



### **Disclaimer Notice**

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Iowa Department of Transportation or the Iowa Highway Research Board. The sponsors assume no liability for the contents or use of the information contained in this document. This report does not constitute a standard, specification, or regulation. The sponsors do not endorse products or manufacturers.

### **About CTRE/ISU**

The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, and reliability while improving the learning environment of students, faculty, and staff in transportation-related fields.

**Technical Report Documentation Page**

<b>1. Report No.</b> IHRB Project TR-473		<b>2. Government Accession No.</b>		<b>3. Recipient's Catalog No.</b>	
<b>4. Title and Subtitle</b> Rehabilitation of Concrete Pavements Utilizing Rubblization and Crack and Seat Methods				<b>5. Report Date</b> June 2005	
				<b>6. Performing Organization Code</b>	
<b>7. Author(s)</b> Halil Ceylan, Reshma Mathews, Tejeswi Kota, Kasthurirangan Gopalakrishnan, and Brian J. Coree				<b>8. Performing Organization Report No.</b> CTRE Project 02-106	
<b>9. Performing Organization Name and Address</b> Center for Transportation Research and Education Iowa State University 2901 South Loop Drive, Suite 3100 Ames, IA 50010-8634				<b>10. Work Unit No. (TRAIS)</b>	
				<b>11. Contract or Grant No.</b>	
<b>12. Sponsoring Organization Name and Address</b> Iowa Highway Research Board Iowa Department of Transportation 800 Lincoln Way Ames, IA 50010				<b>13. Type of Report and Period Covered</b> Final Report	
				<b>14. Sponsoring Agency Code</b>	
<b>15. Supplementary Notes</b> Visit <a href="http://www.ctre.iastate.edu">www.ctre.iastate.edu</a> for color PDF files of this and other research reports.					
<b>16. Abstract</b>  <p>Deterioration in portland cement concrete (PCC) pavements can occur due to distresses caused by a combination of traffic loads and weather conditions. Hot mix asphalt (HMA) overlay is the most commonly used rehabilitation technique for such deteriorated PCC pavements. However, the performance of these HMA overlaid pavements is hindered due to the occurrence of reflective cracking, resulting in significant reduction of pavement serviceability. Various fractured slab techniques, including rubblization, crack and seat, and break and seat are used to minimize reflective cracking by reducing the slab action.</p> <p>However, the design of structural overlay thickness for cracked and seated and rubblized pavements is difficult as the resulting structure is neither a "true" rigid pavement nor a "true" flexible pavement. Existing design methodologies use the empirical procedures based on the AASHO Road Test conducted in 1961. But, the AASHO Road Test did not employ any fractured slab technique, and there are numerous limitations associated with extrapolating its results to HMA overlay thickness design for fractured PCC pavements.</p> <p>The main objective of this project is to develop a mechanistic-empirical (ME) design approach for the HMA overlay thickness design for fractured PCC pavements. In this design procedure, failure criteria such as the tensile strain at the bottom of HMA layer and the vertical compressive strain on the surface of subgrade are used to consider HMA fatigue and subgrade rutting, respectively. The developed ME design system is also implemented in a Visual Basic computer program.</p> <p>A partial validation of the design method with reference to an instrumented trial project (IA-141, Polk County) in Iowa is provided in this report. Tensile strain values at the bottom of the HMA layer collected from the FWD testing at this project site are in agreement with the results obtained from the developed computer program.</p>					
<b>17. Key Words</b> fractured PCC pavements—FWD—mechanistic-empirical design—rubblization				<b>18. Distribution Statement</b> No restrictions.	
<b>19. Security Classification (of this report)</b> Unclassified.		<b>20. Security Classification (of this page)</b> Unclassified.		<b>21. No. of Pages</b> 72 plus appendices	<b>22. Price</b> NA

# **REHABILITATION OF CONCRETE PAVEMENTS UTILIZING RUBBLIZATION AND CRACK AND SEAT METHODS**

**Final Report  
June 2005**

**Principal Investigator**

Halil Ceylan

Assistant Professor

Department of Civil, Construction and Environmental Engineering, Iowa State University

**Co-Principal Investigator**

Brian J. Coree

Assistant Professor

Department of Civil, Construction and Environmental Engineering, Iowa State University

**Post-Doctoral Research Associate**

Kasthurirangan Gopalakrishnan

**Research Assistants**

Reshma Mathews and Tejeswi Kota

**Authors**

Halil Ceylan, Reshma Mathews, Tejeswi Kota, Kasthurirangan Gopalakrishnan, and Brian J. Coree

Sponsored by  
the Iowa Highway Research Board  
(IHRB Project TR-473)

Preparation of this report was financed in part  
through funds provided by the Iowa Department of Transportation  
through its research management agreement with the  
Center for Transportation Research and Education,  
CTRE Project 02-106

A report from  
**Center for Transportation Research and Education**

**Iowa State University**

2901 South Loop Drive, Suite 3100

Ames, IA 50010-8634

Phone: 515-294-8103

Fax: 515-294-0467

[www.ctre.iastate.edu](http://www.ctre.iastate.edu)























































































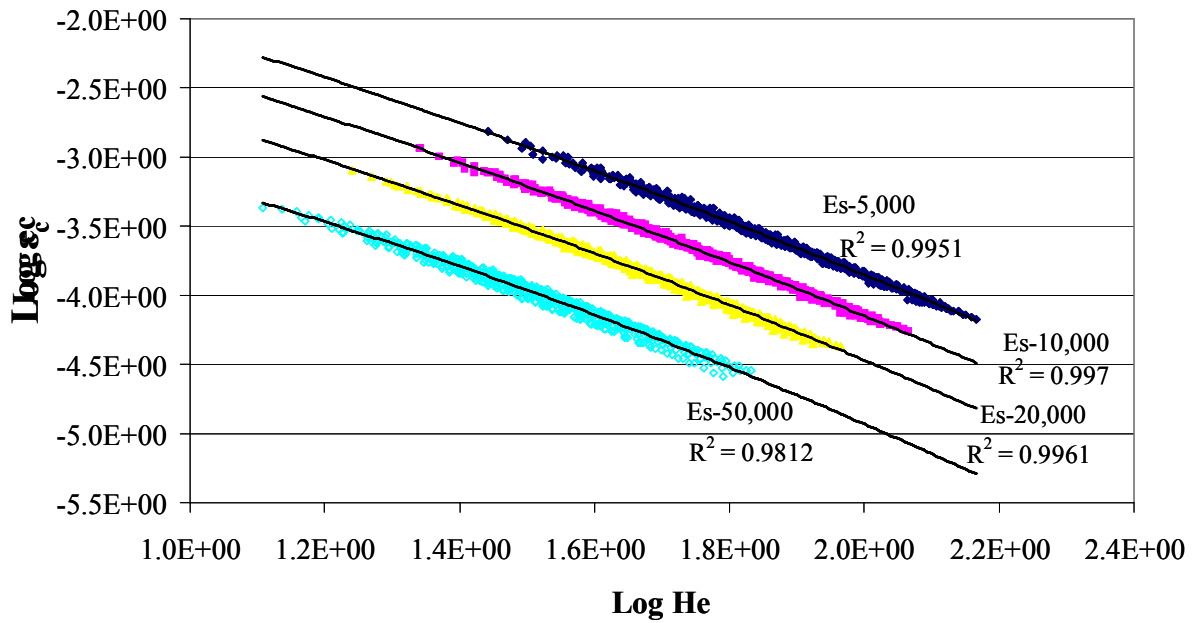




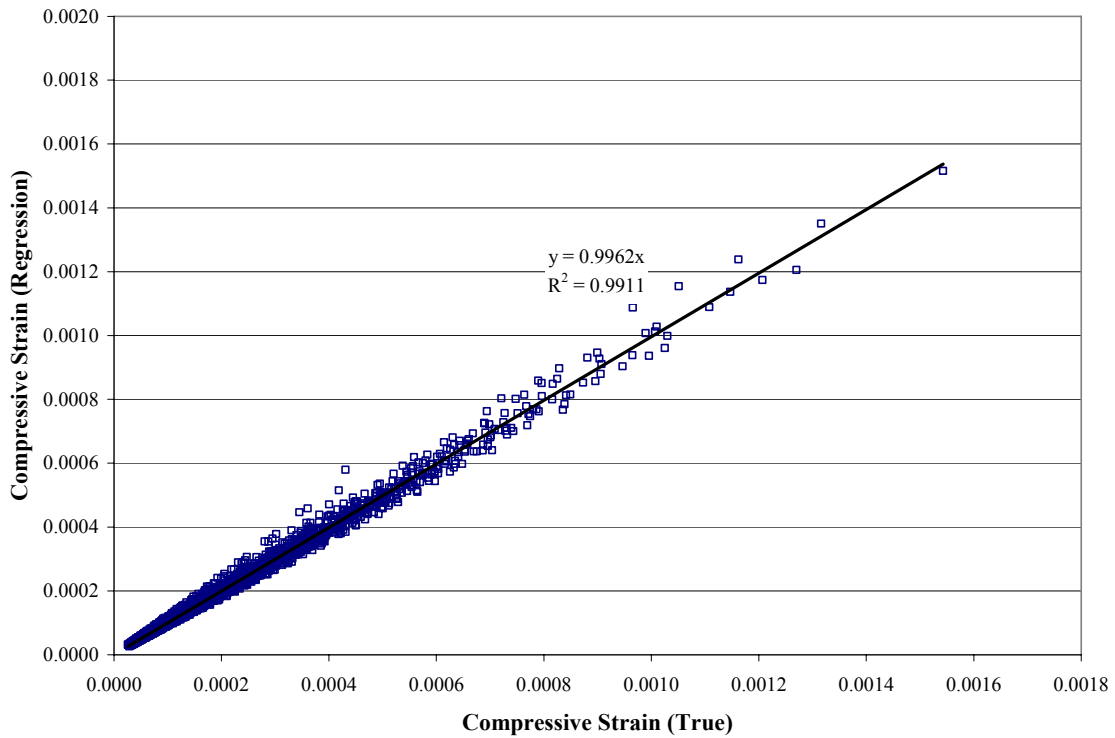








**Figure 8. Relationship between obtained  $\log \epsilon_c$  and  $\log H_e$**



**Figure 9. Relationship between calculated  $\epsilon_c$  and regressed  $\epsilon_c$**



























**APPENDIX A: DATABASE CREATED USING 4-LIP PROGRAM**

## NOTATIONS

$E(1)$  = Elastic modulus of HMA layer (in psi)

$E(2)$  = Elastic modulus of rubblized PCC layer (in psi)

$E(3)$  = Elastic modulus of subgrade (in psi)

$h(1)$  = Thickness of HMA layer (in inches)

$h(2)$  = Thickness of rubblized PCC layer (in inches)

$D(0)$  = Surface deflection measured at 0-inch offset from the center of the load (in mils)

$D(12)$  = Surface deflection measured at 12-inch offset from the center of the load (in mils)

$D(18)$  = Surface deflection measured at 18-inch offset from the center of the load (in mils)

$D(24)$  = Surface deflection measured at 24-inch offset from the center of the load (in mils)

$D(36)$  = Surface deflection measured at 36-inch offset from the center of the load (in mils)

$\epsilon_t$  = Horizontal tensile strain at the bottom of the HMA layer (in strains)

$\epsilon_c$  = Vertical compressive strain on top of the subgrade (in strains)

Note:

1 psi = 6.89 kPa

1 in = 25.4 mm

No.	E(1)	h(1)	E(2)	h(2)	E(3)	D0	D12	D18	D24	D36	et	ec
1	250000	2	50000	6	5000	0.04565	0.02697	0.01937	0.01364	0.005758	-0.000215	2.47E-03
2	250000	2	50000	6	10000	0.03085	0.01526	0.01018	0.00683	0.002835	-0.000217	1.81E-03
3	250000	2	50000	6	20000	0.02112	0.008268	0.005092	0.00328	0.001379	-0.000218	1.23E-03
4	250000	2	50000	6	50000	0.01357	0.003502	0.001948	0.00123	0.0005429	-0.000218	6.47E-04
5	250000	2	50000	8	5000	0.03842	0.02291	0.01703	0.01238	0.005385	-0.000181	1.84E-03
6	250000	2	50000	8	10000	0.02728	0.01368	0.009505	0.0066	0.002795	-0.000195	1.36E-03
7	250000	2	50000	8	20000	0.01963	0.007766	0.004964	0.00329	0.001386	-0.000206	9.40E-04
8	250000	2	50000	8	50000	0.01357	0.003514	0.001961	0.00124	0.0005464	-0.000217	5.04E-04
9	250000	2	50000	10	5000	0.03314	0.01944	0.01471	0.01088	0.004834	-0.00017	1.41E-03
10	250000	2	50000	10	10000	0.02467	0.01223	0.008711	0.00619	0.002673	-0.000188	1.05E-03
11	250000	2	50000	10	20000	0.01855	0.007275	0.004763	0.00323	0.001373	-0.000202	7.32E-04
12	250000	2	50000	10	50000	0.01356	0.003522	0.001971	0.00125	0.0005496	-0.000216	3.96E-04
13	250000	2	50000	12	5000	0.02913	0.01654	0.01261	0.00943	0.004246	-0.000168	1.10E-03
14	250000	2	50000	12	10000	0.02268	0.01096	0.007901	0.0057	0.002502	-0.000186	8.33E-04
15	250000	2	50000	12	20000	0.01773	0.006821	0.004528	0.00312	0.001342	-0.000201	5.82E-04
16	250000	2	50000	12	50000	0.01356	0.003525	0.001977	0.00126	0.0005523	-0.000216	3.17E-04
17	250000	2	50000	14	5000	0.02603	0.01416	0.0108	0.00813	0.003694	-0.00017	8.80E-04
18	250000	2	50000	14	10000	0.02111	0.009847	0.007132	0.0052	0.00231	-0.000186	6.72E-04
19	250000	2	50000	14	20000	0.01708	0.006411	0.00428	0.00298	0.001297	-0.000201	4.72E-04
20	250000	2	50000	14	50000	0.01355	0.003527	0.001981	0.00126	0.0005543	-0.000216	2.57E-04
21	250000	2	75000	6	5000	0.03986	0.02525	0.01873	0.01348	0.005765	-8.81E-05	2.04E-03
22	250000	2	75000	6	10000	0.02684	0.01459	0.01012	0.00694	0.002887	-0.000104	1.53E-03
23	250000	2	75000	6	20000	0.01813	0.008018	0.005156	0.00338	0.001403	-0.000117	1.08E-03
24	250000	2	75000	6	50000	0.01123	0.003431	0.002002	0.00127	0.0005463	-0.000131	6.05E-04
25	250000	2	75000	8	5000	0.03261	0.02086	0.01597	0.01183	0.005224	-6.97E-05	1.49E-03
26	250000	2	75000	8	10000	0.02308	0.01276	0.009226	0.00656	0.002804	-9.12E-05	1.14E-03
27	250000	2	75000	8	20000	0.01635	0.007352	0.00494	0.00335	0.001407	-0.000109	8.15E-04
28	250000	2	75000	8	50000	0.01087	0.003343	0.001999	0.00129	0.0005507	-0.000128	4.66E-04
29	250000	2	75000	10	5000	0.02733	0.01718	0.01336	0.01006	0.004532	-6.81E-05	1.13E-03
30	250000	2	75000	10	10000	0.02035	0.01113	0.008242	0.006	0.002621	-8.96E-05	8.70E-04
31	250000	2	75000	10	20000	0.01507	0.006721	0.004644	0.00323	0.001378	-0.000108	6.30E-04
32	250000	2	75000	10	50000	0.0106	0.003247	0.001975	0.00129	0.0005525	-0.000128	3.63E-04
33	250000	2	75000	12	5000	0.02338	0.01419	0.01111	0.00844	0.003849	-7.23E-05	8.76E-04
34	250000	2	75000	12	10000	0.01827	0.009711	0.007281	0.00537	0.002389	-9.18E-05	6.84E-04
35	250000	2	75000	12	20000	0.01409	0.006147	0.004315	0.00306	0.001324	-0.00011	4.98E-04
36	250000	2	75000	12	50000	0.0104	0.003152	0.001937	0.00128	0.0005511	-0.000128	2.89E-04
37	250000	2	75000	14	5000	0.02038	0.01182	0.009249	0.00706	0.003246	-7.85E-05	6.93E-04
38	250000	2	75000	14	10000	0.01663	0.008501	0.0064	0.00477	0.002145	-9.53E-05	5.49E-04
39	250000	2	75000	14	20000	0.01332	0.005634	0.003983	0.00286	0.001254	-0.000111	4.02E-04
40	250000	2	75000	14	50000	0.01024	0.003063	0.001892	0.00126	0.0005465	-0.000128	2.34E-04
41	250000	2	100000	6	5000	0.03631	0.02404	0.01818	0.01327	0.005731	-1.97E-05	1.76E-03
42	250000	2	100000	6	10000	0.02442	0.0141	0.01002	0.00698	0.002918	-4.2E-05	1.34E-03
43	250000	2	100000	6	20000	0.01637	0.007841	0.005184	0.00344	0.001422	-6.12E-05	9.71E-04
44	250000	2	100000	6	50000	0.009931	0.00339	0.002036	0.0013	0.0005501	-8.21E-05	5.66E-04
45	250000	2	100000	8	5000	0.0291	0.01944	0.01514	0.01136	0.005064	-1.22E-05	1.28E-03
46	250000	2	100000	8	10000	0.02061	0.01212	0.008978	0.00648	0.002795	-3.64E-05	9.89E-04
47	250000	2	100000	8	20000	0.01447	0.007074	0.004901	0.00338	0.00142	-5.77E-05	7.26E-04
48	250000	2	100000	8	50000	0.009389	0.003243	0.002017	0.00131	0.0005555	-8.06E-05	4.32E-04
49	250000	2	100000	10	5000	0.02387	0.01566	0.01238	0.00942	0.00428	-1.71E-05	9.60E-04
50	250000	2	100000	10	10000	0.01784	0.01038	0.007867	0.00581	0.002563	-3.93E-05	7.54E-04

No.	E(1)	h(1)	E(2)	h(2)	E(3)	D0	D12	D18	D24	D36	et	ec
51	250000	2	100000	10	20000	0.0131	0.006361	0.004536	0.00321	0.001378	-5.95E-05	5.58E-04
52	250000	2	100000	10	50000	0.008999	0.00309	0.001969	0.00131	0.000556	-8.11E-05	3.36E-04
53	250000	2	100000	12	5000	0.02	0.01266	0.01006	0.00772	0.003547	-2.54E-05	7.39E-04
54	250000	2	100000	12	10000	0.01573	0.008886	0.006812	0.0051	0.002287	-4.44E-05	5.89E-04
55	250000	2	100000	12	20000	0.01206	0.005718	0.004145	0.00299	0.001305	-6.25E-05	4.40E-04
56	250000	2	100000	12	50000	0.008704	0.002942	0.001903	0.00129	0.000551	-8.22E-05	2.66E-04
57	250000	2	100000	14	5000	0.01711	0.01033	0.008203	0.00632	0.002924	-3.42E-05	5.80E-04
58	250000	2	100000	14	10000	0.01407	0.007631	0.005871	0.00443	0.00201	-4.99E-05	4.70E-04
59	250000	2	100000	14	20000	0.01124	0.005149	0.00376	0.00274	0.001215	-6.57E-05	3.54E-04
60	250000	2	100000	14	50000	0.008472	0.002806	0.001828	0.00125	0.0005412	-8.33E-05	2.15E-04
61	250000	2	125000	6	5000	0.03384	0.0231	0.01771	0.01305	0.00568	2.2E-05	1.58E-03
62	250000	2	125000	6	10000	0.02276	0.01371	0.009923	0.00699	0.002936	-3.48E-06	1.21E-03
63	250000	2	125000	6	20000	0.01518	0.0077	0.005194	0.00349	0.001438	-2.6E-05	8.89E-04
64	250000	2	125000	6	50000	0.009082	0.00336	0.00206	0.00132	0.0005537	-5.12E-05	5.33E-04
65	250000	2	125000	8	5000	0.02667	0.01836	0.01447	0.01094	0.004915	2.15E-05	1.13E-03
66	250000	2	125000	8	10000	0.01893	0.01163	0.008758	0.00639	0.002776	-3.71E-06	8.85E-04
67	250000	2	125000	8	20000	0.01322	0.006862	0.004856	0.00339	0.001429	-2.62E-05	6.60E-04
68	250000	2	125000	8	50000	0.008439	0.003172	0.002027	0.00133	0.0005598	-5.12E-05	4.04E-04
69	250000	2	125000	10	5000	0.0215	0.01453	0.0116	0.00889	0.004066	1.21E-05	8.45E-04
70	250000	2	125000	10	10000	0.01615	0.009809	0.007552	0.00563	0.002504	-9.94E-06	6.71E-04
71	250000	2	125000	10	20000	0.01181	0.006091	0.004438	0.00318	0.001373	-3.04E-05	5.05E-04
72	250000	2	125000	10	50000	0.007977	0.002981	0.00196	0.00132	0.0005591	-5.29E-05	3.13E-04
73	250000	2	125000	12	5000	0.01771	0.01154	0.009258	0.00715	0.003303	9.85E-07	6.46E-04
74	250000	2	125000	12	10000	0.01403	0.008268	0.006433	0.00486	0.002195	-1.71E-05	5.22E-04
75	250000	2	125000	12	20000	0.01074	0.005402	0.004001	0.00292	0.001284	-3.49E-05	3.97E-04
76	250000	2	125000	12	50000	0.007629	0.002799	0.001873	0.00129	0.0005509	-5.48E-05	2.47E-04
77	250000	2	125000	14	5000	0.01492	0.009262	0.007544	0.00583	0.002675	-9.53E-06	5.04E-04
78	250000	2	125000	14	10000	0.01238	0.00699	0.005455	0.00415	0.001896	-2.4E-05	4.15E-04
79	250000	2	125000	14	20000	0.009885	0.004797	0.003579	0.00264	0.001179	-3.91E-05	3.18E-04
80	250000	2	125000	14	50000	0.007355	0.002633	0.001777	0.00124	0.0005364	-5.65E-05	2.00E-04
81	250000	2	150000	6	5000	0.03198	0.02233	0.01729	0.01284	0.005623	4.93E-05	1.44E-03
82	250000	2	150000	6	10000	0.02152	0.0134	0.009822	0.00699	0.002946	2.21E-05	1.11E-03
83	250000	2	150000	6	20000	0.01432	0.00758	0.005194	0.00352	0.00145	-2.26E-06	8.24E-04
84	250000	2	150000	6	50000	0.008477	0.003334	0.002077	0.00134	0.0005571	-3E-05	5.05E-04
85	250000	2	150000	8	5000	0.02484	0.01748	0.0139	0.01058	0.004777	4.27E-05	1.03E-03
86	250000	2	150000	8	10000	0.01769	0.01122	0.008558	0.0063	0.002753	1.74E-05	8.08E-04
87	250000	2	150000	8	20000	0.01232	0.006687	0.00481	0.00339	0.001434	-5.62E-06	6.08E-04
88	250000	2	150000	8	50000	0.007768	0.003116	0.002032	0.00135	0.0005637	-3.15E-05	3.81E-04
89	250000	2	150000	10	5000	0.01973	0.01362	0.01096	0.00844	0.00388	2.99E-05	7.61E-04
90	250000	2	150000	10	10000	0.0149	0.009347	0.007278	0.00547	0.002447	8.63E-06	6.10E-04
91	250000	2	150000	10	20000	0.01088	0.005873	0.004348	0.00315	0.001365	-1.16E-05	4.64E-04
92	250000	2	150000	10	50000	0.007261	0.002896	0.001949	0.00133	0.0005615	-3.43E-05	2.94E-04
93	250000	2	150000	12	5000	0.01602	0.01066	0.008611	0.00668	0.003099	1.69E-05	5.77E-04
94	250000	2	150000	12	10000	0.01278	0.007773	0.006113	0.00465	0.002112	-6.09E-08	4.72E-04
95	250000	2	150000	12	20000	0.009786	0.005149	0.003874	0.00286	0.001262	-1.72E-05	3.63E-04
96	250000	2	150000	12	50000	0.006879	0.002691	0.001845	0.00128	0.0005503	-3.69E-05	2.32E-04
97	250000	2	150000	14	5000	0.01333	0.008439	0.006811	0.0053	0.002473	5.3E-06	4.47E-04
98	250000	2	150000	14	10000	0.01114	0.006485	0.005113	0.00391	0.001797	-7.88E-06	3.73E-04
99	250000	2	150000	14	20000	0.008918	0.004519	0.003423	0.00255	0.001145	-2.22E-05	2.91E-04
100	250000	2	150000	14	50000	0.006579	0.002503	0.001733	0.00122	0.0005317	-3.92E-05	1.87E-04

No.	E(1)	h(1)	E(2)	h(2)	E(3)	D0	D12	D18	D24	D36	et	ec
101	250000	4	50000	6	5000	0.03773	0.02662	0.02128	0.01698	0.0108	-0.000324	1.54E-03
102	250000	4	50000	6	10000	0.02511	0.0155	0.01158	0.00877	0.005205	-0.000301	1.15E-03
103	250000	4	50000	6	20000	0.01702	0.008793	0.006058	0.00435	0.002479	-0.00028	7.96E-04
104	250000	4	50000	6	50000	0.01083	0.004066	0.002447	0.00166	0.0009442	-0.000259	4.31E-04
105	250000	4	50000	8	5000	0.03338	0.02365	0.01932	0.01583	0.0106	-0.000288	1.21E-03
106	250000	4	50000	8	10000	0.0229	0.01417	0.01084	0.00843	0.005236	-0.000278	9.06E-04
107	250000	4	50000	8	20000	0.0161	0.008317	0.005844	0.00429	0.002515	-0.000268	6.34E-04
108	250000	4	50000	8	50000	0.01082	0.004073	0.002456	0.00167	0.000949	-0.000258	3.45E-04
109	250000	4	50000	10	5000	0.03007	0.02121	0.01757	0.01467	0.01021	-0.000268	9.65E-04
110	250000	4	50000	10	10000	0.02121	0.01305	0.01013	0.00804	0.005185	-0.000265	7.28E-04
111	250000	4	50000	10	20000	0.01538	0.007893	0.005617	0.0042	0.00253	-0.000262	5.12E-04
112	250000	4	50000	10	50000	0.01082	0.004077	0.002463	0.00168	0.0009536	-0.000258	2.80E-04
113	250000	4	50000	12	5000	0.02747	0.01917	0.01601	0.01355	0.009698	-0.000258	7.87E-04
114	250000	4	50000	12	10000	0.01987	0.01209	0.009468	0.00763	0.005076	-0.000258	5.96E-04
115	250000	4	50000	12	20000	0.01481	0.007523	0.005394	0.00409	0.002524	-0.000258	4.21E-04
116	250000	4	50000	12	50000	0.01082	0.004079	0.002467	0.00168	0.0009579	-0.000258	2.31E-04
117	250000	4	50000	14	5000	0.02535	0.01744	0.01463	0.01249	0.009131	-0.000252	6.52E-04
118	250000	4	50000	14	10000	0.0188	0.01127	0.008869	0.00723	0.004926	-0.000254	4.95E-04
119	250000	4	50000	14	20000	0.01435	0.007199	0.005181	0.00397	0.002502	-0.000256	3.50E-04
120	250000	4	50000	14	50000	0.01082	0.00408	0.00247	0.00169	0.0009616	-0.000257	1.93E-04
121	250000	4	75000	6	5000	0.03406	0.02484	0.02037	0.0166	0.01091	-0.000228	1.32E-03
122	250000	4	75000	6	10000	0.02263	0.01459	0.01125	0.00872	0.005319	-0.000216	1.01E-03
123	250000	4	75000	6	20000	0.01523	0.008311	0.005962	0.00439	0.00254	-0.000205	7.27E-04
124	250000	4	75000	6	50000	0.009457	0.003805	0.002433	0.0017	0.0009621	-0.000193	4.18E-04
125	250000	4	75000	8	5000	0.0296	0.02172	0.01823	0.01527	0.01057	-0.000197	1.01E-03
126	250000	4	75000	8	10000	0.02022	0.0131	0.01038	0.00828	0.005319	-0.000195	7.80E-04
127	250000	4	75000	8	20000	0.01407	0.007698	0.005667	0.00429	0.002579	-0.000193	5.69E-04
128	250000	4	75000	8	50000	0.009218	0.003707	0.002404	0.0017	0.0009738	-0.00019	3.31E-04
129	250000	4	75000	10	5000	0.02627	0.0192	0.01635	0.01395	0.01003	-0.000183	7.96E-04
130	250000	4	75000	10	10000	0.01841	0.01187	0.009563	0.0078	0.005221	-0.000185	6.19E-04
131	250000	4	75000	10	20000	0.01319	0.007166	0.005367	0.00415	0.002585	-0.000187	4.54E-04
132	250000	4	75000	10	50000	0.009034	0.003614	0.002366	0.00169	0.0009827	-0.000189	2.66E-04
133	250000	4	75000	12	5000	0.02366	0.01712	0.0147	0.01271	0.009393	-0.000176	6.43E-04
134	250000	4	75000	12	10000	0.01701	0.01084	0.008827	0.00732	0.005057	-0.000181	5.01E-04
135	250000	4	75000	12	20000	0.01251	0.006709	0.005078	0.004	0.002564	-0.000184	3.69E-04
136	250000	4	75000	12	50000	0.008889	0.00353	0.002324	0.00168	0.0009882	-0.000188	2.17E-04
137	250000	4	75000	14	5000	0.02156	0.01535	0.01325	0.01156	0.008708	-0.000173	5.29E-04
138	250000	4	75000	14	10000	0.01589	0.009961	0.008164	0.00685	0.004851	-0.000178	4.13E-04
139	250000	4	75000	14	20000	0.01196	0.006315	0.004809	0.00383	0.002522	-0.000183	3.05E-04
140	250000	4	75000	14	50000	0.008773	0.003456	0.002281	0.00166	0.0009901	-0.000187	1.80E-04
141	250000	4	100000	6	5000	0.03165	0.02364	0.01971	0.01629	0.01094	-0.000167	1.16E-03
142	250000	4	100000	6	10000	0.02101	0.01398	0.01101	0.00867	0.005392	-0.000161	9.04E-04
143	250000	4	100000	6	20000	0.01408	0.008003	0.005893	0.00441	0.002583	-0.000156	6.68E-04
144	250000	4	100000	6	50000	0.008628	0.003662	0.00243	0.00172	0.0009756	-0.000151	4.01E-04
145	250000	4	100000	8	5000	0.02721	0.02047	0.01746	0.01483	0.0105	-0.000142	8.81E-04
146	250000	4	100000	8	10000	0.01853	0.01241	0.01005	0.00816	0.005362	-0.000144	6.92E-04
147	250000	4	100000	8	20000	0.01281	0.007316	0.005546	0.00428	0.002622	-0.000145	5.16E-04
148	250000	4	100000	8	50000	0.008263	0.003507	0.002377	0.00172	0.0009916	-0.000147	3.13E-04
149	250000	4	100000	10	5000	0.02391	0.01792	0.01552	0.01343	0.009859	-0.000132	6.89E-04
150	250000	4	100000	10	10000	0.01669	0.01113	0.009181	0.00762	0.005224	-0.000137	5.44E-04

No.	E(1)	h(1)	E(2)	h(2)	E(3)	D0	D12	D18	D24	D36	et	ec
151	250000	4	100000	10	20000	0.01187	0.006728	0.005201	0.00411	0.002618	-0.000141	4.08E-04
152	250000	4	100000	10	50000	0.007987	0.003363	0.002313	0.0017	0.001002	-0.000146	2.50E-04
153	250000	4	100000	12	5000	0.02134	0.01583	0.01383	0.01211	0.009126	-0.000128	5.53E-04
154	250000	4	100000	12	10000	0.01528	0.01007	0.008401	0.00709	0.005017	-0.000134	4.37E-04
155	250000	4	100000	12	20000	0.01114	0.006228	0.004876	0.00392	0.002583	-0.000139	3.30E-04
156	250000	4	100000	12	50000	0.007771	0.003235	0.002245	0.00167	0.001007	-0.000145	2.03E-04
157	250000	4	100000	14	5000	0.01926	0.01405	0.01234	0.0109	0.008363	-0.000127	4.53E-04
158	250000	4	100000	14	10000	0.01415	0.009169	0.007704	0.00658	0.004771	-0.000133	3.59E-04
159	250000	4	100000	14	20000	0.01056	0.005801	0.004576	0.00373	0.002524	-0.000139	2.71E-04
160	250000	4	100000	14	50000	0.007599	0.003122	0.002177	0.00164	0.001006	-0.000145	1.67E-04
161	250000	4	125000	6	5000	0.02993	0.02276	0.01919	0.01603	0.01094	-0.000124	1.05E-03
162	250000	4	125000	6	10000	0.01984	0.01352	0.01081	0.00861	0.005441	-0.000123	8.25E-04
163	250000	4	125000	6	20000	0.01326	0.007779	0.005835	0.00442	0.002617	-0.000122	6.20E-04
164	250000	4	125000	6	50000	0.008057	0.003568	0.002428	0.00174	0.0009864	-0.000121	3.83E-04
165	250000	4	125000	8	5000	0.02552	0.01956	0.01689	0.01448	0.01041	-0.000105	7.90E-04
166	250000	4	125000	8	10000	0.01734	0.01191	0.009801	0.00805	0.005383	-0.000109	6.26E-04
167	250000	4	125000	8	20000	0.01194	0.007044	0.005452	0.00427	0.002652	-0.000113	4.75E-04
168	250000	4	125000	8	50000	0.007616	0.003375	0.002358	0.00173	0.001005	-0.000118	2.97E-04
169	250000	4	125000	10	5000	0.02227	0.01701	0.01491	0.01301	0.009696	-9.8E-05	6.14E-04
170	250000	4	125000	10	10000	0.01551	0.01061	0.008893	0.00747	0.005212	-0.000104	4.89E-04
171	250000	4	125000	10	20000	0.01096	0.006423	0.005077	0.00407	0.002639	-0.00011	3.73E-04
172	250000	4	125000	10	50000	0.007285	0.0032	0.002276	0.0017	0.001017	-0.000116	2.35E-04
173	250000	4	125000	12	5000	0.01973	0.01491	0.01318	0.01165	0.008894	-9.6E-05	4.91E-04
174	250000	4	125000	12	10000	0.01409	0.009528	0.008085	0.0069	0.004972	-0.000103	3.92E-04
175	250000	4	125000	12	20000	0.01021	0.005899	0.004727	0.00386	0.002592	-0.000109	3.00E-04
176	250000	4	125000	12	50000	0.007029	0.003045	0.00219	0.00167	0.00102	-0.000116	1.90E-04
177	250000	4	125000	14	5000	0.01767	0.01313	0.01167	0.01039	0.008073	-9.62E-05	4.01E-04
178	250000	4	125000	14	10000	0.01296	0.008617	0.007365	0.00636	0.004693	-0.000103	3.20E-04
179	250000	4	125000	14	20000	0.009608	0.005453	0.004406	0.00365	0.002519	-0.000109	2.46E-04
180	250000	4	125000	14	50000	0.006825	0.002909	0.002106	0.00162	0.001017	-0.000116	1.56E-04
181	250000	4	150000	6	5000	0.02862	0.02207	0.01878	0.01581	0.01093	-9.36E-05	9.66E-04
182	250000	4	150000	6	10000	0.01895	0.01316	0.01065	0.00856	0.005476	-9.51E-05	7.64E-04
183	250000	4	150000	6	20000	0.01265	0.007604	0.005786	0.00442	0.002644	-9.66E-05	5.80E-04
184	250000	4	150000	6	50000	0.007633	0.003498	0.002425	0.00175	0.0009956	-9.92E-05	3.66E-04
185	250000	4	150000	8	5000	0.02426	0.01886	0.01643	0.01419	0.01033	-7.83E-05	7.21E-04
186	250000	4	150000	8	10000	0.01645	0.01153	0.009598	0.00796	0.005392	-8.39E-05	5.75E-04
187	250000	4	150000	8	20000	0.01129	0.006837	0.005374	0.00425	0.002674	-8.92E-05	4.41E-04
188	250000	4	150000	8	50000	0.007142	0.003279	0.002342	0.00174	0.001017	-9.59E-05	2.82E-04
189	250000	4	150000	10	5000	0.02104	0.01631	0.01442	0.01267	0.009546	-7.39E-05	5.58E-04
190	250000	4	150000	10	10000	0.01462	0.01021	0.008662	0.00734	0.005193	-8.08E-05	4.47E-04
191	250000	4	150000	10	20000	0.01029	0.006193	0.004976	0.00403	0.002653	-8.73E-05	3.45E-04
192	250000	4	150000	10	50000	0.006776	0.003082	0.002247	0.0017	0.001028	-9.51E-05	2.23E-04
193	250000	4	150000	12	5000	0.01853	0.0142	0.01267	0.01126	0.008688	-7.36E-05	4.45E-04
194	250000	4	150000	12	10000	0.01322	0.009119	0.007833	0.00675	0.004925	-8.08E-05	3.57E-04
195	250000	4	150000	12	20000	0.009526	0.005653	0.004608	0.00381	0.002594	-8.74E-05	2.76E-04
196	250000	4	150000	12	50000	0.006486	0.002909	0.00215	0.00166	0.001032	-9.38E-05	1.79E-04
197	250000	4	150000	14	5000	0.01648	0.01243	0.01113	0.00997	0.007822	-7.48E-05	3.62E-04
198	250000	4	150000	14	10000	0.01209	0.0082	0.007096	0.00618	0.004619	-8.17E-05	2.91E-04
199	250000	4	150000	14	20000	0.008919	0.005195	0.004273	0.00358	0.00251	-8.81E-05	2.26E-04
200	250000	4	150000	14	50000	0.00627	0.002757	0.002053	0.00161	0.001024	-9.56E-05	1.47E-04

No.	E(1)	h(1)	E(2)	h(2)	E(3)	D0	D12	D18	D24	D36	et	ec
201	250000	6	50000	6	5000	0.03112	0.02387	0.02018	0.01698	0.01193	-0.000272	1.03E-03
202	250000	6	50000	6	10000	0.02065	0.01422	0.01136	0.00911	0.005953	-0.000249	7.75E-04
203	250000	6	50000	6	20000	0.01399	0.008312	0.006189	0.0047	0.002884	-0.000229	5.46E-04
204	250000	6	50000	6	50000	0.008916	0.004059	0.002664	0.00187	0.00109	-0.000208	3.02E-04
205	250000	6	50000	8	5000	0.02828	0.02167	0.01853	0.01584	0.01152	-0.000246	8.41E-04
206	250000	6	50000	8	10000	0.01921	0.01319	0.01067	0.00869	0.005874	-0.000233	6.35E-04
207	250000	6	50000	8	20000	0.01339	0.007923	0.005958	0.00459	0.002888	-0.00022	4.48E-04
208	250000	6	50000	8	50000	0.008915	0.004062	0.002669	0.00187	0.001094	-0.000207	2.47E-04
209	250000	6	50000	10	5000	0.02597	0.01981	0.01707	0.01475	0.01104	-0.000231	6.96E-04
210	250000	6	50000	10	10000	0.01803	0.0123	0.01003	0.00827	0.005749	-0.000222	5.27E-04
211	250000	6	50000	10	20000	0.01289	0.007579	0.005734	0.00446	0.002873	-0.000215	3.72E-04
212	250000	6	50000	10	50000	0.008914	0.004064	0.002673	0.00188	0.001099	-0.000207	2.06E-04
213	250000	6	50000	12	5000	0.02408	0.01823	0.01578	0.01376	0.01053	-0.000221	5.84E-04
214	250000	6	50000	12	10000	0.01706	0.01154	0.009445	0.00787	0.005595	-0.000216	4.43E-04
215	250000	6	50000	12	20000	0.01248	0.007276	0.005523	0.00433	0.002845	-0.000212	3.14E-04
216	250000	6	50000	12	50000	0.008913	0.004065	0.002676	0.00188	0.001102	-0.000207	1.73E-04
217	250000	6	50000	14	5000	0.02251	0.01688	0.01464	0.01285	0.01001	-0.000214	4.96E-04
218	250000	6	50000	14	10000	0.01625	0.01088	0.008924	0.00748	0.005425	-0.000212	3.77E-04
219	250000	6	50000	14	20000	0.01214	0.00701	0.005328	0.00421	0.002807	-0.000209	2.68E-04
220	250000	6	50000	14	50000	0.008912	0.004066	0.002678	0.00188	0.001105	-0.000207	1.48E-04
221	250000	6	75000	6	5000	0.02873	0.02237	0.01922	0.01642	0.01184	-0.000211	9.07E-04
222	250000	6	75000	6	10000	0.01908	0.01339	0.01093	0.00892	0.005989	-0.000195	7.01E-04
223	250000	6	75000	6	20000	0.01288	0.007829	0.00599	0.00465	0.002926	-0.000181	5.12E-04
224	250000	6	75000	6	50000	0.008074	0.003759	0.002573	0.00186	0.001111	-0.000166	3.01E-04
225	250000	6	75000	8	5000	0.02568	0.02	0.01741	0.01513	0.01133	-0.000186	7.25E-04
226	250000	6	75000	8	10000	0.01744	0.01221	0.01011	0.00842	0.005872	-0.000179	5.63E-04
227	250000	6	75000	8	20000	0.01209	0.007319	0.005682	0.00449	0.002922	-0.000171	4.13E-04
228	250000	6	75000	8	50000	0.007909	0.00367	0.002531	0.00185	0.001118	-0.000164	2.43E-04
229	250000	6	75000	10	5000	0.02328	0.01804	0.01584	0.01394	0.01075	-0.000173	5.90E-04
230	250000	6	75000	10	10000	0.01613	0.01122	0.009383	0.00792	0.005702	-0.000169	4.60E-04
231	250000	6	75000	10	20000	0.01146	0.006878	0.005389	0.00433	0.002893	-0.000166	3.39E-04
232	250000	6	75000	10	50000	0.007777	0.003589	0.002488	0.00183	0.001123	-0.000162	2.00E-04
233	250000	6	75000	12	5000	0.02135	0.01641	0.01449	0.01287	0.01015	-0.000165	4.89E-04
234	250000	6	75000	12	10000	0.01508	0.01038	0.008735	0.00746	0.005504	-0.000164	3.82E-04
235	250000	6	75000	12	20000	0.01095	0.006497	0.00512	0.00415	0.002847	-0.000163	2.82E-04
236	250000	6	75000	12	50000	0.007669	0.003517	0.002444	0.00181	0.001123	-0.000161	1.67E-04
237	250000	6	75000	14	5000	0.01977	0.01503	0.01332	0.01191	0.009561	-0.00016	4.11E-04
238	250000	6	75000	14	10000	0.01422	0.009666	0.008163	0.00703	0.005293	-0.00016	3.22E-04
239	250000	6	75000	14	20000	0.01053	0.006168	0.004874	0.00399	0.002788	-0.000161	2.38E-04
240	250000	6	75000	14	50000	0.00758	0.003453	0.002401	0.00179	0.001121	-0.000161	1.41E-04
241	250000	6	100000	6	5000	0.02706	0.02131	0.01852	0.01599	0.01175	-0.000168	8.17E-04
242	250000	6	100000	6	10000	0.01799	0.01281	0.01061	0.00878	0.006005	-0.000158	6.41E-04
243	250000	6	100000	6	20000	0.01213	0.007509	0.005858	0.00462	0.002955	-0.000148	4.79E-04
244	250000	6	100000	6	50000	0.007542	0.003586	0.002526	0.00186	0.001125	-0.000138	2.93E-04
245	250000	6	100000	8	5000	0.02395	0.01887	0.01663	0.01461	0.01116	-0.000146	6.44E-04
246	250000	6	100000	8	10000	0.01625	0.01156	0.009733	0.00822	0.005855	-0.000142	5.08E-04
247	250000	6	100000	8	20000	0.01124	0.006933	0.005503	0.00443	0.002943	-0.000138	3.82E-04
248	250000	6	100000	8	50000	0.007285	0.003445	0.002458	0.00184	0.001135	-0.000134	2.35E-04
249	250000	6	100000	10	5000	0.02154	0.01688	0.01502	0.01337	0.01051	-0.000135	5.19E-04
250	250000	6	100000	10	10000	0.0149	0.01052	0.008957	0.00768	0.005653	-0.000134	4.11E-04





































































































































































