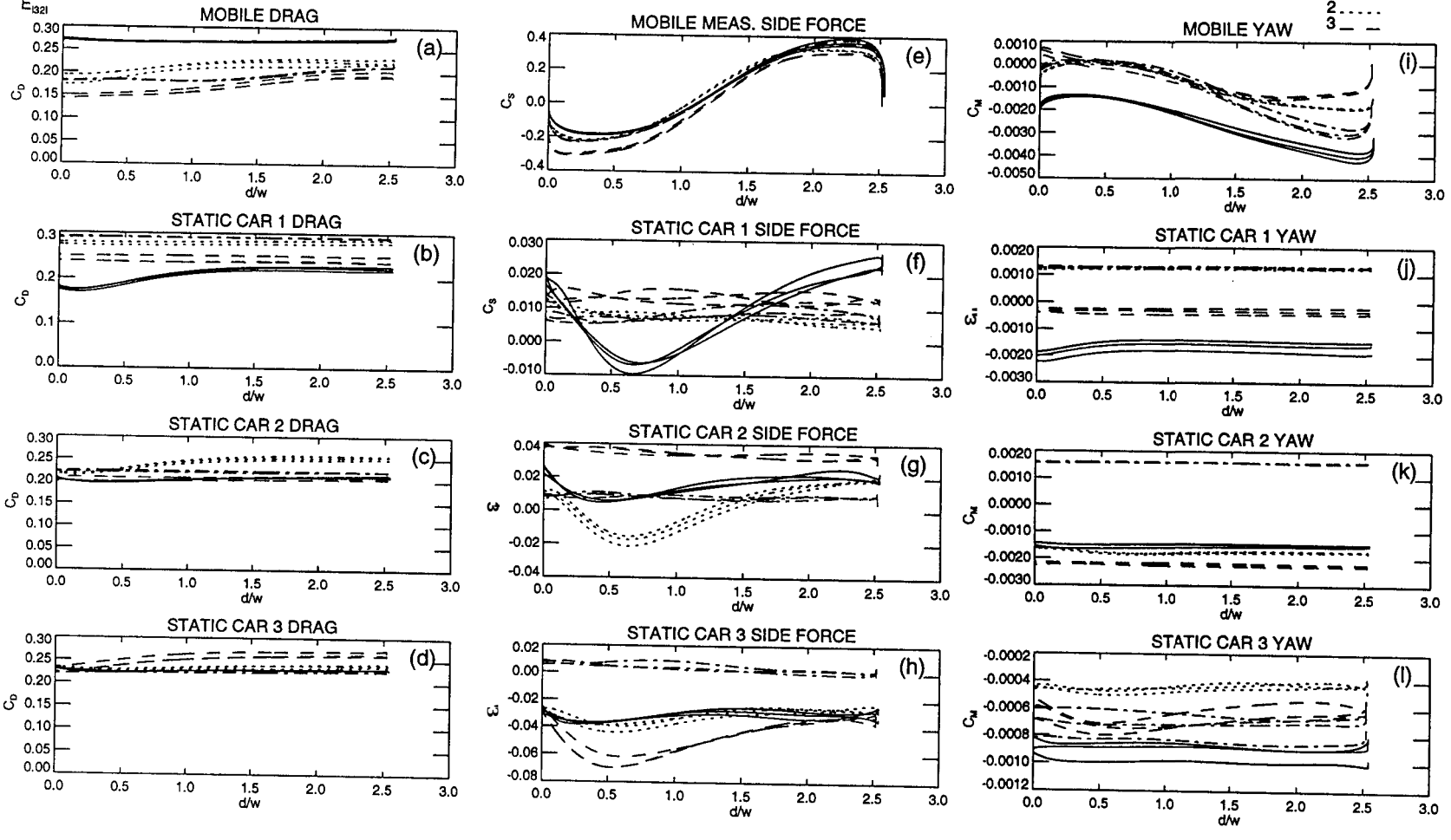
separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of platoon

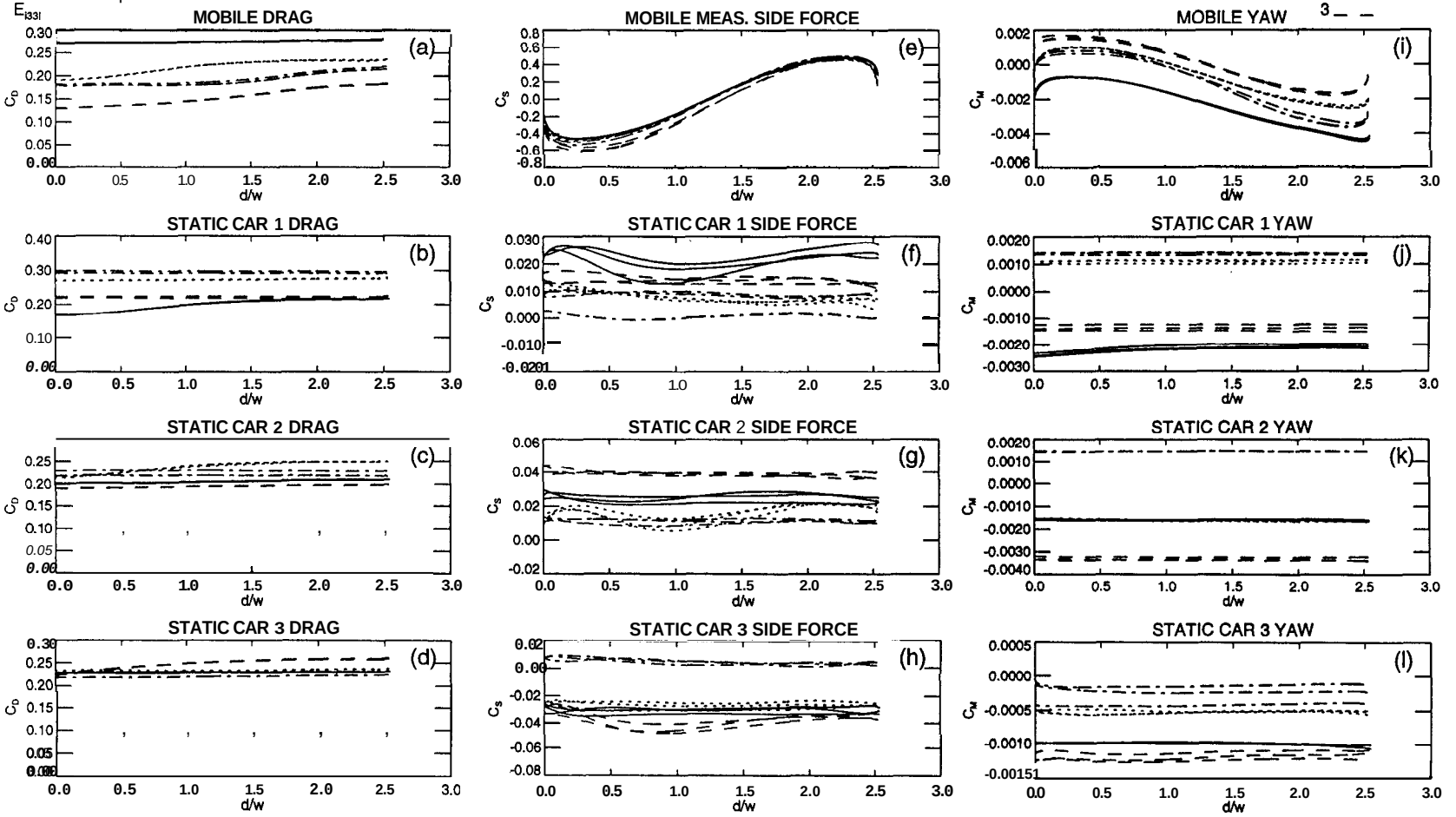
moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6(0. 2
motion: into platoon
E_{132l}

moving car position:
1 —— 4 — · —
2 ·····
3 — —

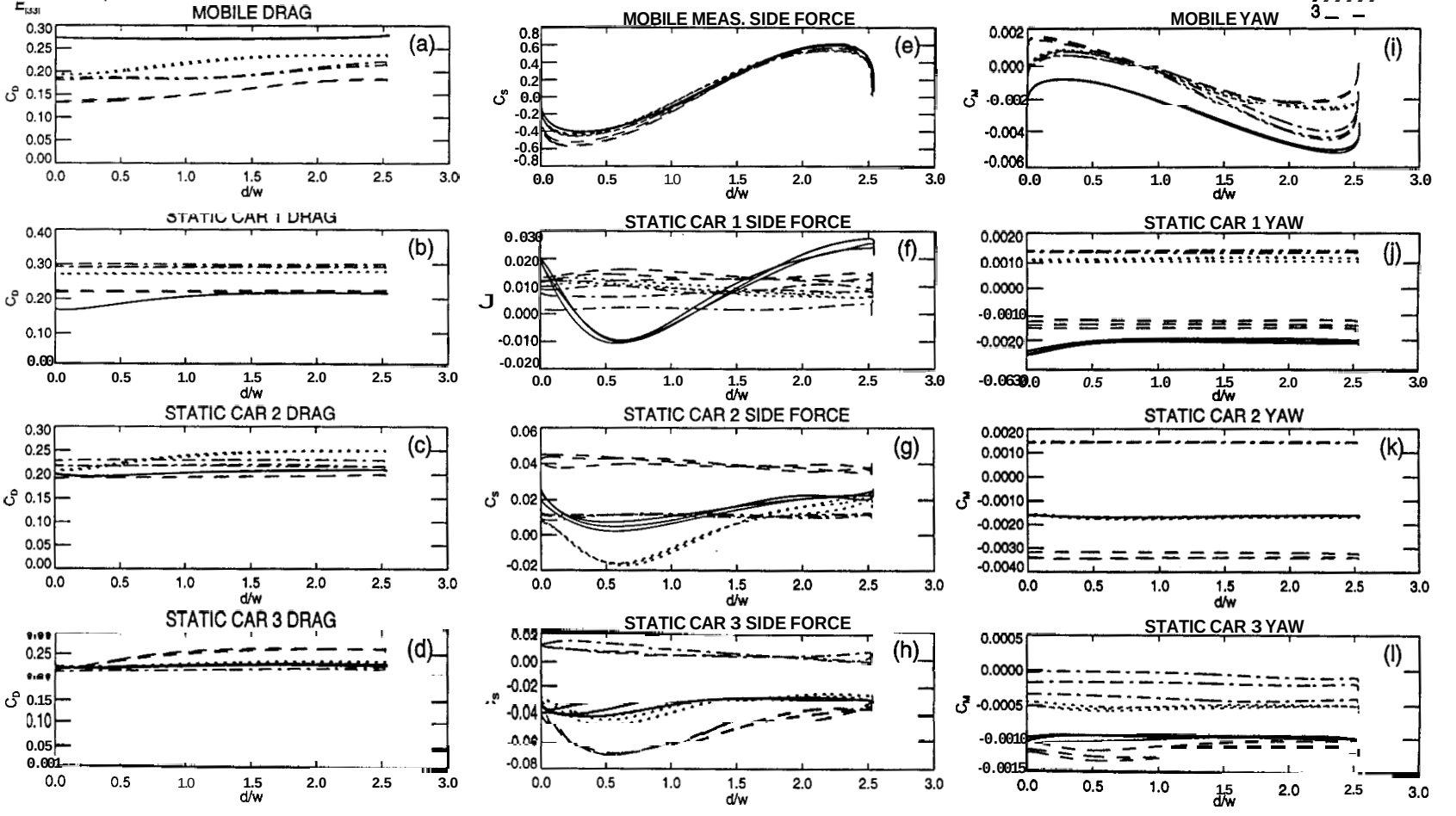


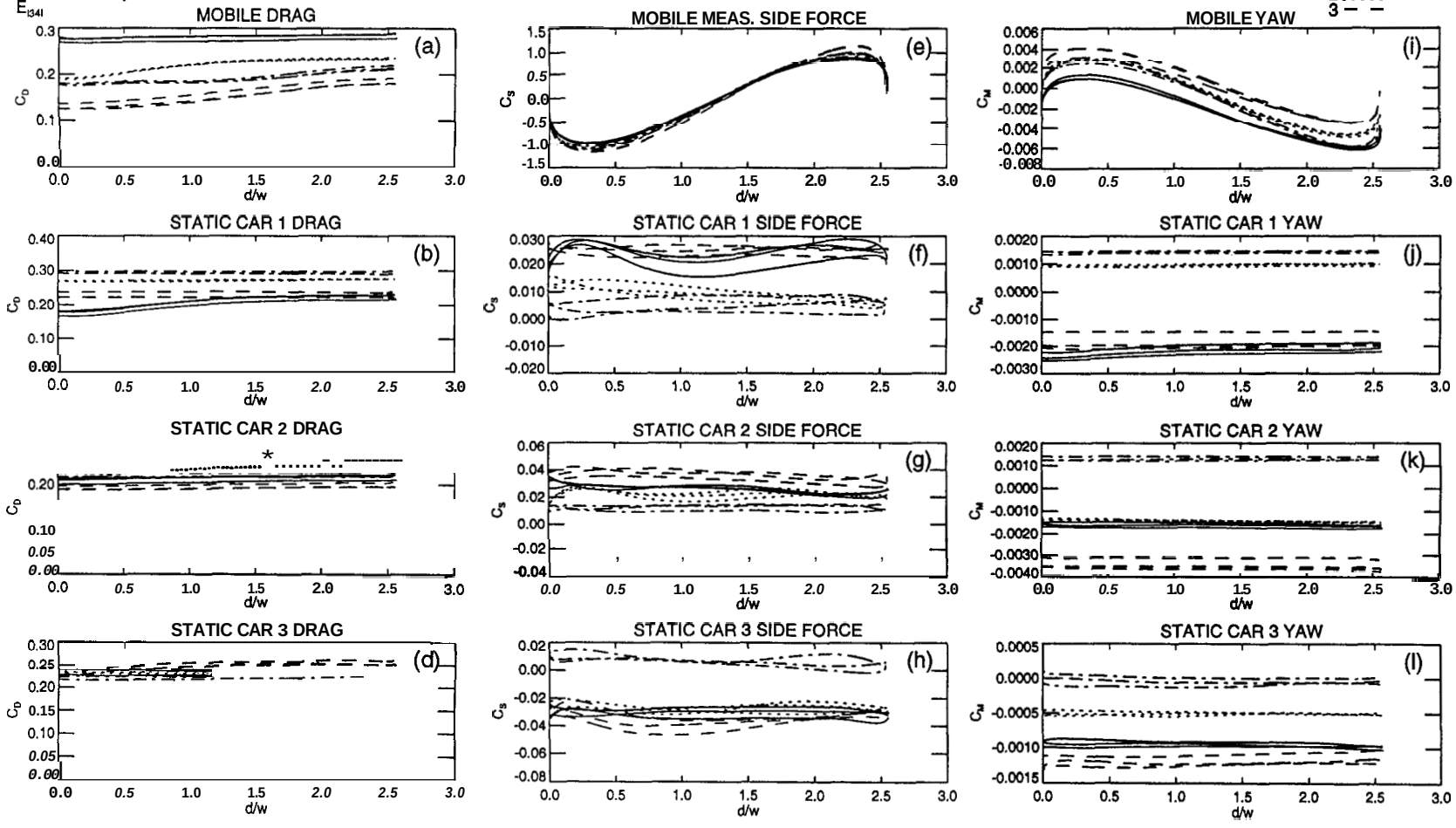

separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 3
motion: out of platoon
E_i33l
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

separation: 1(0.2l), 2(0.4l), 3(l) = 3

motion: into platoon

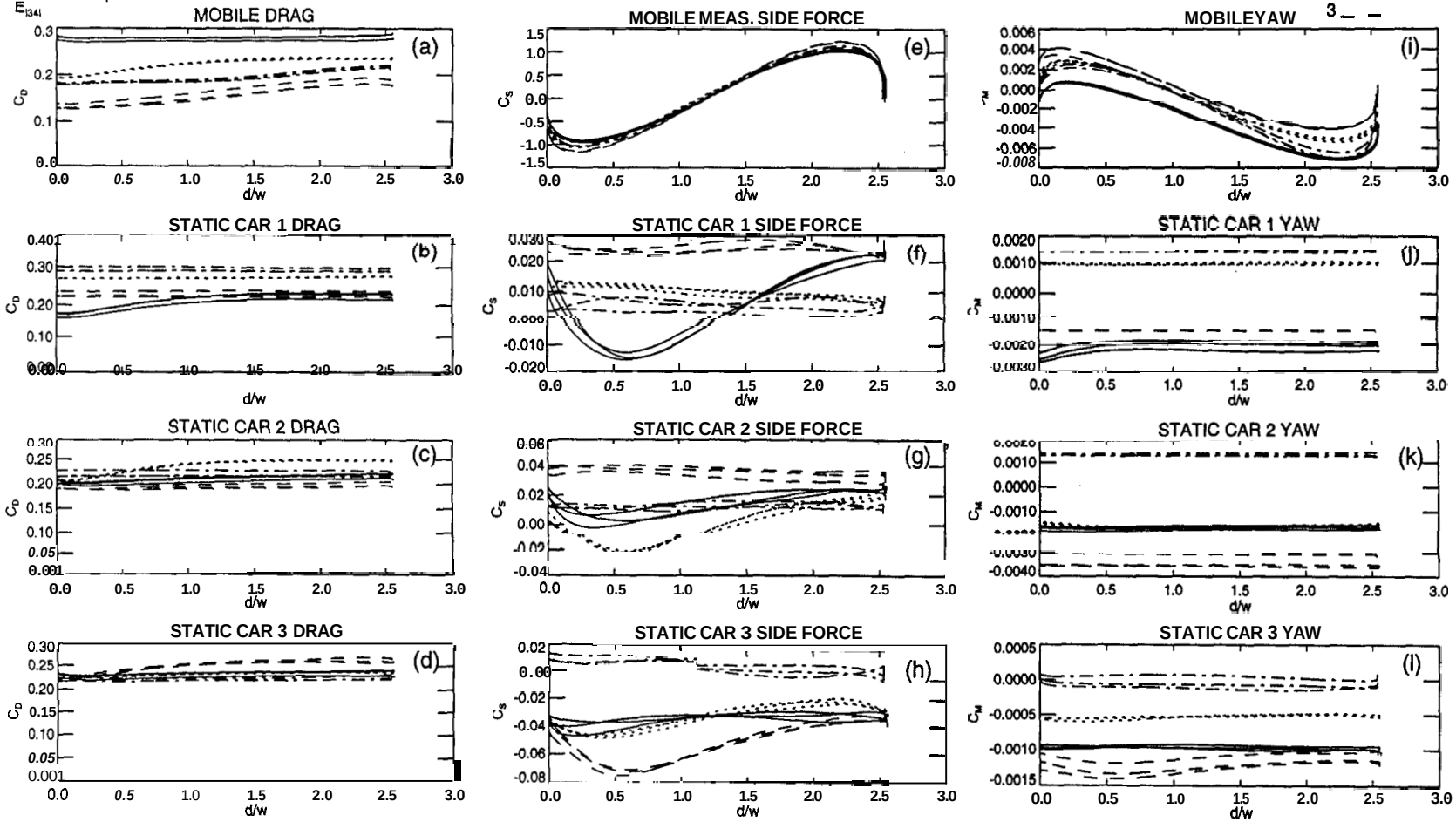
moving car position:

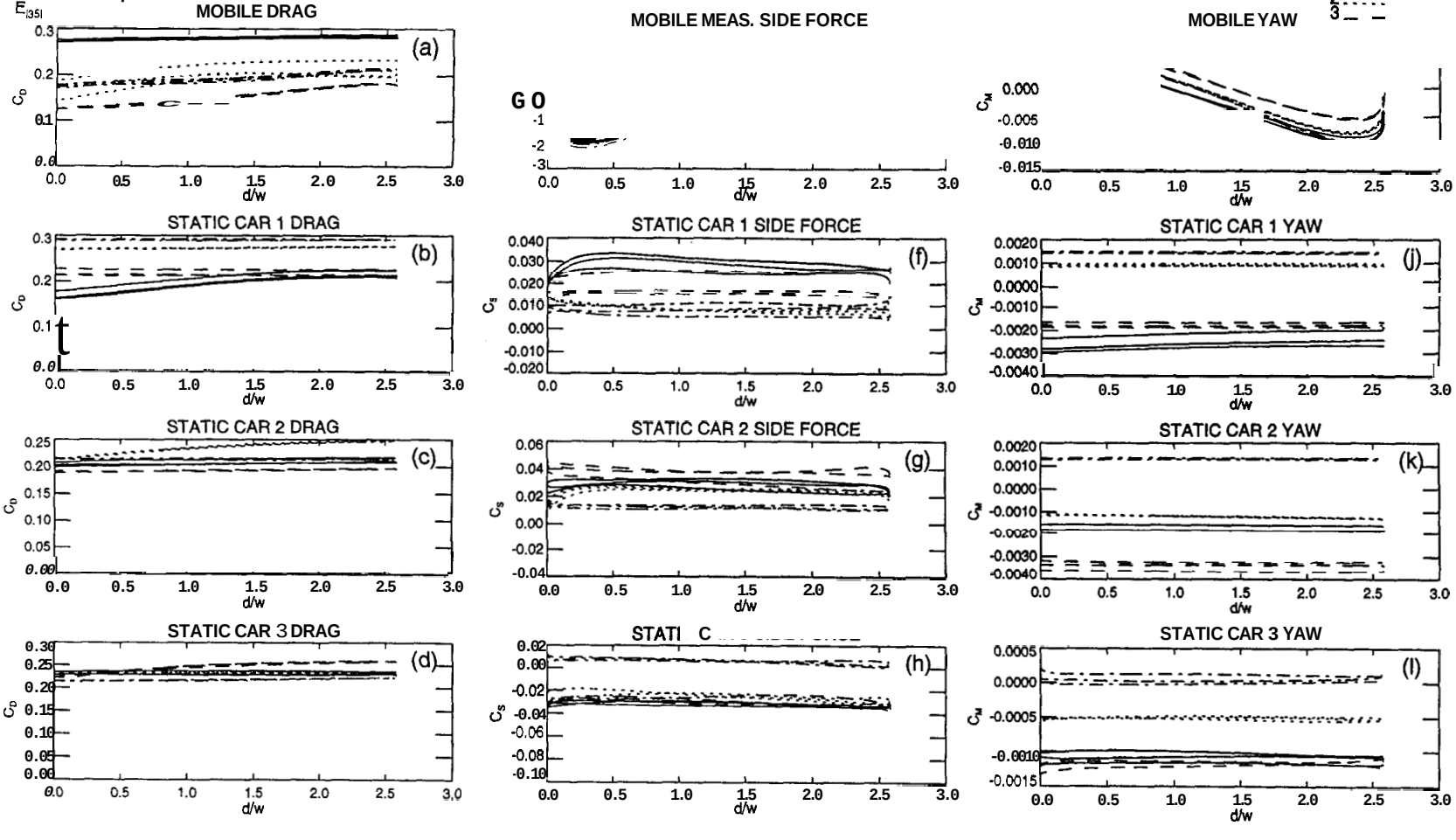


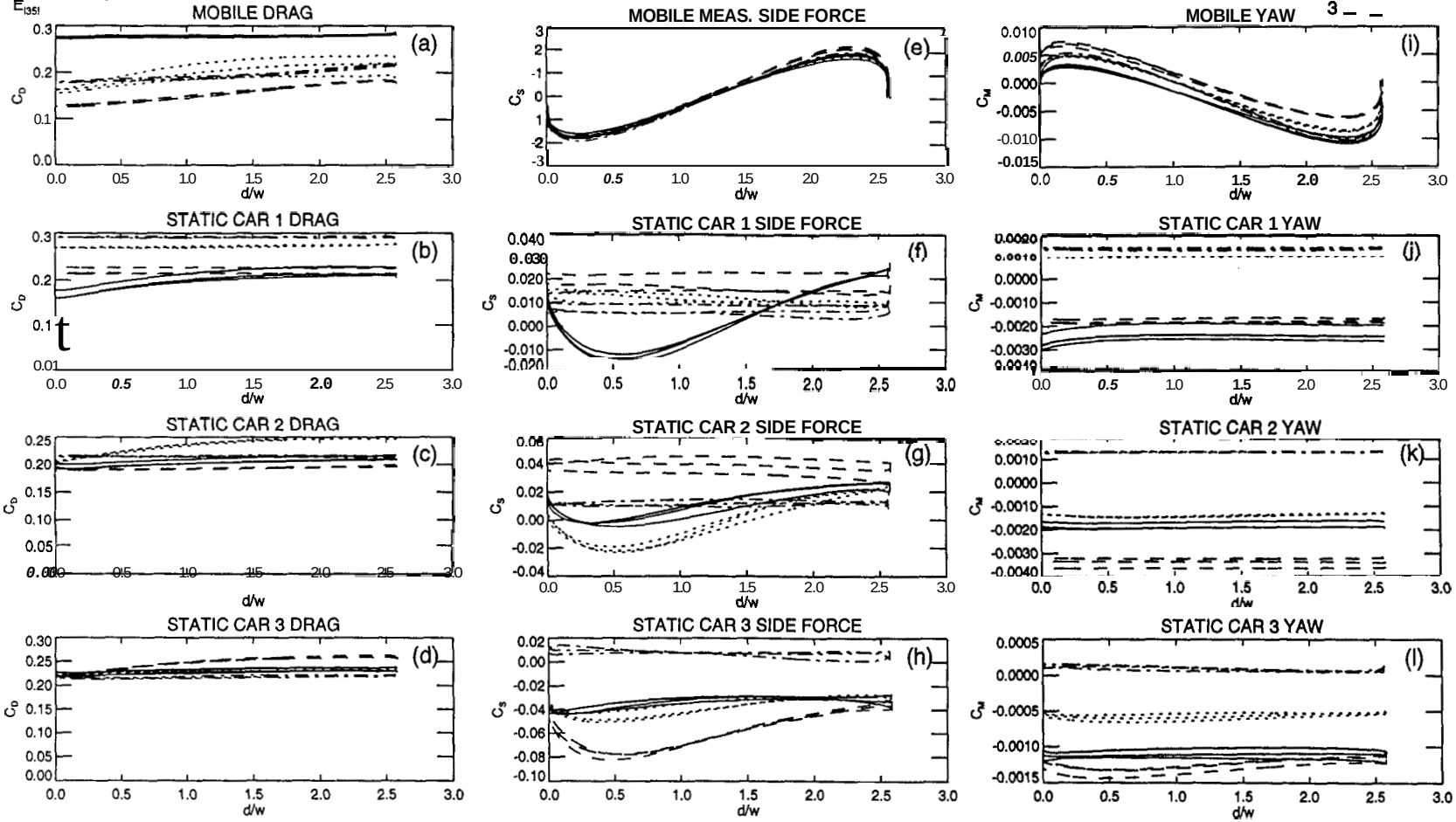

separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d) = 4
motion: out of platoon
moving car position:
1
2
3
4
MOBILE DRAG
(a)
STATIC CAR 1 DRAG
(b)
STATIC CAR 2 DRAG
STATIC CAR 3 DRAG
(d)
MOBILE MEAS. SIDE FORCE
(e)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 3 SIDE FORCE
(h)
MOBILE YAW
(i)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

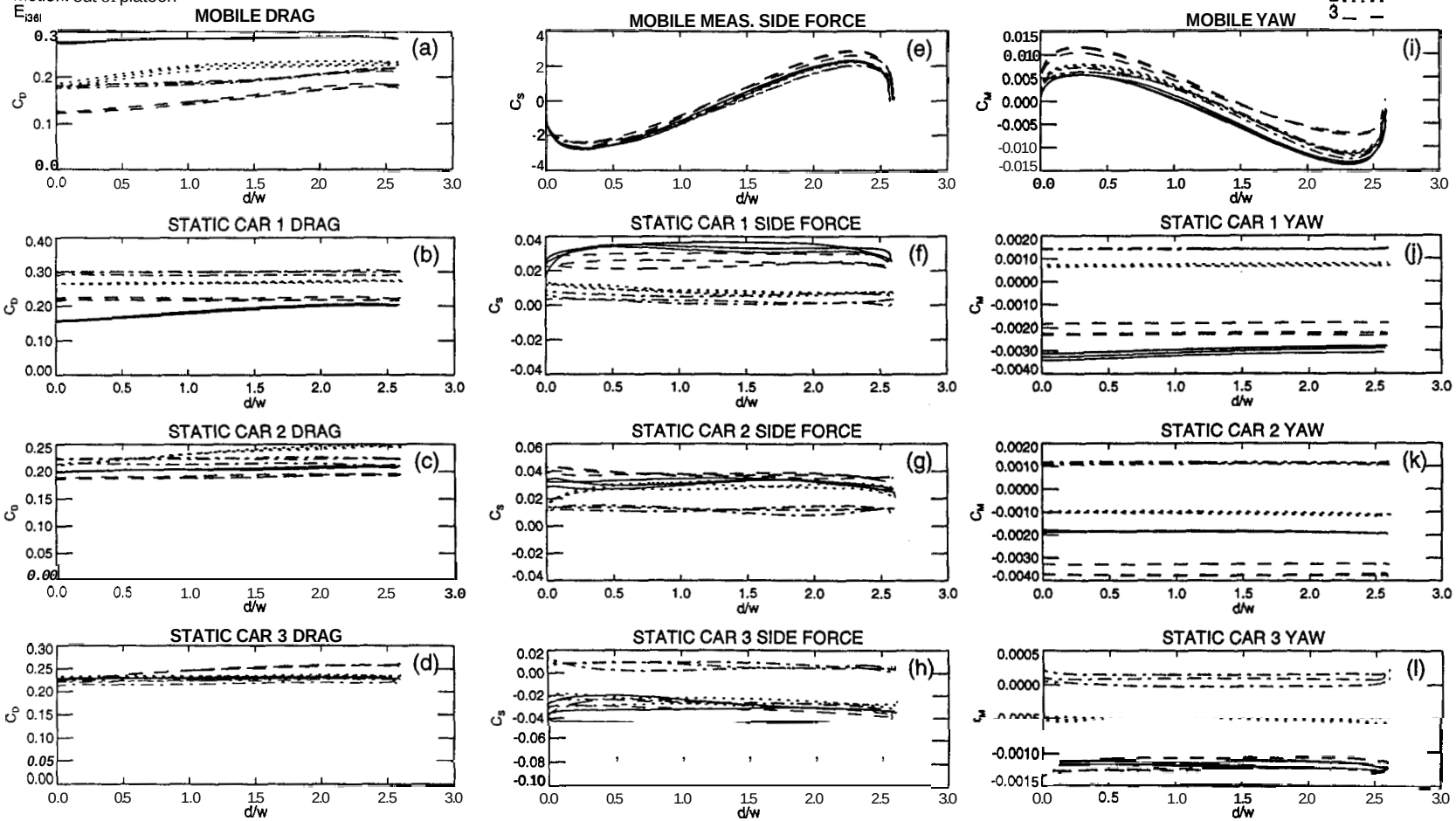
separation: 1(0.2l 2(0.4l), 3(l) = 3
acceleration profik: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon

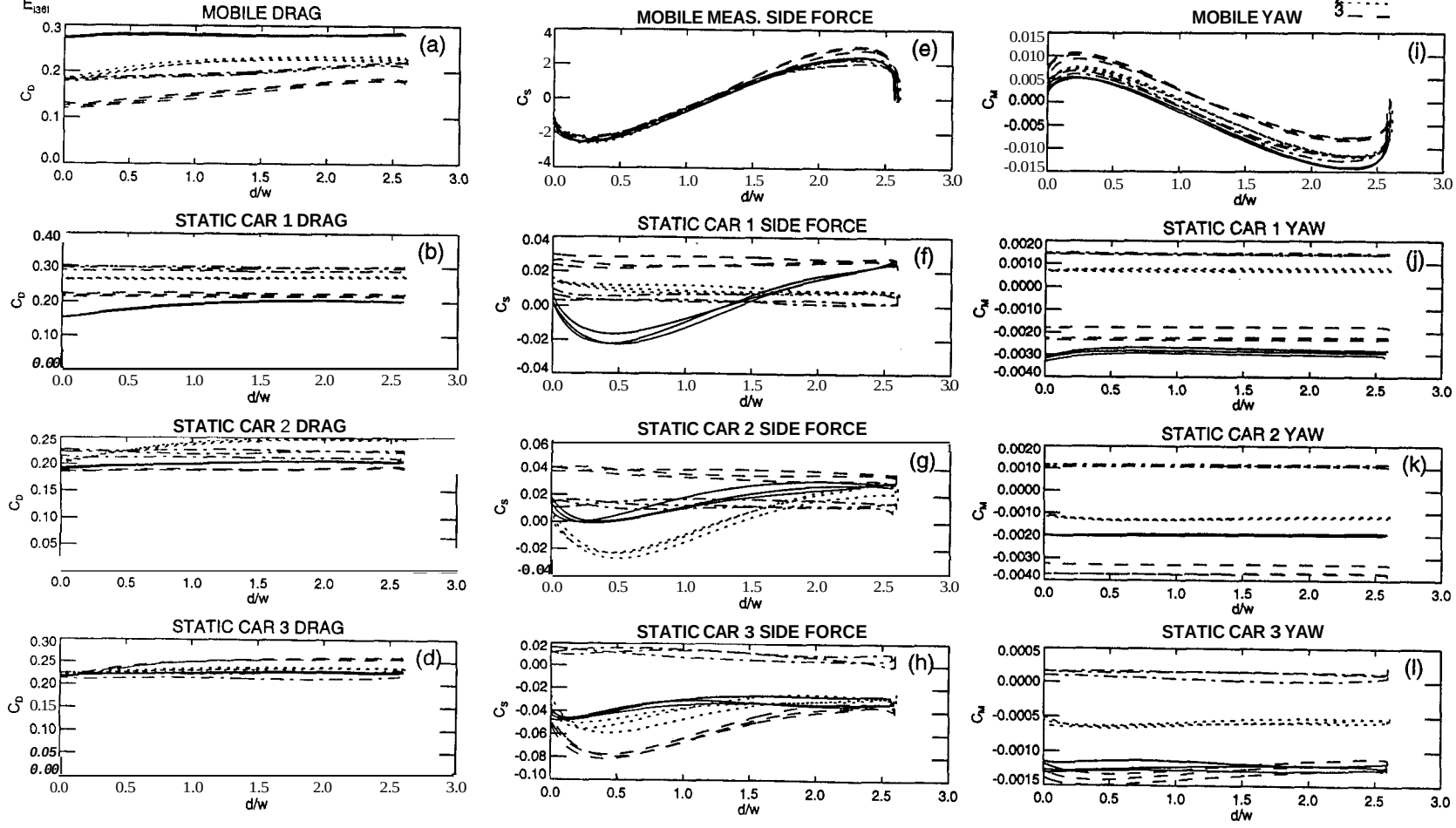
moving car position:
1 —— 4 — · —
2 · · · · ·
3 — —




separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: out of platoon
moving car position:
1
2
3
4
MOBILE DRAG
MOBILE MEAS. SIDE FORCE
MOBILE YAW
STATIC CAR 1 DRAG
STATIC CAR 1 SIDE FORCE
STATIC CAR 1 YAW
STATIC CAR 2 DRAG
STATIC CAR 2 SIDE FORCE
STATIC CAR 2 YAW
STATIC CAR 3 DRAG
STATIC CAR 3 YAW
(a)
(b)
(c)
(d)
(f)
(g)
(h)
(j)
(k)
(l)
C_D
C_S
C_M
d/w


separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: Into platoon
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w


separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: out of platoon
E_i36l
moving car position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILE YAW
(i)
STATIC CAR 1 DRAG
(b)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 DRAG
(c)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 DRAG
(d)
STATIC CAR 3 SIDE FORCE
(h)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w


separation: 1(0.2l), 2(0.4l), 3(l) = 3
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d) = 6
motion: Into platoon
E_i36i
moving car position:
1
2
3
4
MOBILE DRAG
(a)
STATIC CAR 1 DRAG
(b)
STATIC CAR 2 DRAG
STATIC CAR 3 DRAG
(d)
MOBILE MEAS. SIDE FORCE
(e)
STATIC CAR 1 SIDE FORCE
(f)
STATIC CAR 2 SIDE FORCE
(g)
STATIC CAR 3 SIDE FORCE
(h)
MOBILE YAW
(i)
STATIC CAR 1 YAW
(j)
STATIC CAR 2 YAW
(k)
STATIC CAR 3 YAW
(l)
C_D
C_S
C_M
d/w

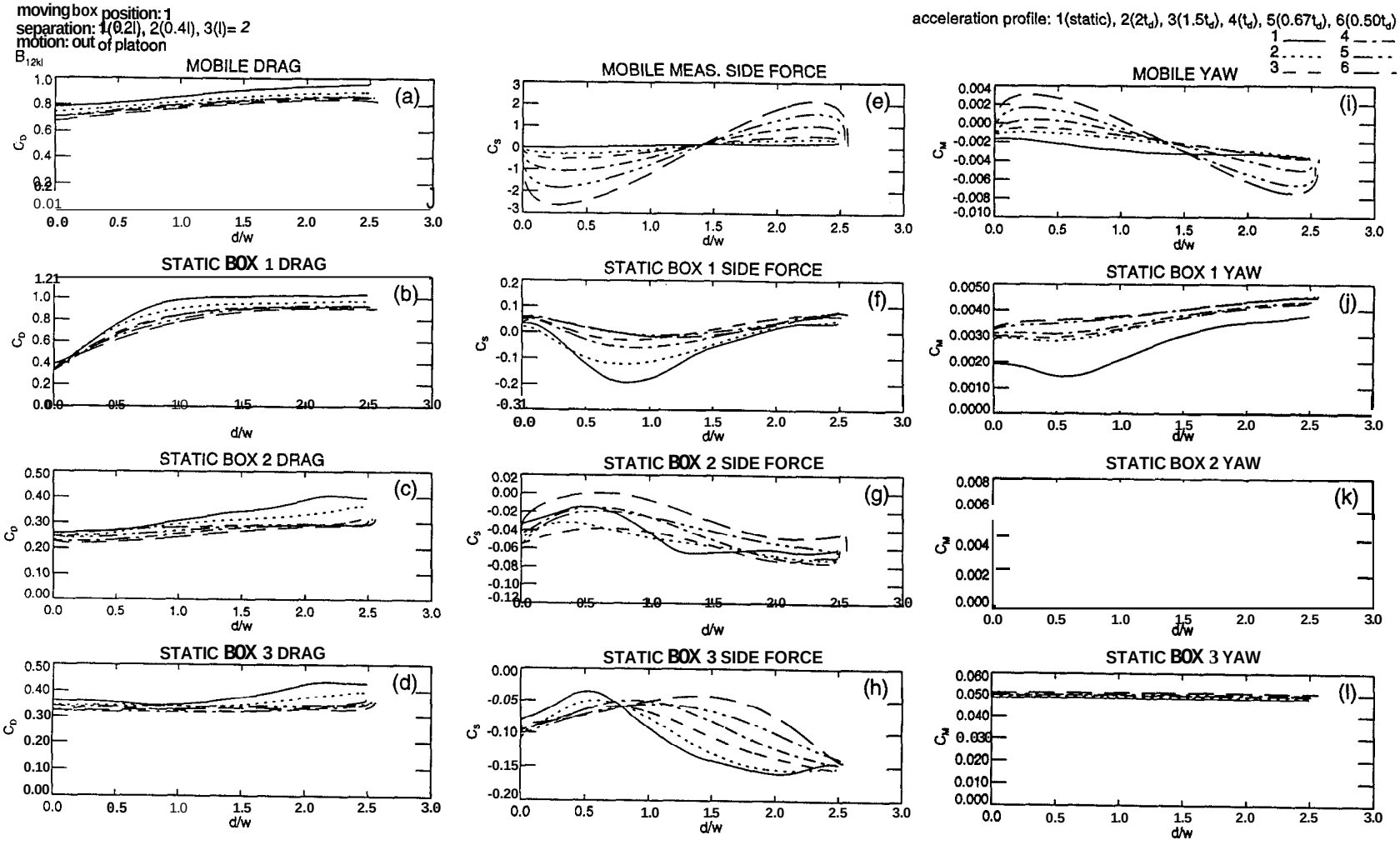
Chapter 5

Acceleration Profiles - Boxes

The drag, side force, and yawing moment coefficients measured on each of the four rectangular boxes in a platoon during a simulated lane change are shown on the following figures. One of the boxes moves out of the platoon, and after a pause, returns into the platoon. The coefficients are plotted with respect to the nondimensional lateral displacement of the maneuvering box d/w, where the displacement d is scaled with the box width w. The measurements made during movement out of the platoon for one platoon configuration are shown first. The measurements made during movement into the platoon for the same configuration are shown in the next figure. This arrangement of the figures for motion out of the platoon and into the platoon is used for all of the platoon configurations. Each figure represents one of the four possible locations of the mobile box and a platoon configuration at one of the three possible inter-vehicle spacings. The different linetypes in each figure represent the six acceleration profiles used by the maneuvering box. For simplification, the curve for each acceleration profile is an average of the three experimental runs performed with that particular platoon configuration.

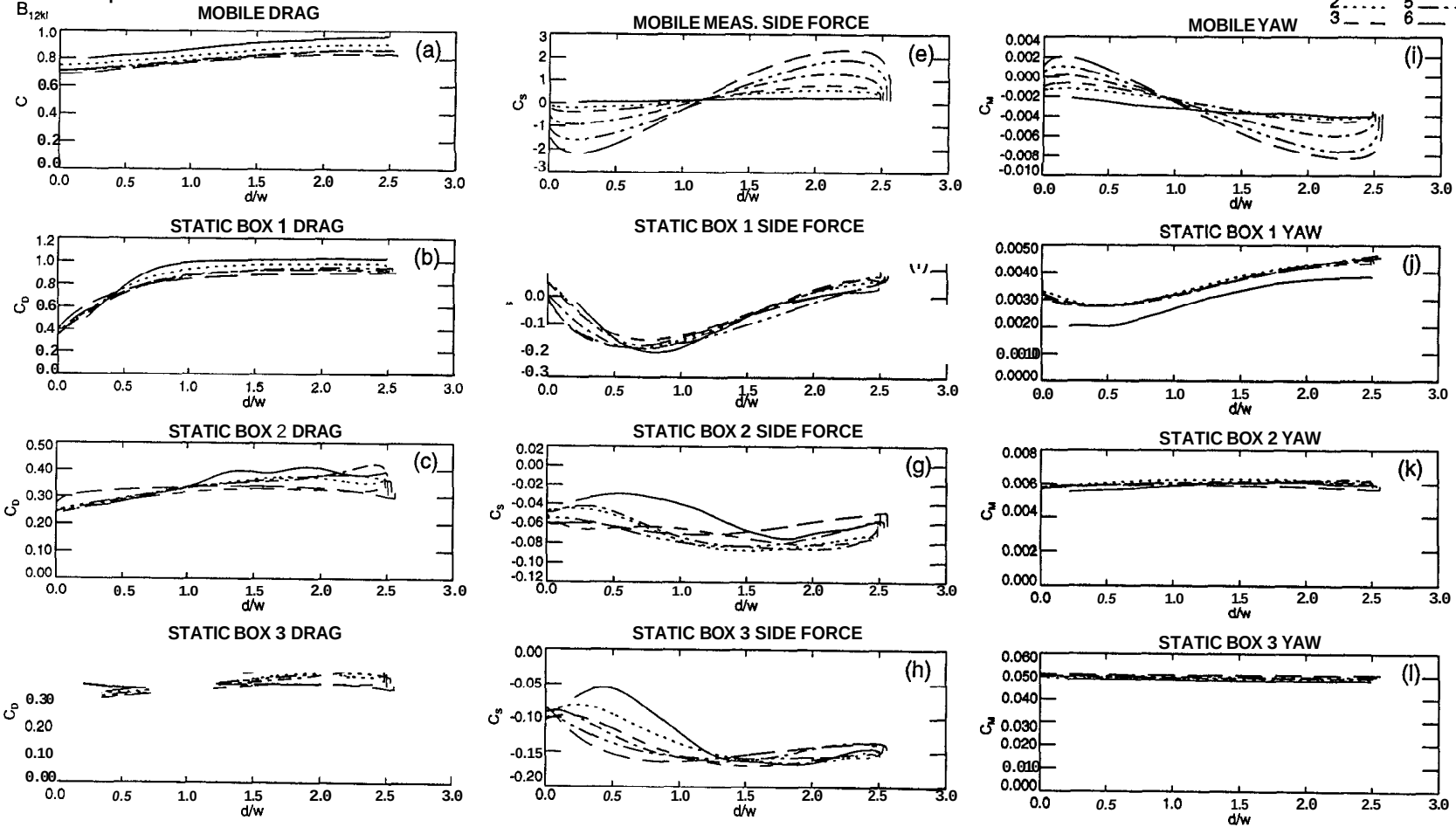
moving box position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



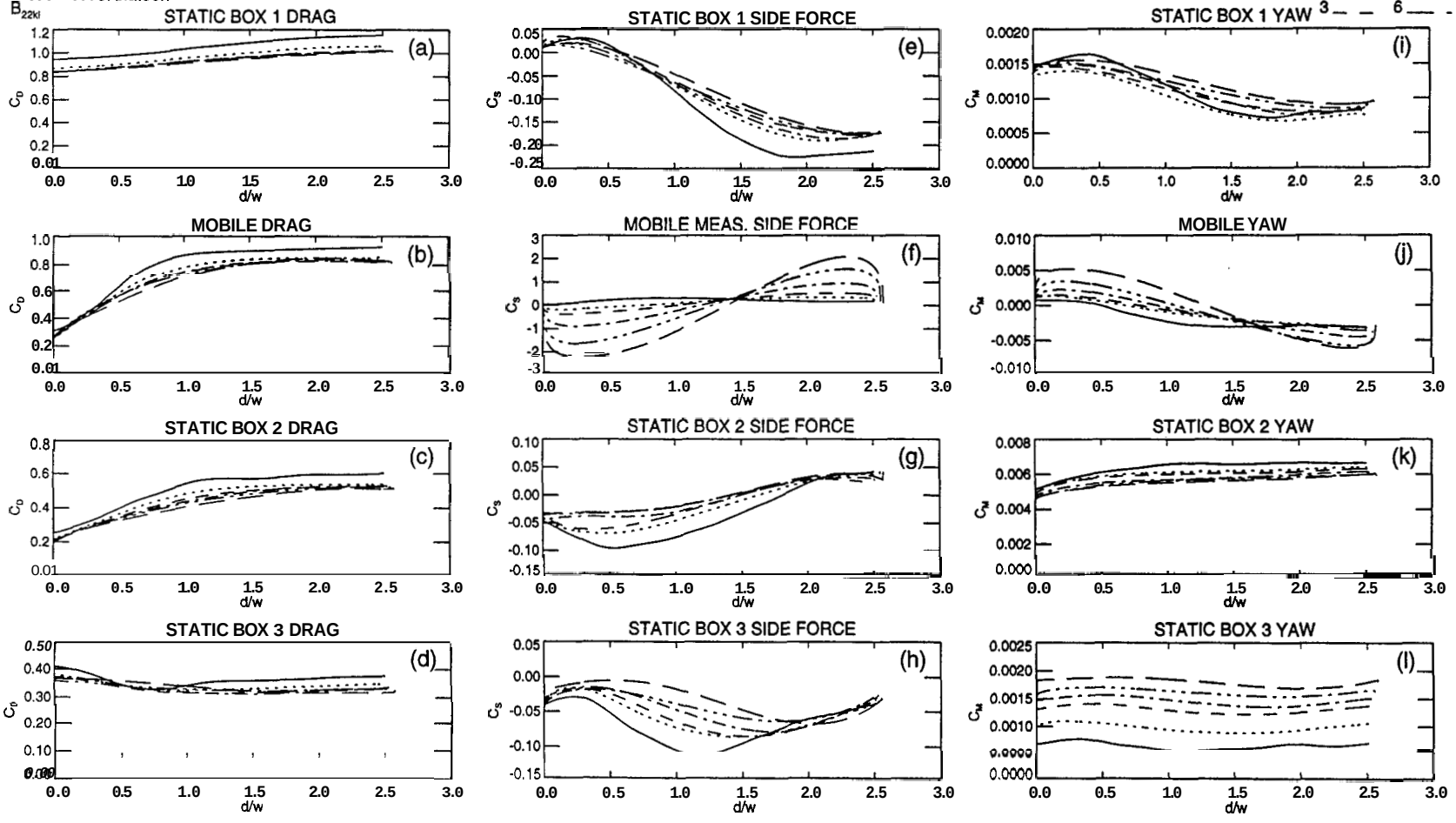
moving box position: 1
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



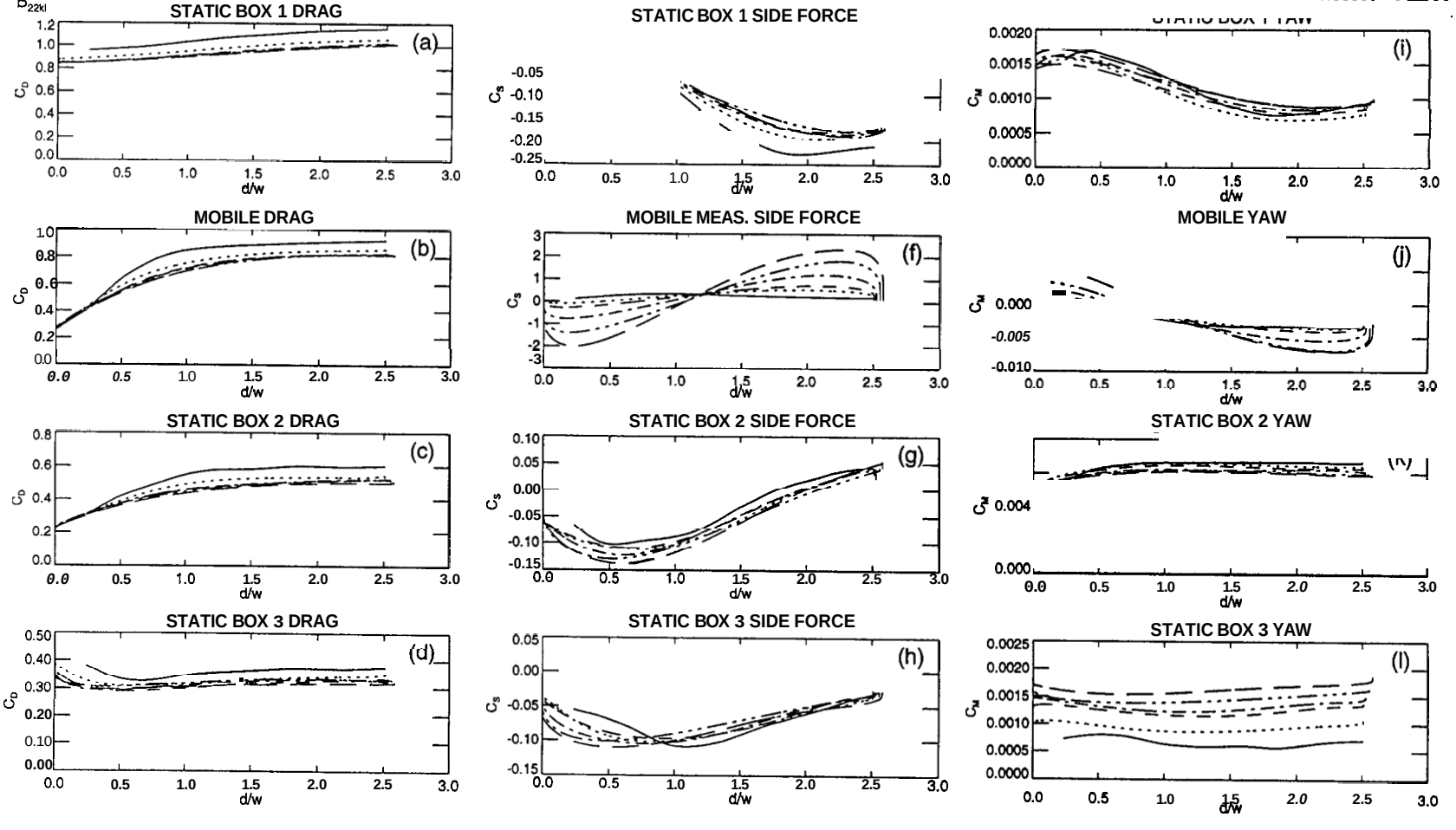
moving box position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

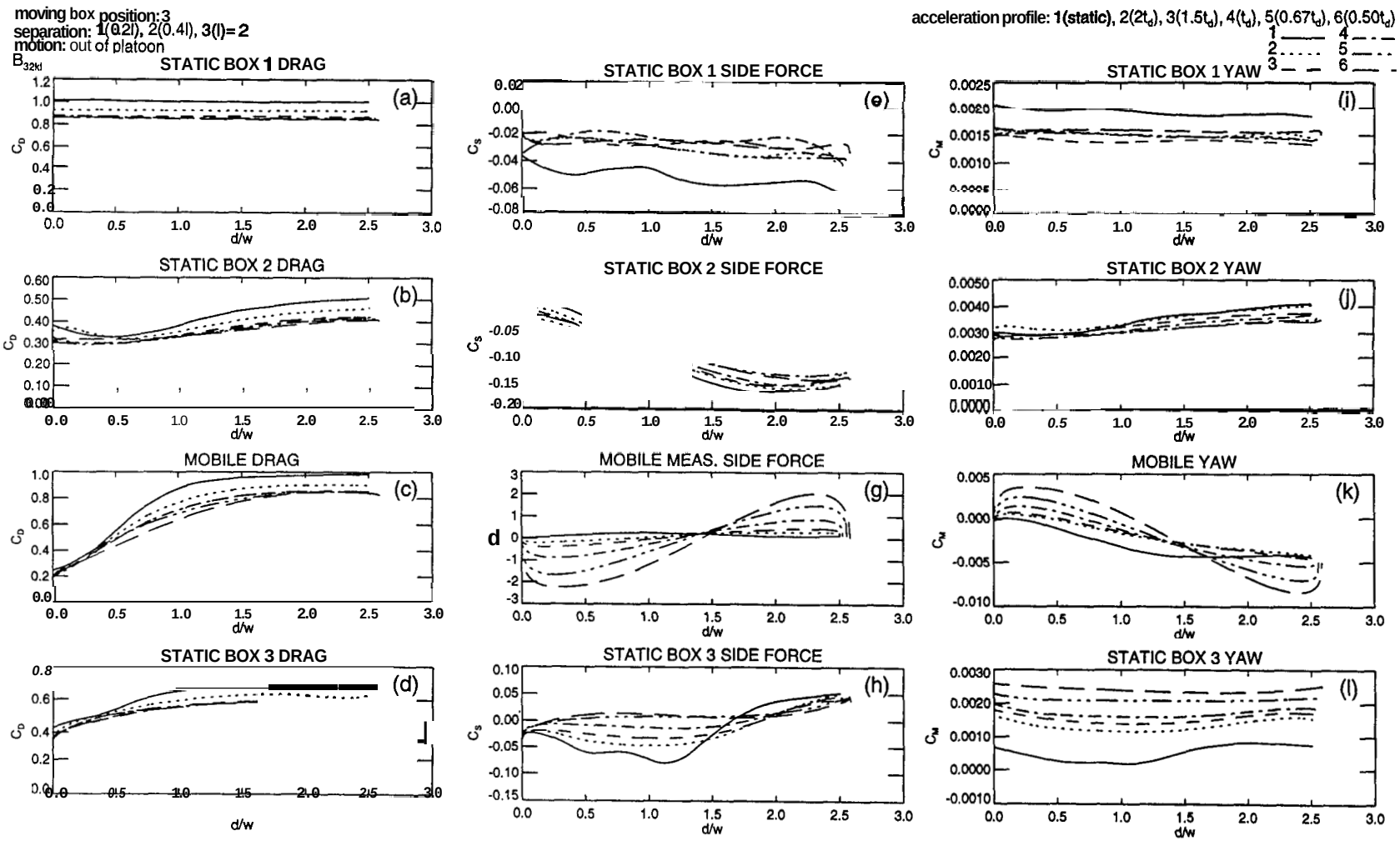
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)



moving box position: 2
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon
B_{22kl}

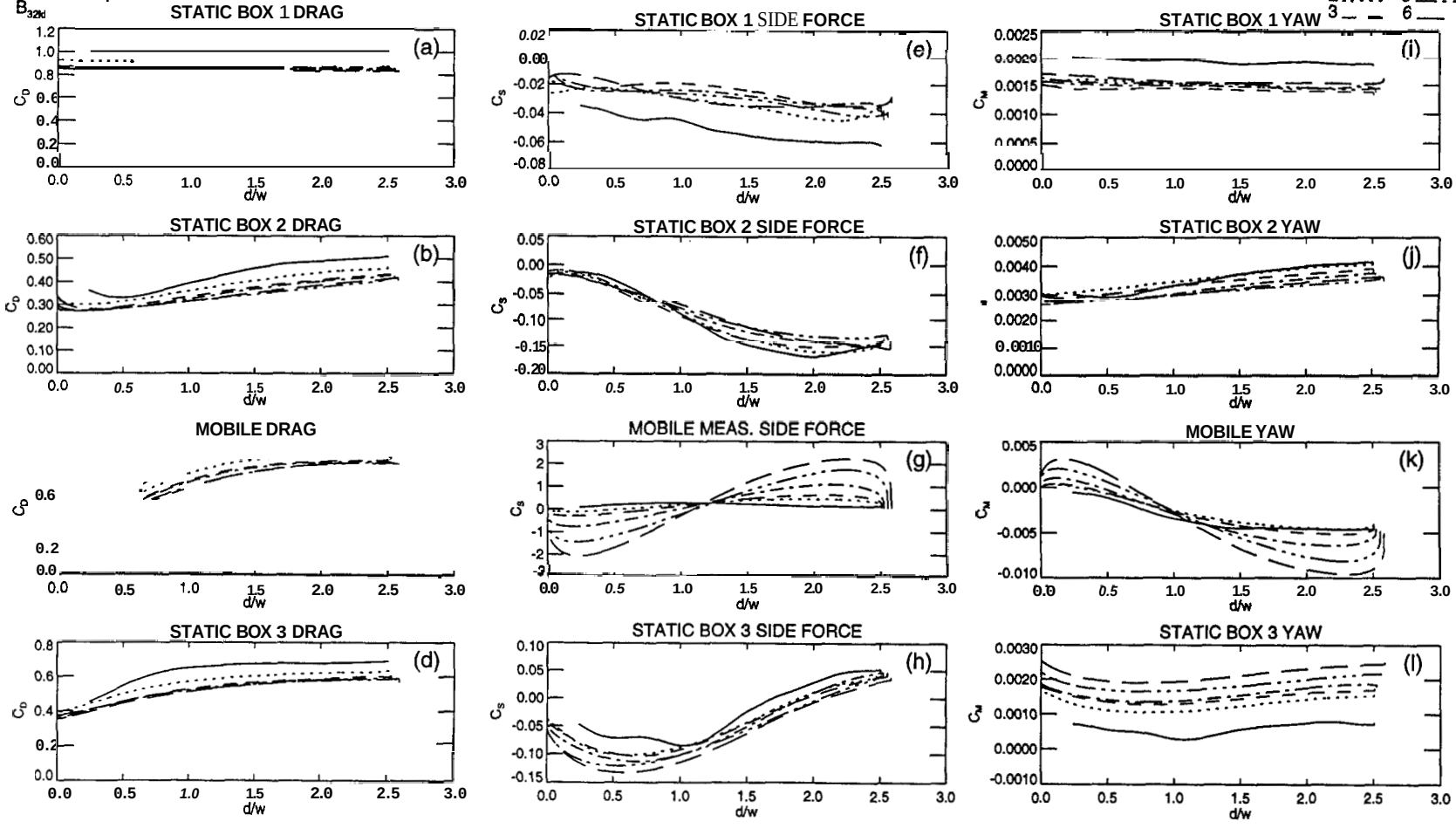
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)




moving box position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)
1 4
2 5
3 6
B32kl
STATIC BOX 1 DRAG
(a)
STATIC BOX 1 SIDE FORCE
(e)
STATIC BOX 1 YAW
(i)
STATIC BOX 2 DRAG
(b)
STATIC BOX 2 SIDE FORCE
STATIC BOX 2 YAW
(j)
MOBILE DRAG
(c)
MOBILE MEAS. SIDE FORCE
(g)
MOBILE YAW
(k)
STATIC BOX 3 DRAG
(d)
STATIC BOX 3 SIDE FORCE
(h)
STATIC BOX 3 YAW
(l)
C_D
C_S
C_M
d/w

moving box position: 3
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: into platoon

acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)

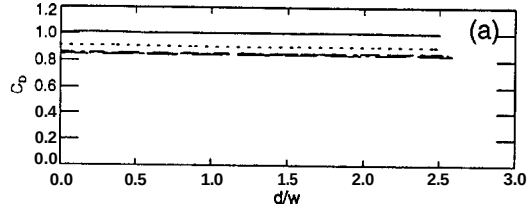


moving box position: 4
separation: 1(0.2l), 2(0.4l), 3(l)= 2
motion: out of platoon

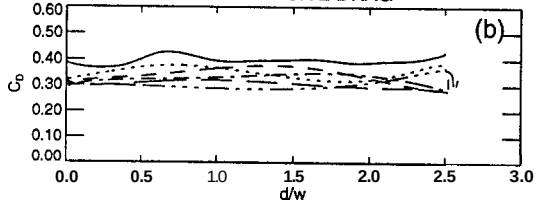
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)

B_{42kl}

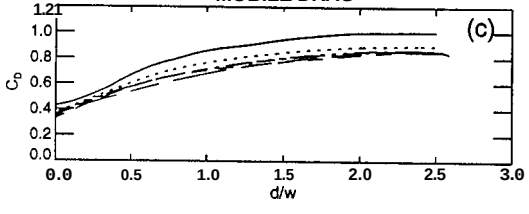
STATIC BOX 1 DRAG



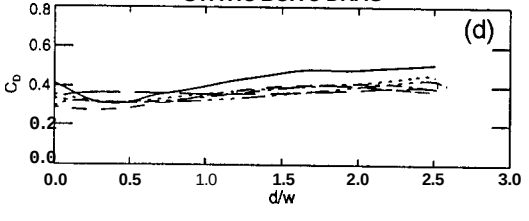
STATIC BOX 2 DRAG



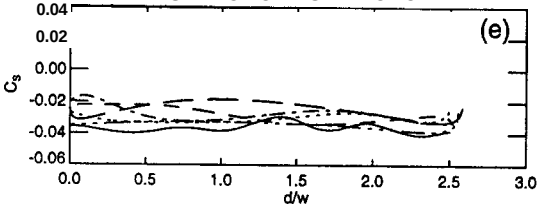
MOBILE DRAG



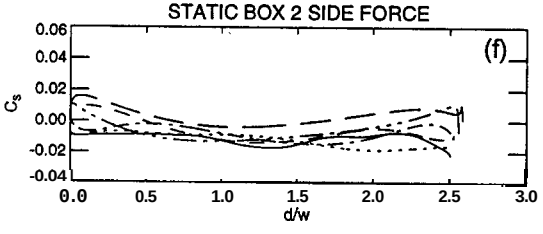
STATIC BOX 3 DRAG



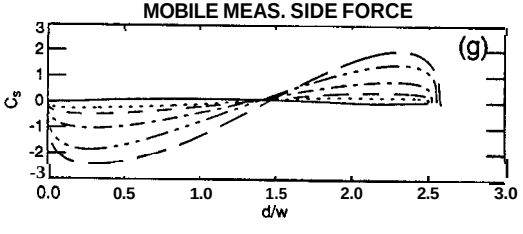
STATIC BOX 1 SIDE FORCE



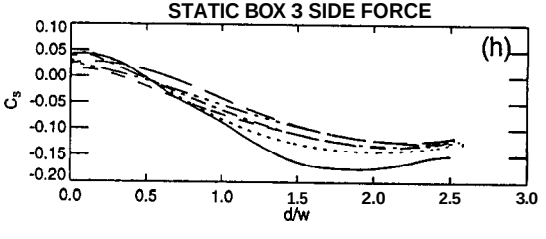
STATIC BOX 2 SIDE FORCE



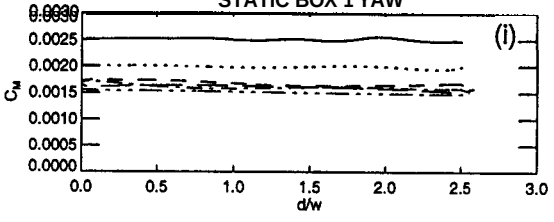
MOBILE MEAS. SIDE FORCE



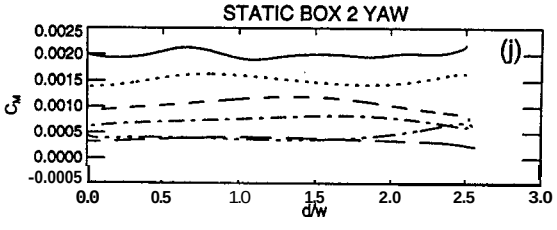
STATIC BOX 3 SIDE FORCE



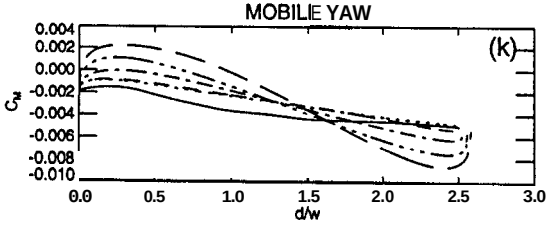
STATIC BOX 1 YAW



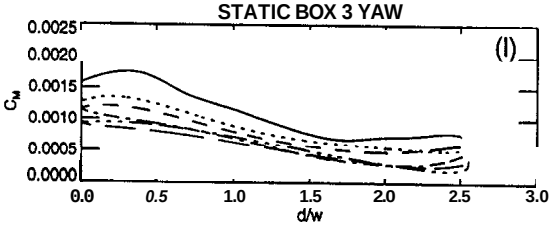
STATIC BOX 2 YAW



MOBILE YAW

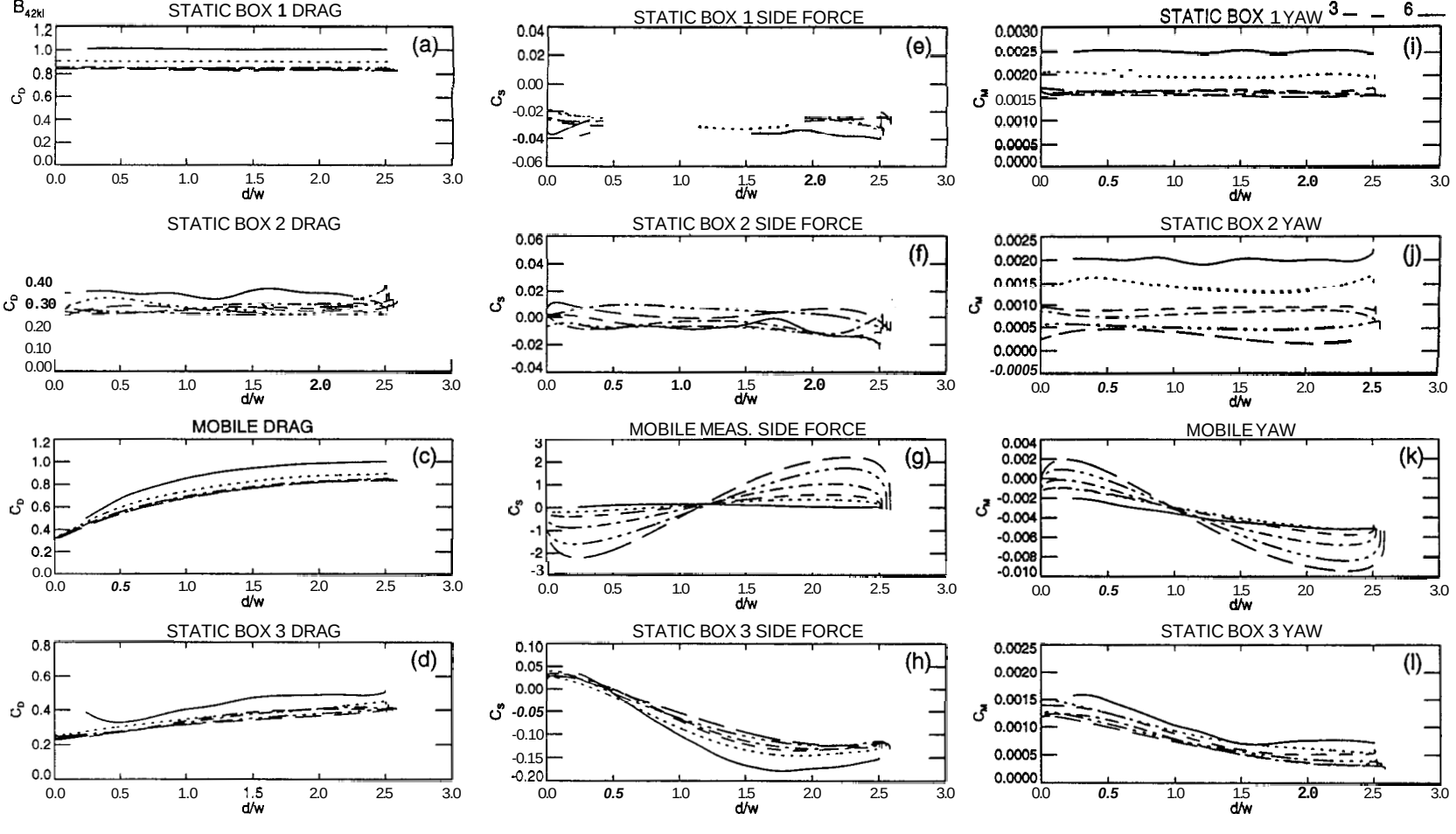


STATIC BOX 3 YAW



moving **box** position: 4
separation: **1(0.2l),** 2(0.4l), 3(l)= **2**
motion: into platoon

acceleration profile: 1(static), **2($2t_d$)**, **3($1.5t_d$)**, 4(t_d), **5($0.67t_d$)**, **6($0.50t_d$)**



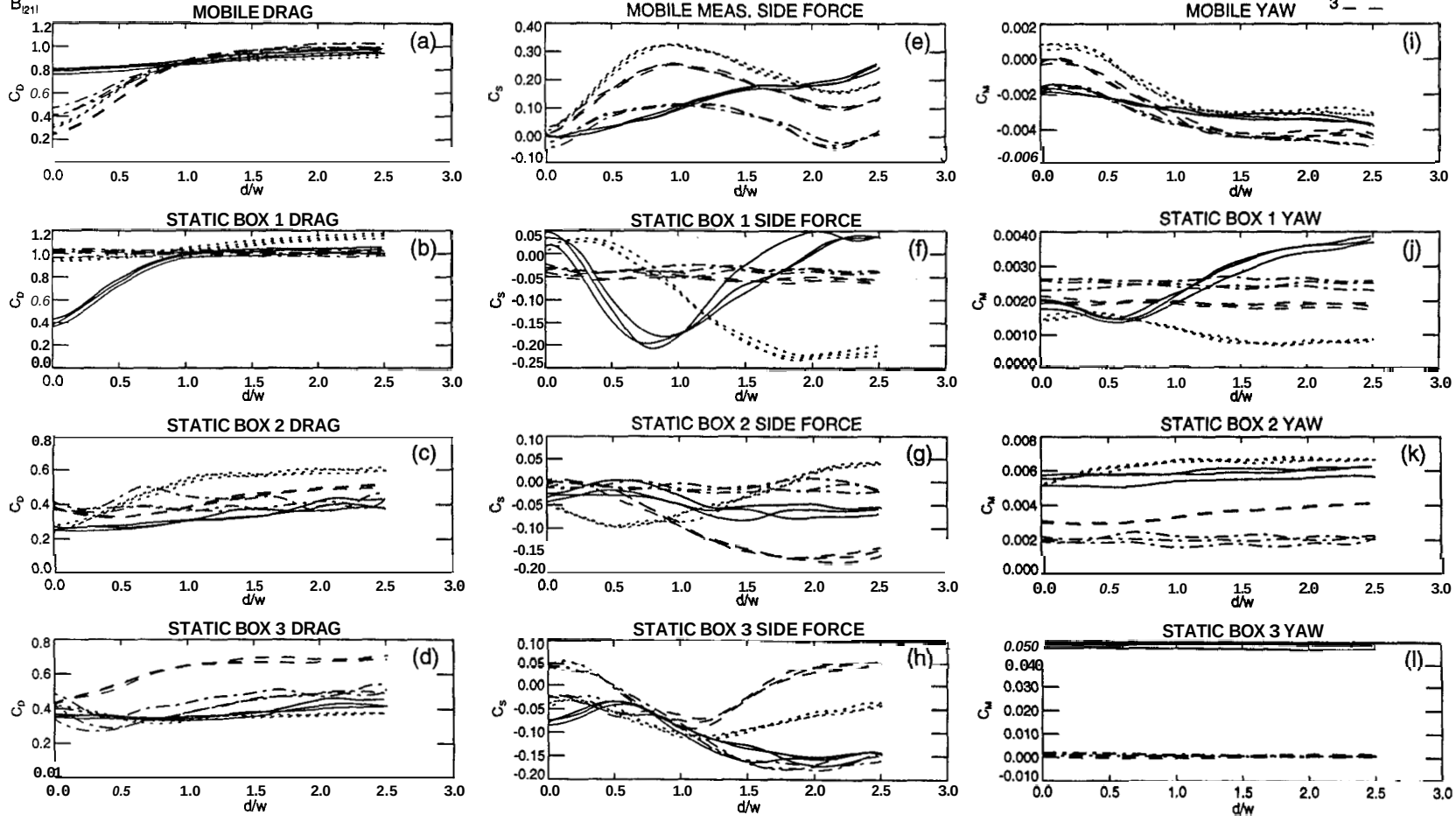
Chapter 6

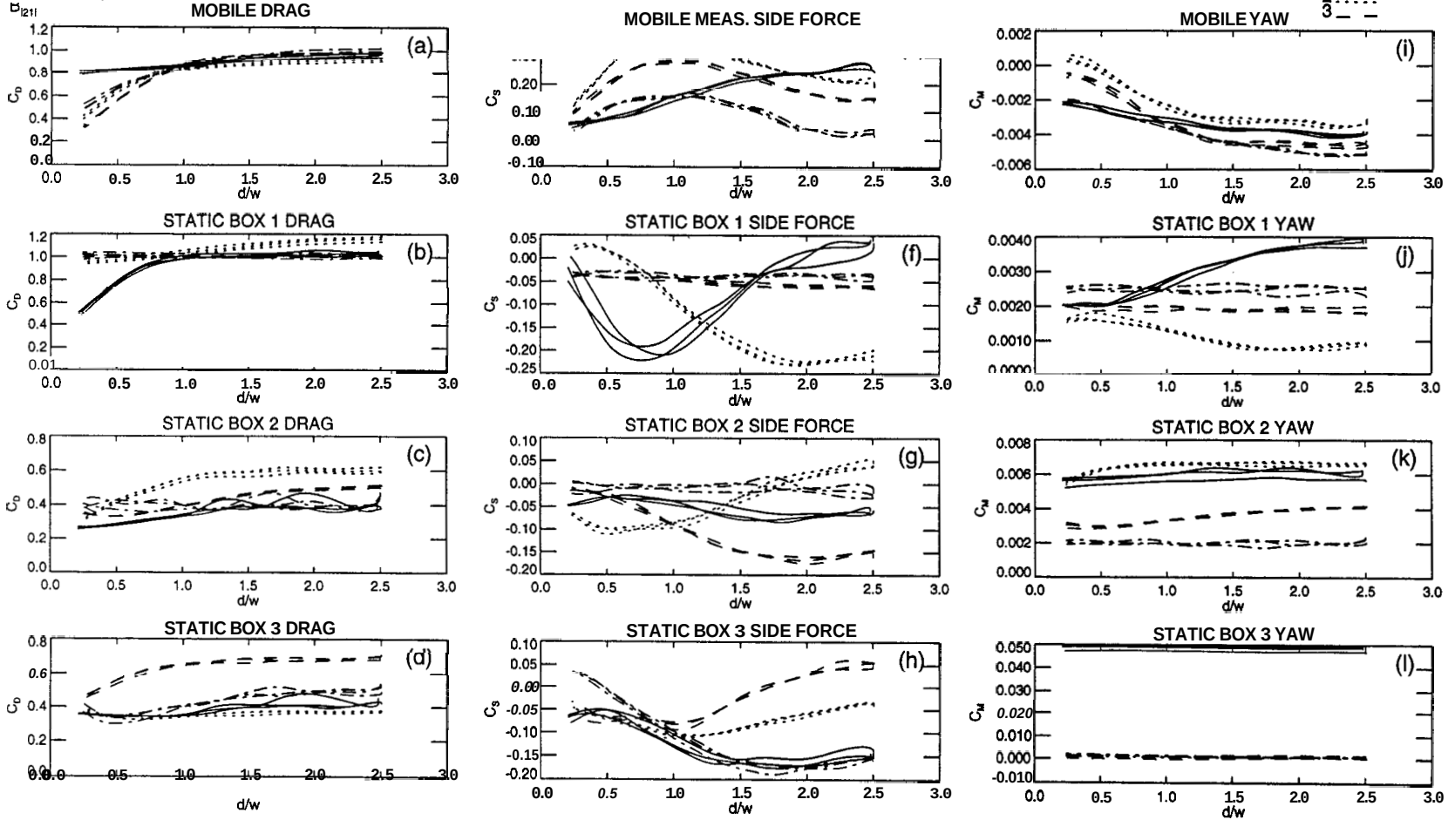
Location Profiles - Boxes

The drag, side force, and yawing moment coefficients measured on each of the four rectangular boxes in a platoon during a simulated lane change are shown on the following figures. One of the boxes moves out of the platoon, and after a pause, returns into the platoon. The coefficients are plotted with respect to the nondimensional lateral displacement of the maneuvering box d/w, where the displacement d is scaled with the box width w. The measurements made during movement out of the platoon for one platoon configuration are shown first. The measurements made during movement into the platoon for the same configuration are shown in the next figure. This arrangement of the figures for motion out of the platoon and into the platoon is used for all of the platoon configurations. Each figure represents one of the three possible inter-vehicle spacings in the platoon and one acceleration profile used by the maneuvering box. The different linetypes in each figure represent the four possible locations of the mobile box. The three experimental runs performed with each platoon configuration are shown.

separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 1
motion: out of platoon
B_{l21l}

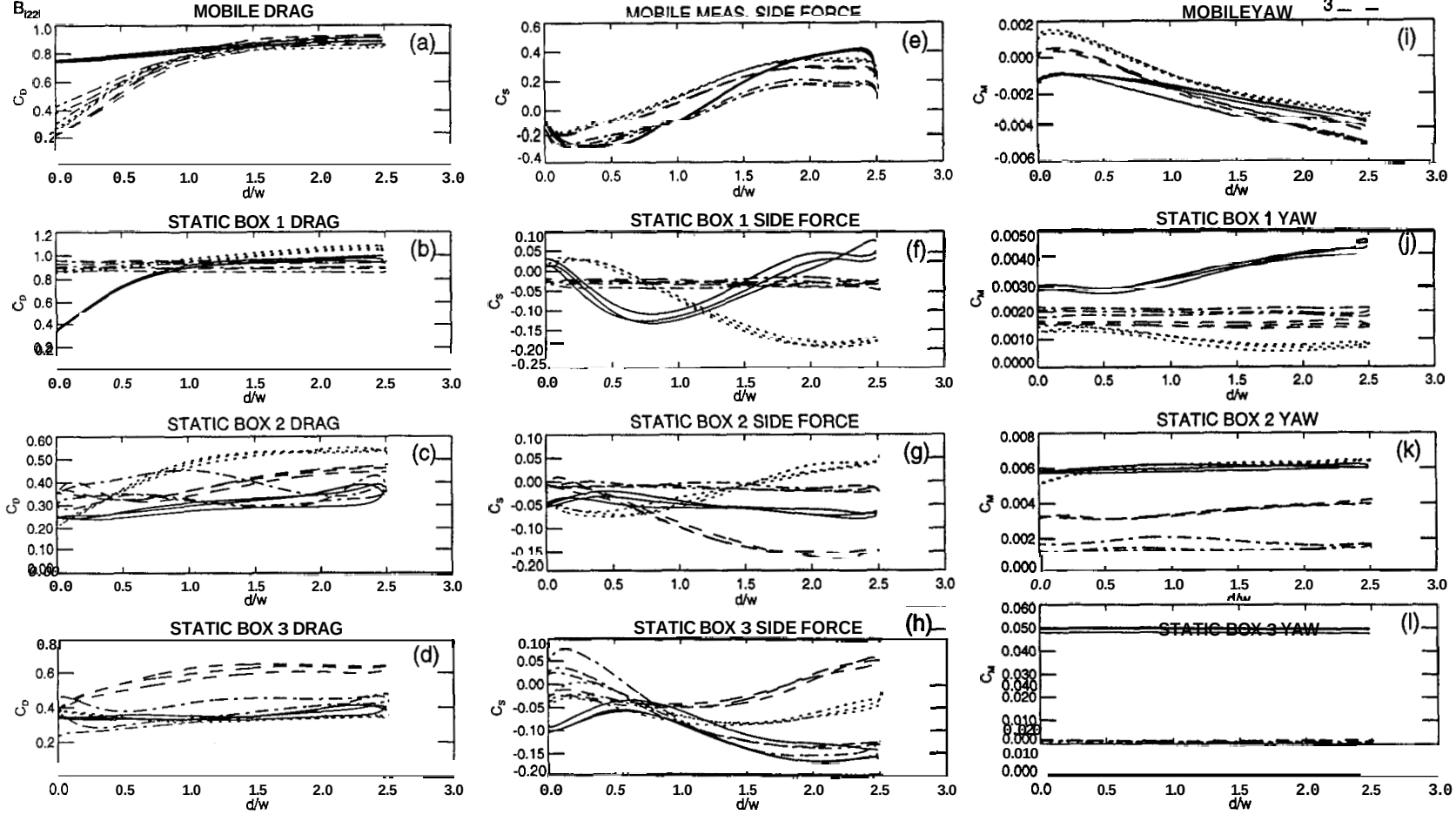
moving box position:
1 —— 4 — · —
2 · · · · ·
3 — —




separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 1
motion: into platoon
moving box position:
1
2
3
4
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
MOBILE YAW
(i)
STATIC BOX 1 DRAG
(b)
STATIC BOX 1 SIDE FORCE
(f)
STATIC BOX 1 YAW
(j)
STATIC BOX 2 DRAG
(c)
STATIC BOX 2 SIDE FORCE
(g)
STATIC BOX 2 YAW
(k)
STATIC BOX 3 DRAG
(d)
STATIC BOX 3 SIDE FORCE
(h)
STATIC BOX 3 YAW
(l)
C_D
C_S
C_M
d/w

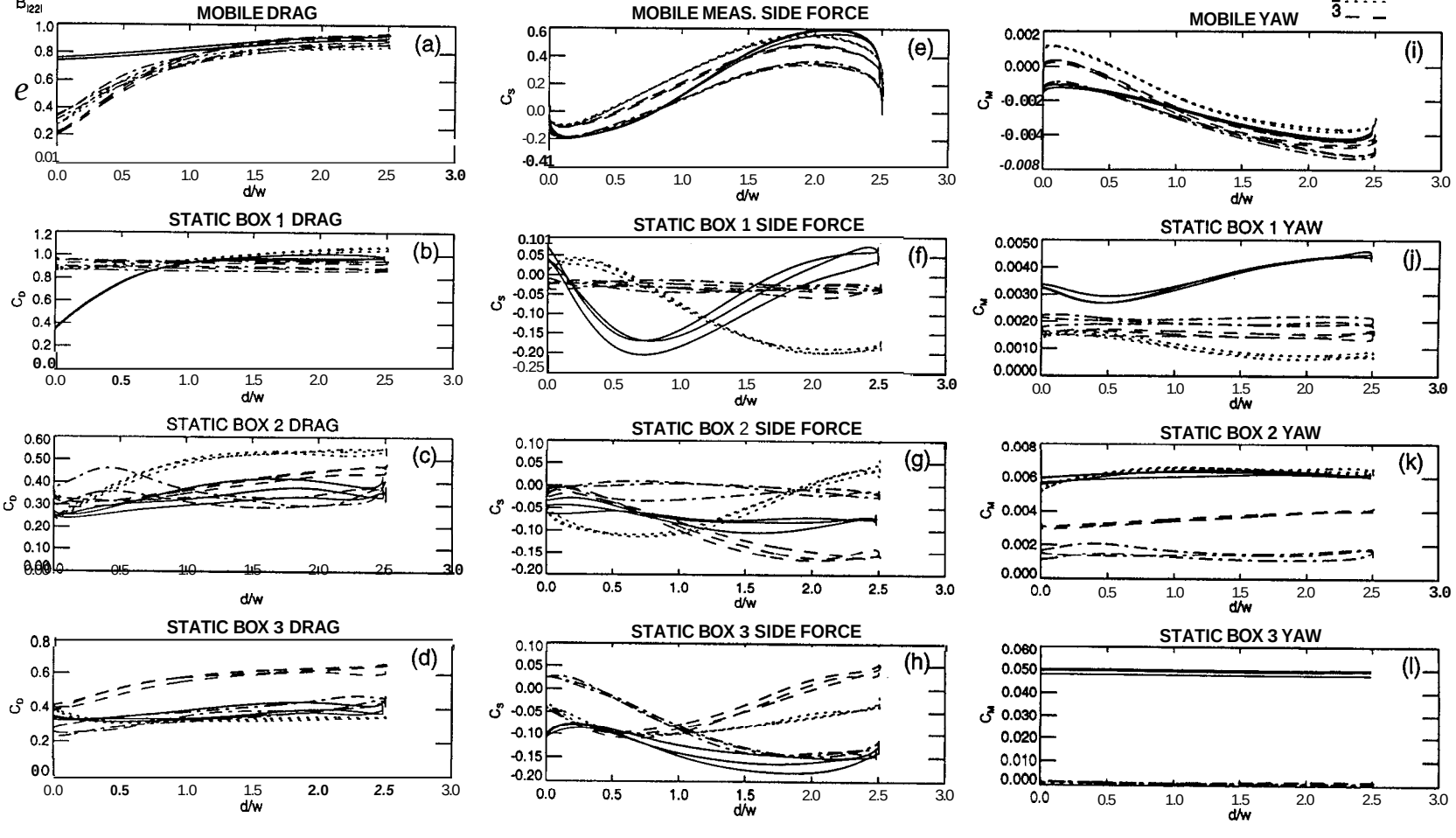
separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: out of Dlatoon
B_{122l}

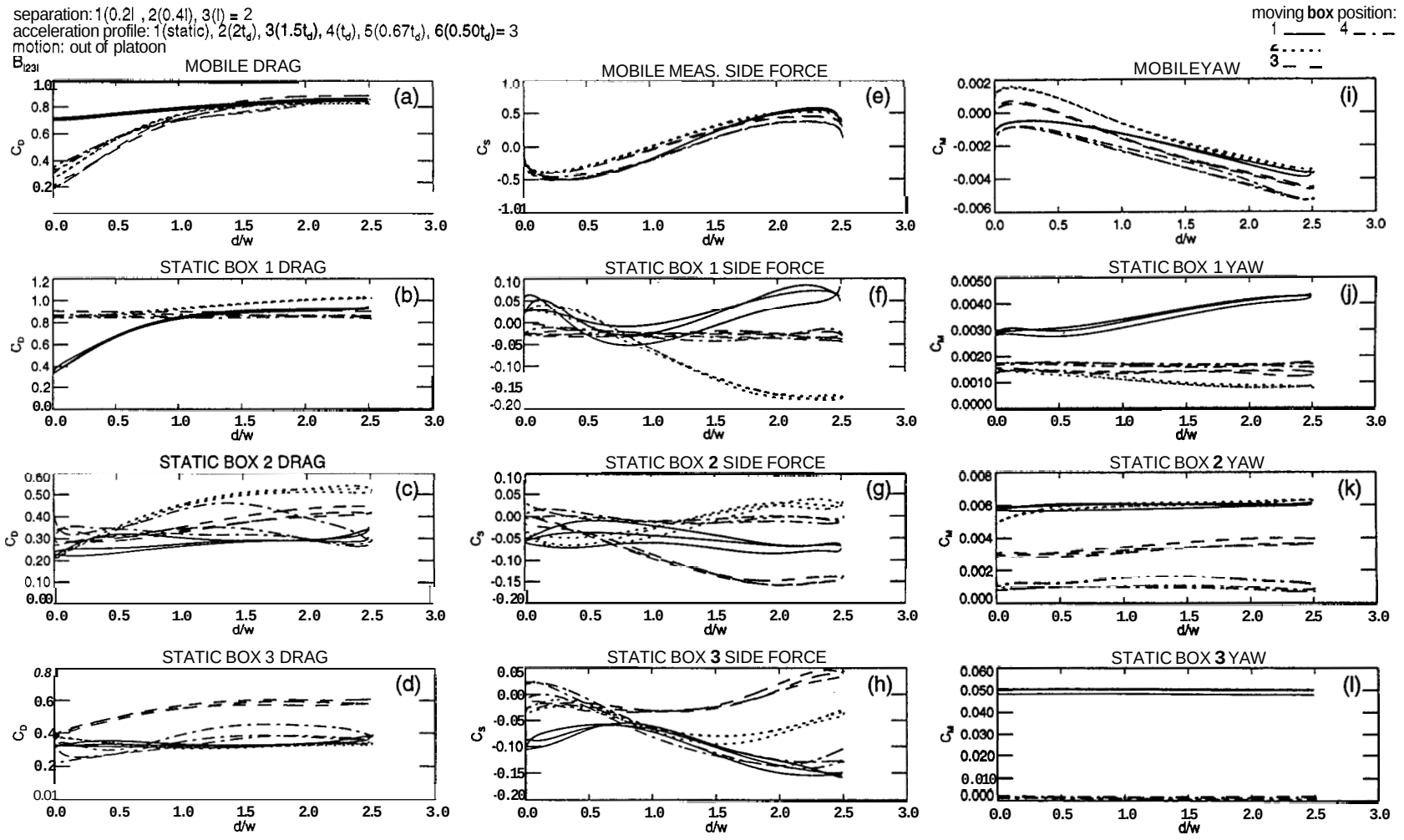
moving box position:
1 —— 4 — · —
2 · · · · ·
3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 2
motion: into platoon

moving box position:
1 —— 4 – – –
2 ·····
3 — —

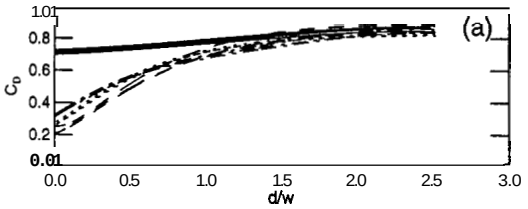



separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2(2t_d), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 3
motion: out of platoon
B_l23l
moving box position:
1
4
2
3
MOBILE DRAG
(a)
MOBILE MEAS. SIDE FORCE
(e)
MOBILEYAW
(i)
STATIC BOX 1 DRAG
(b)
STATIC BOX 1 SIDE FORCE
(f)
STATIC BOX 1 YAW
(j)
STATIC BOX 2 DRAG
(c)
STATIC BOX 2 SIDE FORCE
(g)
STATIC BOX 2 YAW
(k)
STATIC BOX 3 DRAG
(d)
STATIC BOX 3 SIDE FORCE
(h)
STATIC BOX 3 YAW
(l)
C_D
C_S
C_M
d/w

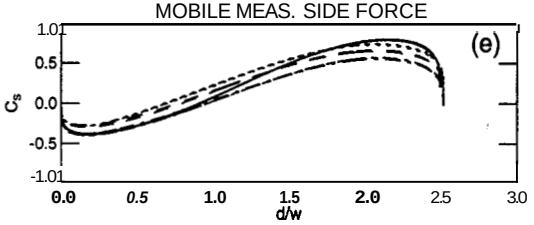
separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 3
motion: into platoon
B_{123}

moving box position:
1 ——— 4 — · —
2 · · · · ·
3 — —

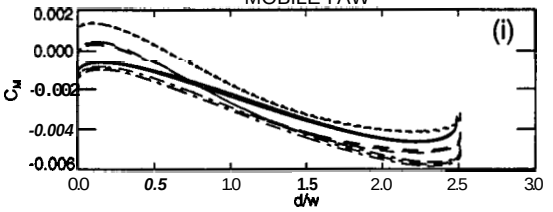
MOBILE DRAG



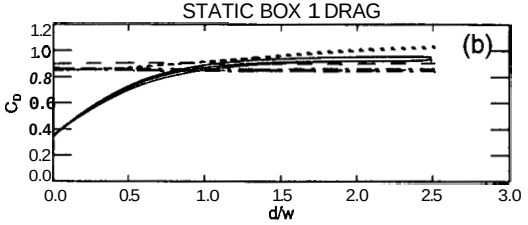
MOBILE MEAS. SIDE FORCE



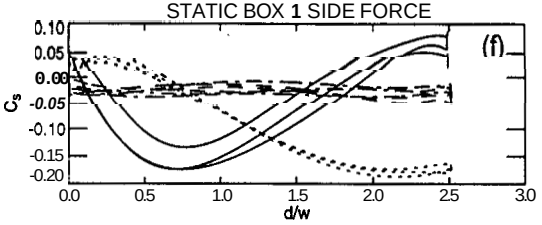
MOBILE YAW



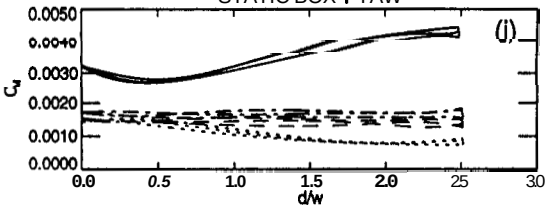
STATIC BOX 1 DRAG



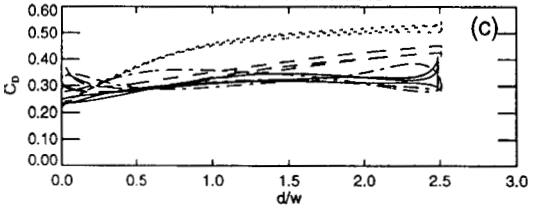
STATIC BOX 1 SIDE FORCE



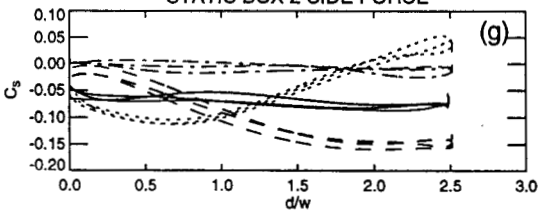
STATIC BOX 1 YAW



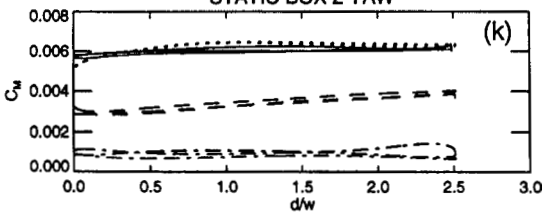
STATIC BOX 2 DRAG



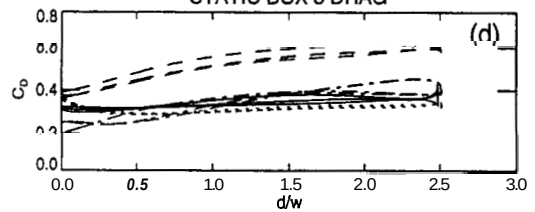
STATIC BOX 2 SIDE FORCE



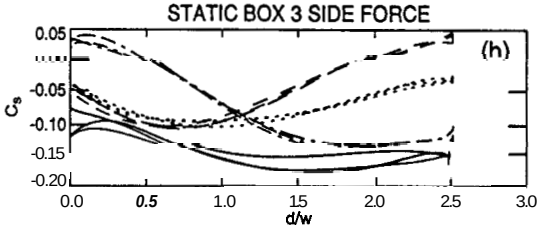
STATIC BOX 2 YAW



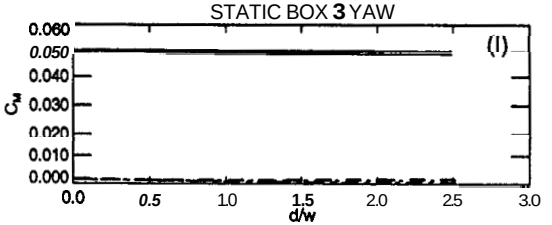
STATIC BOX 3 DRAG



STATIC BOX 3 SIDE FORCE

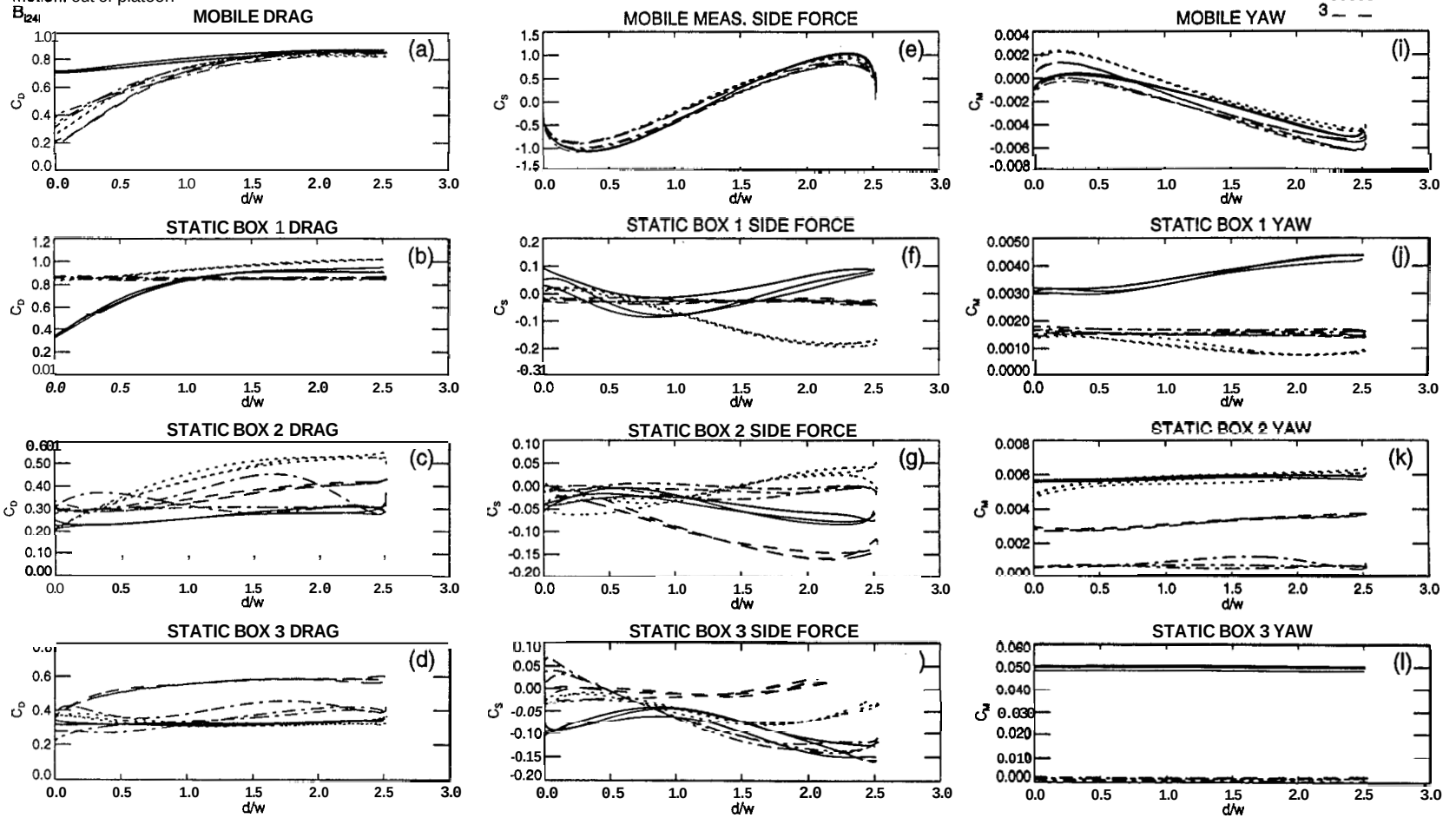


STATIC BOX 3 YAW



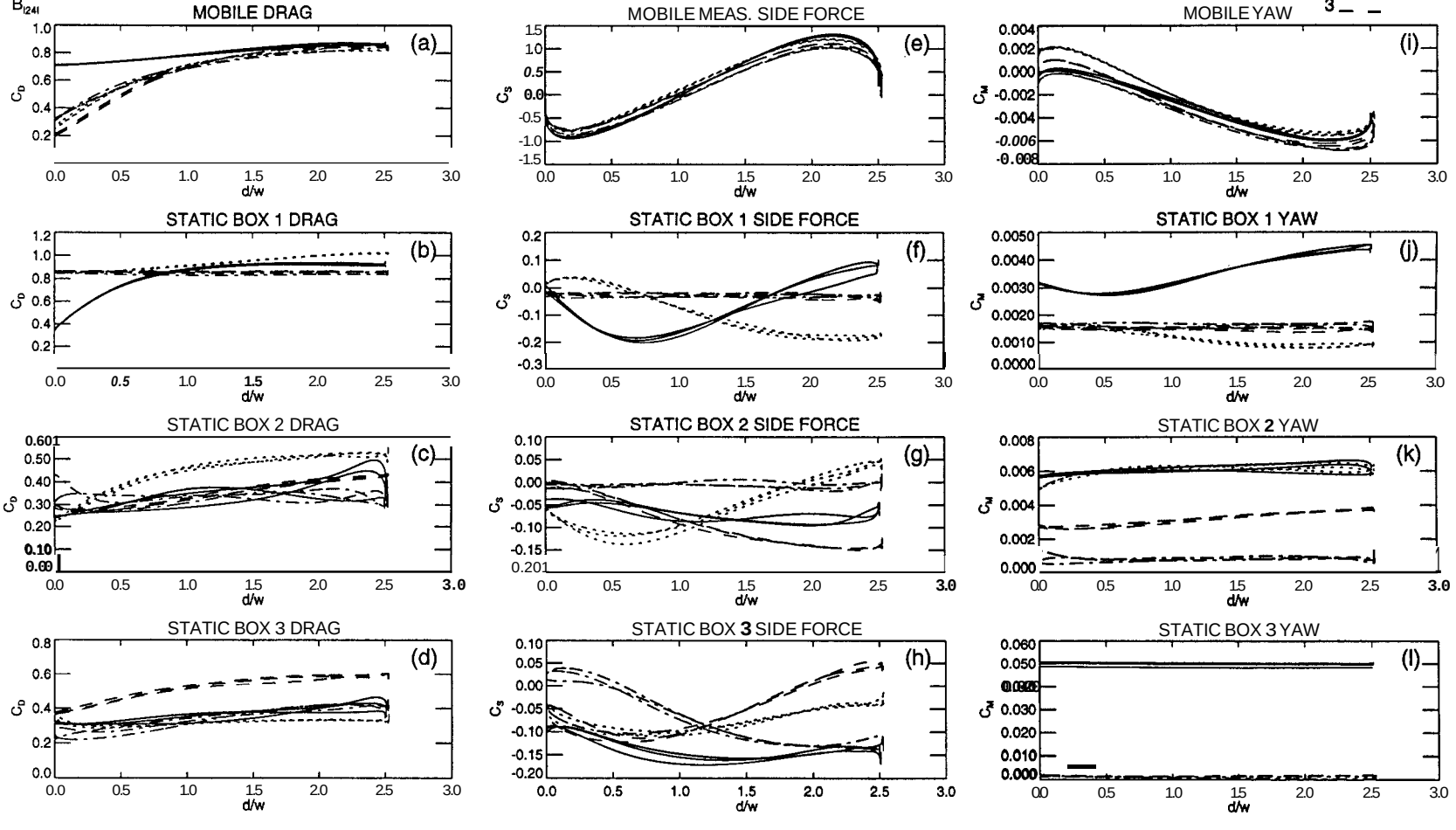
separation: 1(0.2l , 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: out of platoon

moving box position:
1 ——— 4 — · —
2 · · · · ·
3 — —



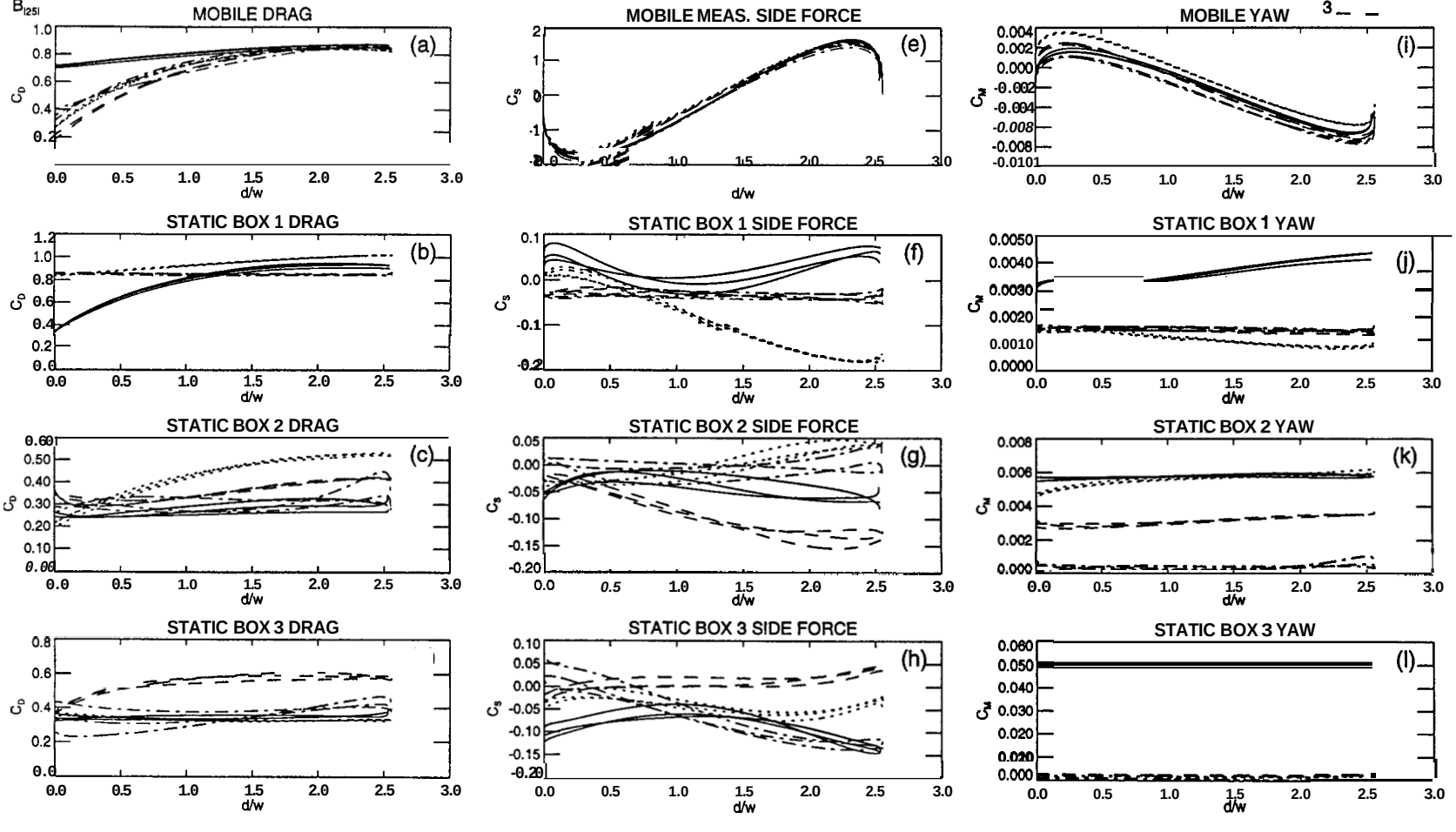
separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: into platoon
B_{l241}

moving box position: 1 —— 4 — · — 2 ····· 3 — —



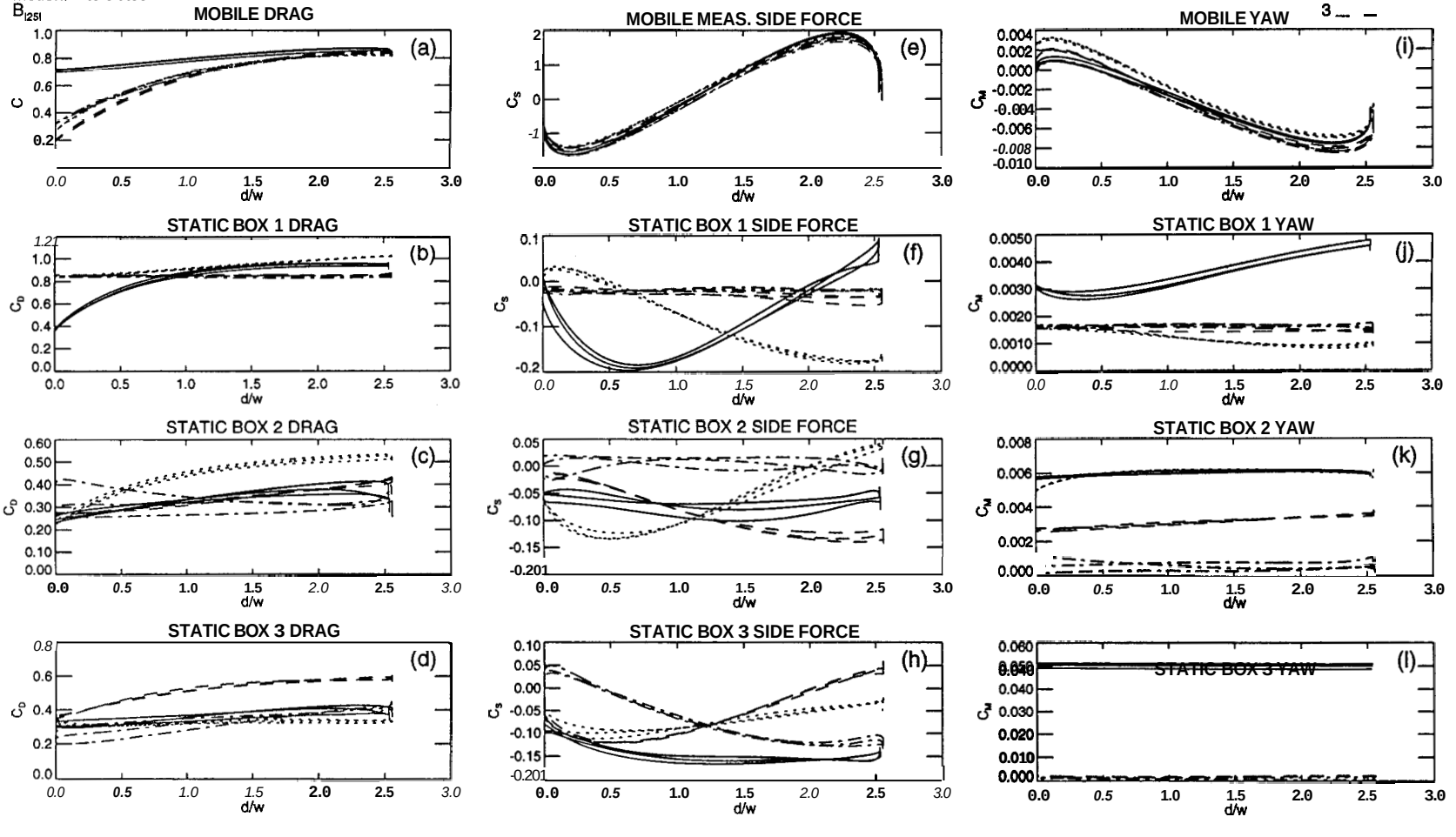
separation: 1(0.2l 2(0.4l), 3(l) = 2
acceleration profik: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: out of platoon

moving box position:
1 —— 4 — · —
2 ····· 3 — —



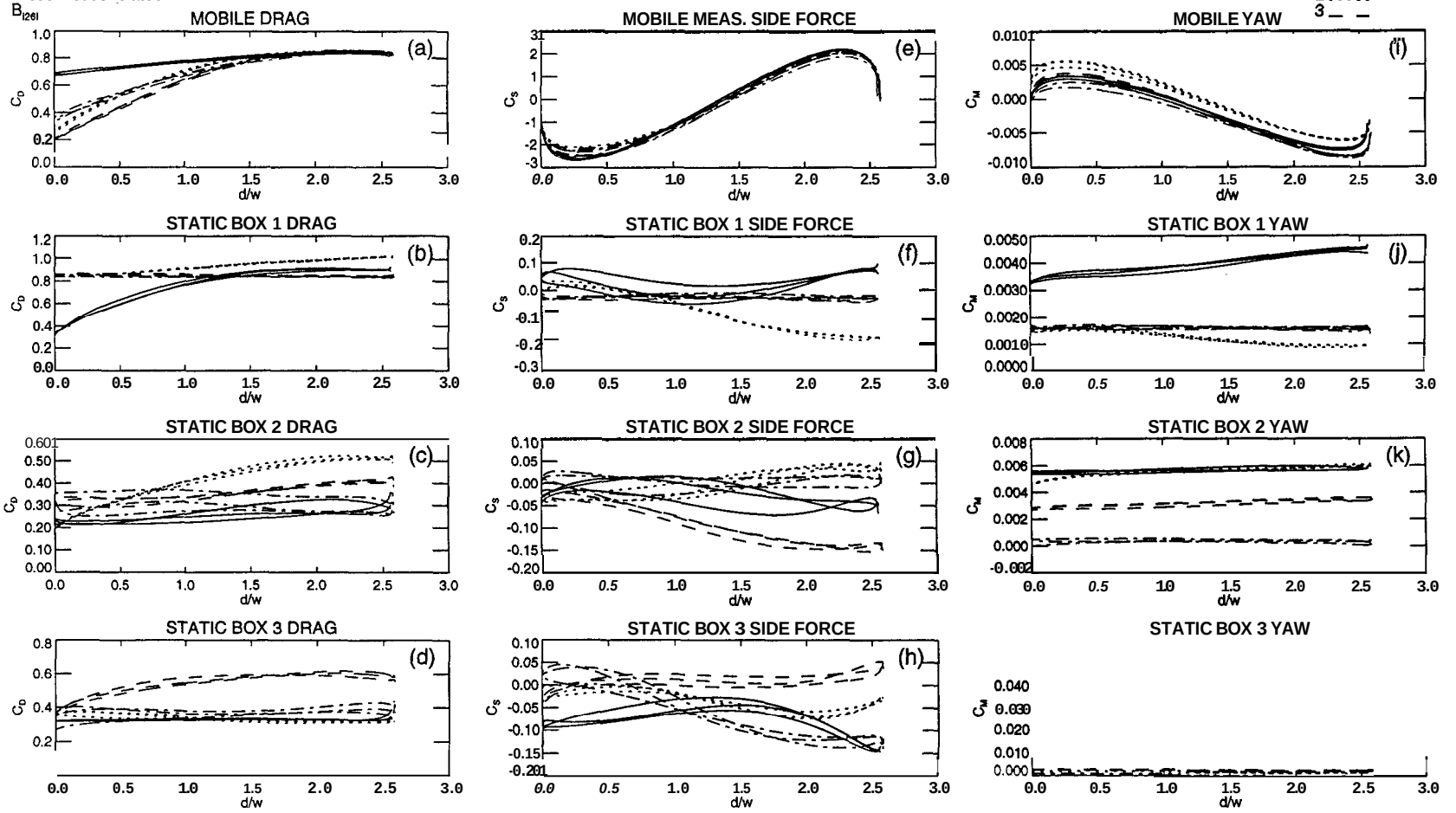
separation: i(0.21 2(0.4l), 3(l) = 2
acceleration profik: 1(static), 2($2t_d$), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 5
motion: into olatoon
B_{l25l}

moving box position:
1 ——— 4 — · —
2 · · · · ·
3 — — —



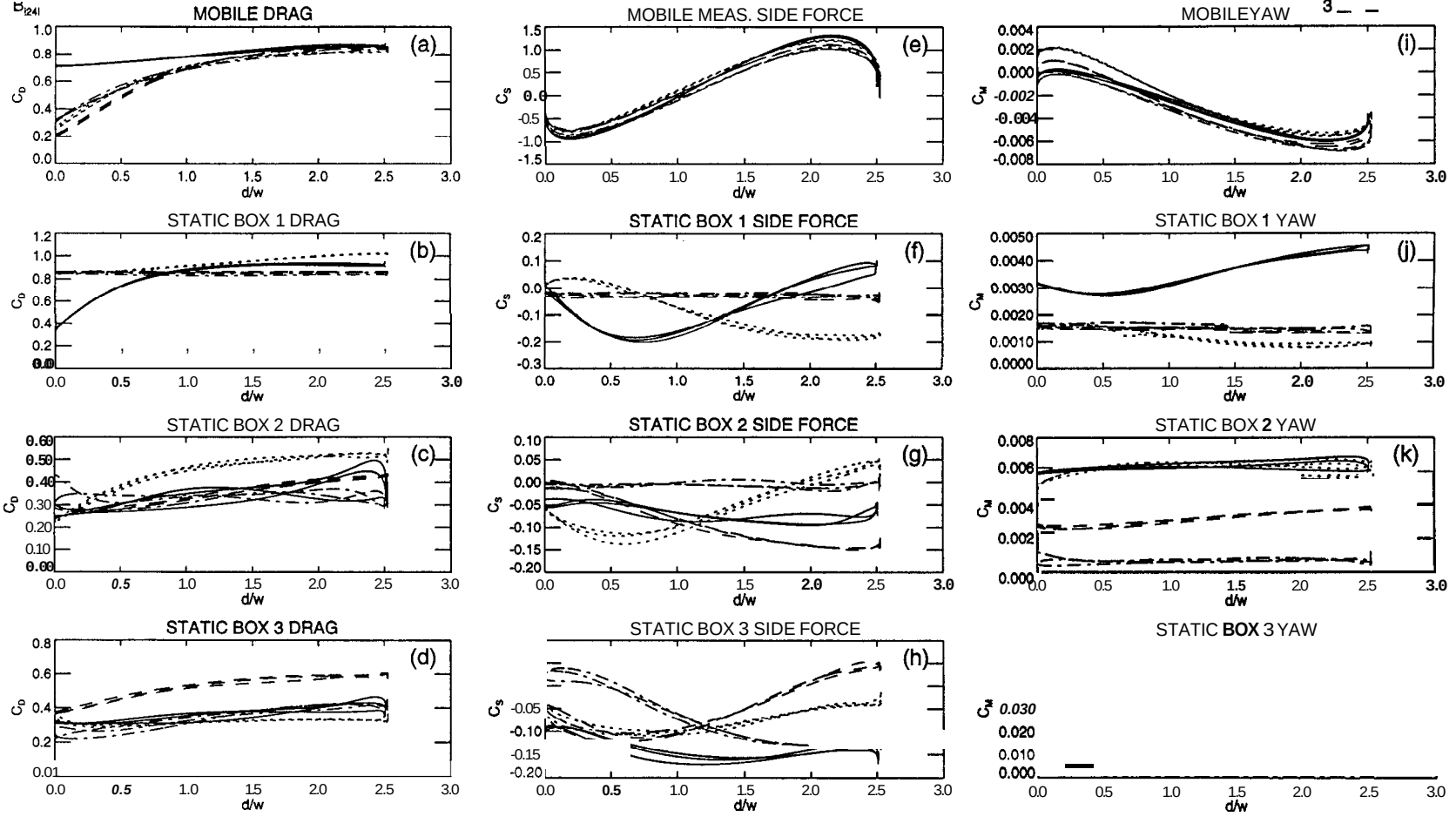
separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 6
motion: out of plane

moving box position:
1 —— 4 — · —
2 · · · · ·
3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 4
motion: Into platoon

moving box position:
1 —— 4 — · —
2 ·····
3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: out of platoon

moving box position:
1 —— 4 — · —
2 - - - - -
3 — —

B_{125l}

MOBILE DRAG (a)

MOBILE MEAS. SIDE FORCE (e)

MOBILE YAW (i)

STATIC BOX 1 DRAG (b)

STATIC BOX 1 SIDE FORCE (f)

STATIC BOX 1 YAW (j)

STATIC BOX 2 DRAG (c)

STATIC BOX 2 SIDE FORCE (g)

STATIC BOX 2 YAW (k)

STATIC BOX 3 DRAG (d)

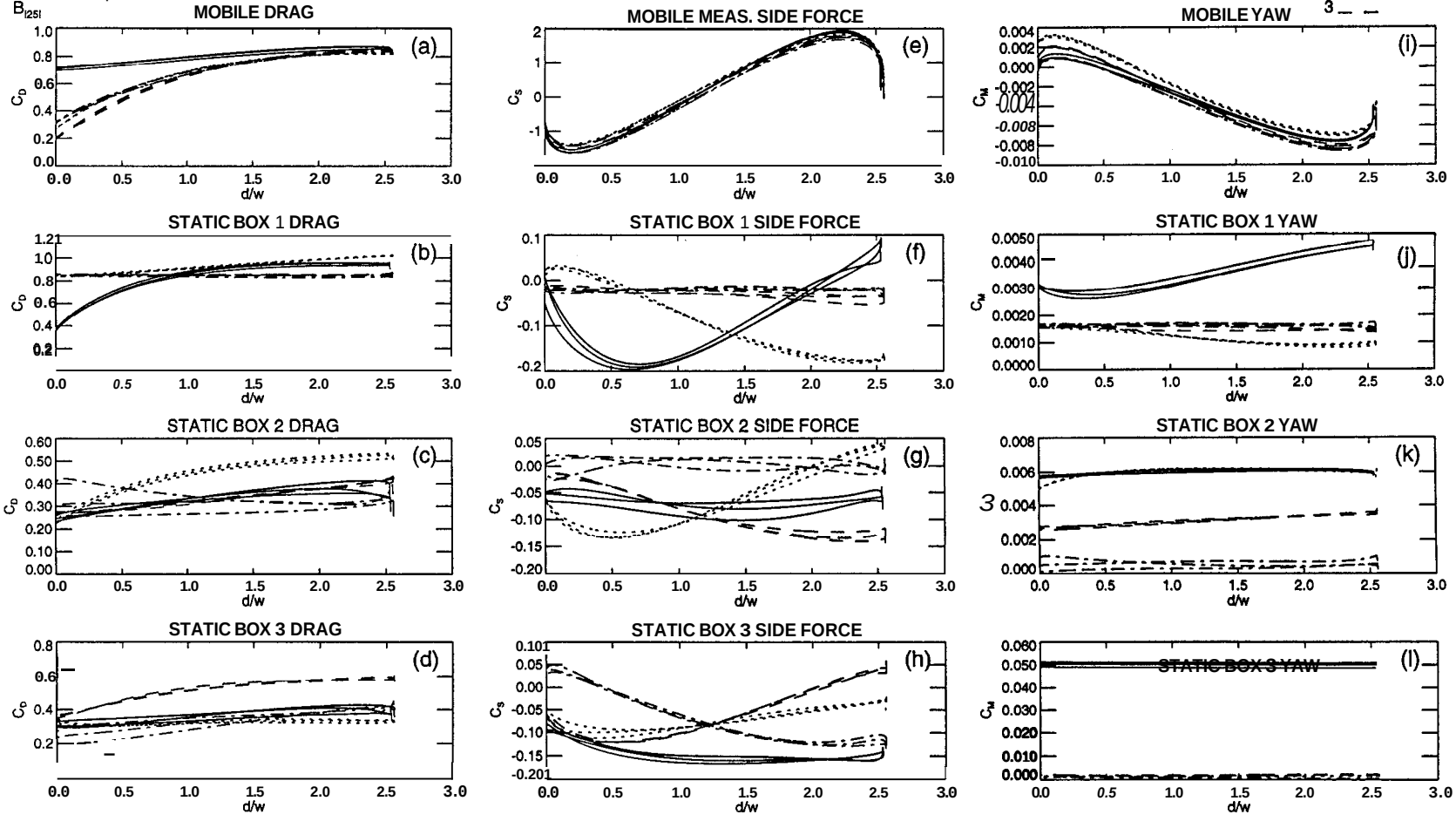
STATIC BOX 3 SIDE FORCE (h)

STATIC BOX 3 YAW (l)

separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3($1.5t_d$), 4(t_d), 5($0.67t_d$), 6($0.50t_d$)= 5
motion: into platoon

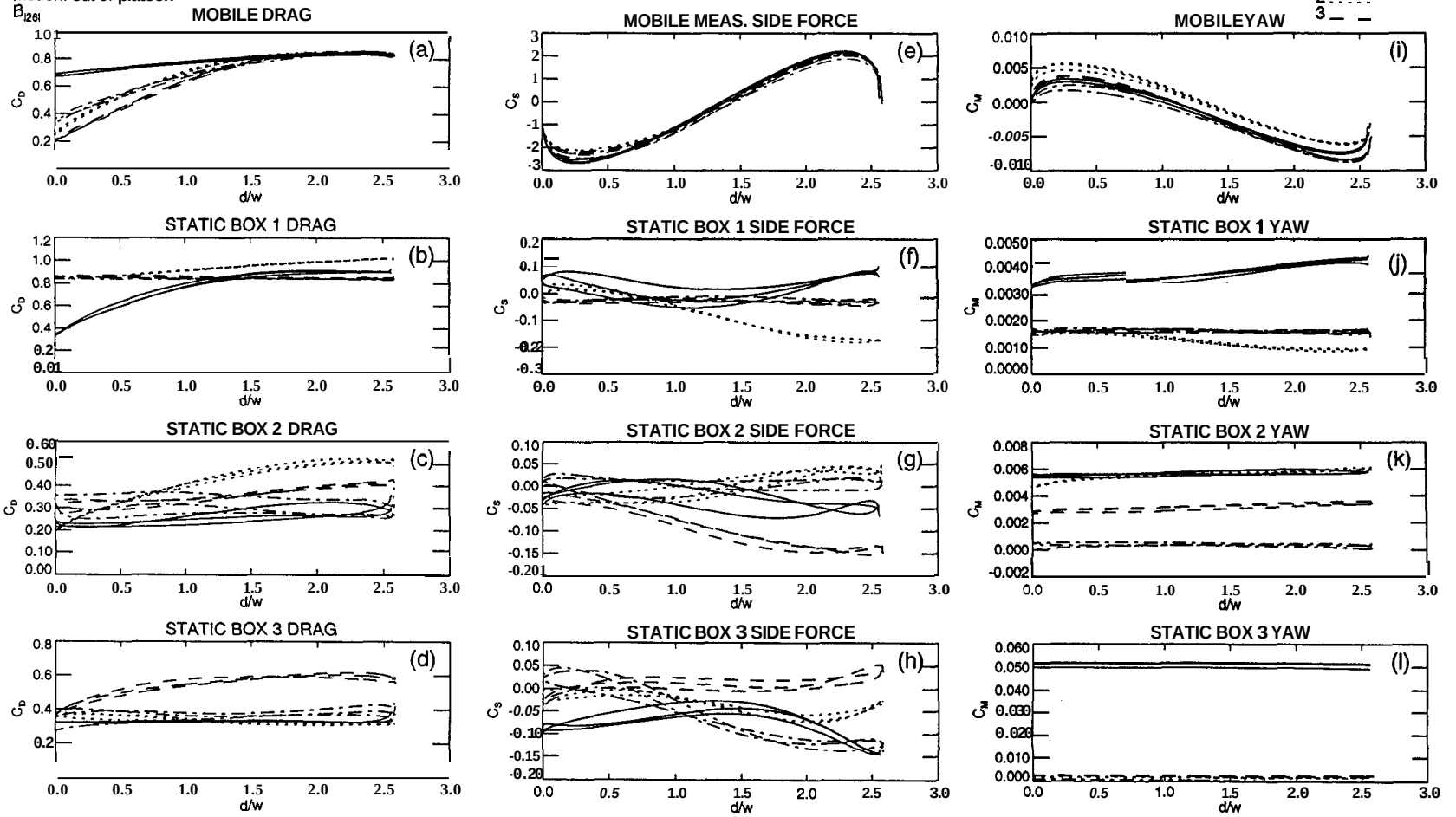
moving box position:
1 ——— 4 — · —
2 · · · · ·
3 — —

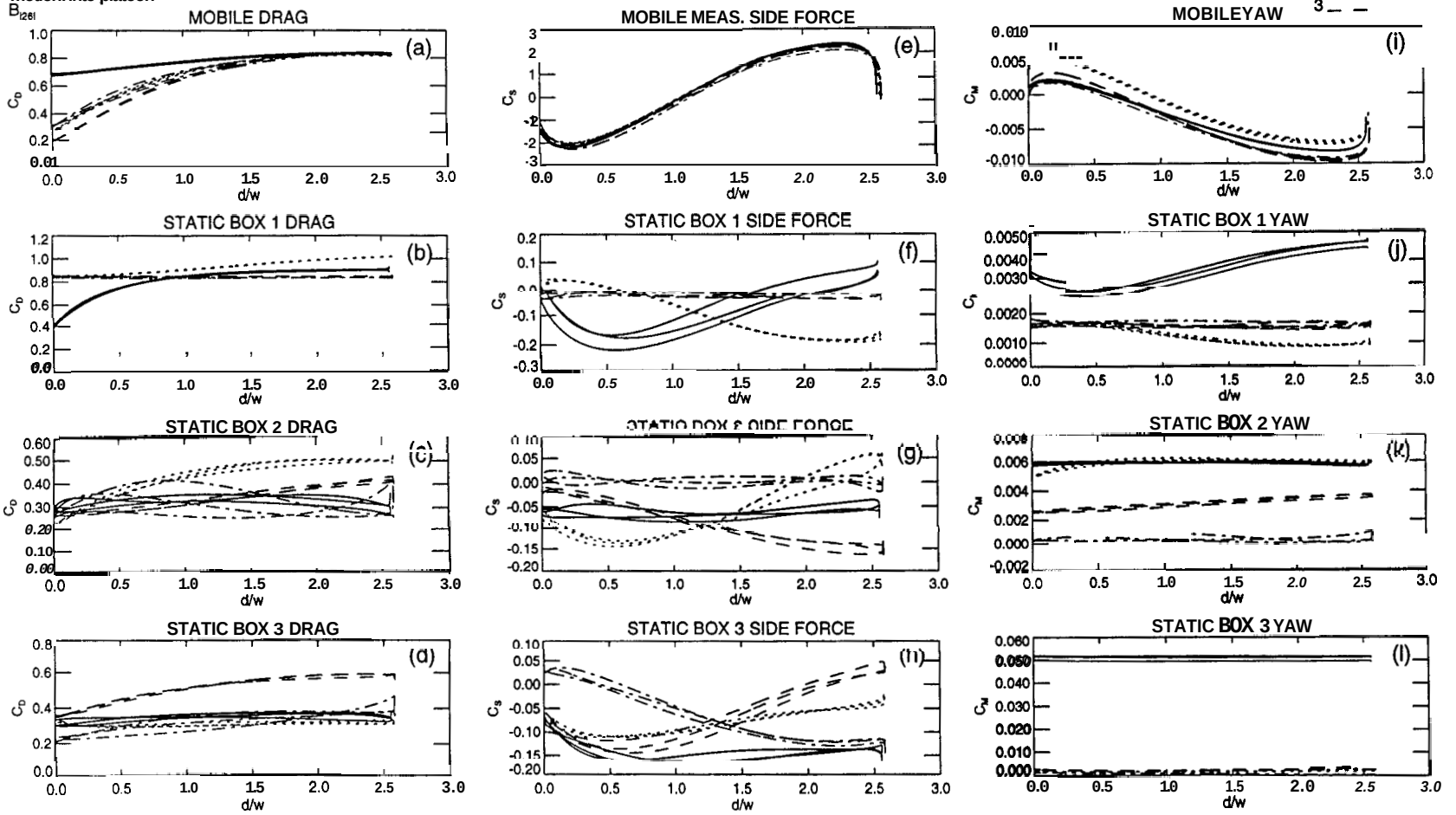
B_{125l}



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static), 2($2t_d$), 3(1.5t_d), 4(t_d), 5(0.67t_d), 6(0.50t_d)= 6
motion: out of platoon
B_{i26l}

moving box position:
1 —— 4 – – –
2 · · · · ·
3 — —



separation: 1(0.2l), 2(0.4l), 3(l) = 2
acceleration profile: 1(static). 2(2t_a). 3(1.5t_a). 4(t_a). 5(0.67t_a). 6(0.50t_a)= 6
motion: into platoon
B_{i26i}

moving box position:
1 —— 4 – · – ·
2 · · · · ·
3 – – –