

# Lempel-Ziv Compression With Random Access

Shaik Mastan Vali, Srikanth Kamparaju

Supervisor - Dr. Shashank Vatedka

Experimental Results

## 1) ENWIK8

### a) dictionary compression

#### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	36676181	86955	2.726565	0.840054	0.000021	0.233403
19000	35909723	45747	2.784761	0.869406	0.000039	0.231133
28000	35557828	31035	2.812320	0.831187	0.000056	0.224199
37000	35404362	23484	2.824511	0.795873	0.000073	0.222125
46000	35292227	18887	2.833485	0.774139	0.000089	0.217441
55000	35191545	15803	2.841592	0.750091	0.000106	0.217042
64000	35163084	13580	2.843892	0.759344	0.000122	0.214863
73000	35113027	11904	2.847946	0.745672	0.000138	0.212443
82000	35093452	10601	2.849534	0.732697	0.000151	0.207019
91000	35080922	9551	2.850552	0.717567	0.000166	0.204280
100000	35034613	8691	2.854320	0.738126	0.000179	0.200899

#### ii) BV\_RLZ(Header as a sd\_vector)

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	36608429	19203	2.731611	0.848103	0.000021	0.240840
19000	35874783	10807	2.787473	0.890133	0.000039	0.231758
28000	35534342	7549	2.814179	0.831961	0.000057	0.226369
37000	35386803	5925	2.825912	0.801496	0.000074	0.223782
46000	35278265	4925	2.834607	0.768405	0.000090	0.216764
55000	35179963	4221	2.842527	0.771015	0.000105	0.213259
64000	35153213	3709	2.844690	0.748075	0.000123	0.216522
73000	35104448	3325	2.848642	0.755237	0.000138	0.212767
82000	35085872	3021	2.850150	0.750112	0.000152	0.208558
91000	35074152	2781	2.851102	0.731210	0.000165	0.205610
100000	35028479	2557	2.854820	0.752705	0.000182	0.205016

### iii) Dense sparse(Tatwawadi-based scheme)

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	43983965	2.273556	35800000	8183965	1.566141	0.000065	0.676689
19000	41064226	2.435210	35805728	5258498	1.387206	0.000087	0.482370
28000	39785107	2.513503	35805728	3979379	1.228271	0.000106	0.403097
37000	39142822	2.554747	35803938	3338884	1.165643	0.000125	0.363007
46000	38615675	2.589622	35803606	2812069	1.094204	0.000146	0.339890
55000	38285853	2.611931	35817929	2467924	1.059579	0.000163	0.320830
64000	38044482	2.628502	35813019	2231463	1.047428	0.000180	0.305873
73000	37903173	2.638302	35806320	2096853	1.034015	0.000196	0.292786
82000	37741464	2.649606	35815540	1925924	1.015355	0.000212	0.281494
91000	37621590	2.658048	35806519	1815071	1.004309	0.000229	0.276982
100000	37436587	2.671184	35801000	1635587	0.981960	0.000245	0.271194

### b) Without dictionary compression

#### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	45062891	87552	2.219121	0.510122	0.000017	0.199278
19000	44157711	46068	2.264610	0.526084	0.000027	0.163336
28000	43267583	31245	2.311199	0.483977	0.000035	0.149774
37000	42707722	23637	2.341497	0.464767	0.000046	0.150243
46000	42362424	19008	2.360583	0.447507	0.000056	0.149397
55000	42104034	15903	2.375069	0.436663	0.000065	0.144294
64000	41921054	13664	2.385436	0.422388	0.000074	0.139090
73000	41779032	11977	2.393545	0.412102	0.000083	0.138774
82000	41673651	10666	2.399598	0.408591	0.000094	0.137691
91000	41582425	9609	2.404862	0.401700	0.000104	0.137979
100000	41512802	8743	2.408895	0.394829	0.000115	0.136557

**ii) BV\_RLZ(Header as a sd\_vector)**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	44994542	19203	2.222492	0.522895	0.000017	0.197678
19000	44122450	10807	2.266420	0.536463	0.000027	0.162540
28000	43243887	7549	2.312466	0.494352	0.000036	0.150905
37000	42690010	5925	2.342468	0.475997	0.000048	0.152843
46000	42348341	4925	2.361368	0.456346	0.000057	0.148447
55000	42092352	4221	2.375728	0.444806	0.000066	0.144876
64000	41911099	3709	2.386003	0.433919	0.000074	0.139444
73000	41770380	3325	2.394041	0.426517	0.000085	0.140367
82000	41666006	3021	2.400038	0.417466	0.000094	0.137806
91000	41575597	2781	2.405257	0.412945	0.000105	0.139569
100000	41506616	2557	2.409254	0.404420	0.000116	0.138826

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
10000	59914123	1.669056	41070000	18844123	2.278837	0.000135	1.380206
19000	56455286	1.771313	41080256	15375030	1.917482	0.000203	1.092847
28000	53467001	1.870312	41078000	12389001	1.613082	0.000236	0.865426
37000	51529111	1.940651	41077491	10451620	1.416720	0.000259	0.722250
46000	49944011	2.002242	41075556	8868455	1.250659	0.000277	0.625541
55000	49027284	2.039681	41091210	7936074	1.160856	0.000296	0.563676
64000	48261515	2.072044	41086581	7174934	1.089729	0.000312	0.511441
73000	47694560	2.096675	41078080	6616480	1.029718	0.000329	0.474988
82000	47309242	2.113752	41089600	6219642	0.997028	0.000349	0.449803
91000	46879962	2.133108	41077323	5802639	0.961161	0.000363	0.422305
100000	46491515	2.150930	41074000	5417515	0.909819	0.000375	0.401996

## 2) ENWIK9

### a) dictionary compression

#### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	318072572	96881	3.143937	6.771404	0.000168	1.905445
190000	316240026	50997	3.162155	6.549851	0.000288	1.717789
280000	315581573	34607	3.168753	6.457259	0.000419	1.715424
370000	315102153	26190	3.173574	6.400405	0.000520	1.619471
460000	314850453	21065	3.176111	6.389236	0.000642	1.622640
550000	314785490	17627	3.176767	6.368636	0.000743	1.562035
640000	314527926	15147	3.179368	6.207046	0.000838	1.516178
730000	314518452	13279	3.179464	6.196497	0.000949	1.503724
820000	314408957	11826	3.180571	6.295364	0.001055	1.483749
910000	314228256	10654	3.182400	6.222728	0.001149	1.469155
1000000	314179125	9695	3.182898	6.218167	0.001279	1.489169

#### ii) BV\_RLZ(Header as a sd\_vector)

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	317998647	22956	3.144667	6.855484	0.000165	1.875980
190000	316201805	12776	3.162537	6.726468	0.000296	1.779012
280000	315555852	8886	3.169011	6.585229	0.000417	1.718941
370000	315082897	6934	3.173768	6.489172	0.000524	1.636196
460000	314835130	5742	3.176266	6.506041	0.000643	1.624987
550000	314772765	4902	3.176895	6.450254	0.000750	1.576626
640000	314517073	4294	3.179478	6.430664	0.000863	1.564774
730000	314509011	3838	3.179559	6.435145	0.000959	1.525729
820000	314400617	3486	3.180655	6.429054	0.001076	1.526832
910000	314220800	3198	3.182476	6.398439	0.001167	1.507567
1000000	314172364	2934	3.182966	6.368560	0.001281	1.505490

### iii) Dense sparse(Tatwawadi-based scheme)

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	437932230	2.283458	315360000	122572230	18.276635	0.000912	9.373514
190000	431392421	2.318075	315413616	115978805	17.542152	0.001622	8.778200
280000	428421639	2.334149	315414744	113006895	17.238486	0.002310	8.488760
370000	426088267	2.346932	315396852	110691415	16.946349	0.002960	8.228708
460000	424448939	2.355996	315375658	109073281	16.787710	0.003627	8.120543
550000	424029611	2.358326	315505550	108524061	16.656968	0.004285	8.012319
640000	422387942	2.367492	315464979	106922963	16.584569	0.004881	7.746500
730000	421499804	2.372480	315395920	106103884	16.236780	0.005520	7.784130
820000	421405502	2.373011	315490780	105914722	16.405771	0.006188	7.790020
910000	420399488	2.378690	315393218	105006270	16.321293	0.006793	7.701035
1000000	420038303	2.380735	315364000	104674303	16.263908	0.007410	`

### b) Without dictionary compression

#### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	367190310	97323	2.723383	3.680429	0.000108	1.310459
190000	364255150	51183	2.822824	3.781974	0.000195	1.252486
280000	362418542	34761	2.759241	3.436176	0.000265	1.166240
370000	360927590	26304	2.770639	3.275442	0.000348	1.170113
460000	360105824	21157	2.776961	3.391001	0.000431	1.153022
550000	359629940	17703	2.780636	3.319419	0.000523	1.181961
640000	359188718	15212	2.784052	3.306670	0.000592	1.128550
730000	358916056	13335	2.786167	3.200419	0.000684	1.154639
820000	358712991	11875	2.787744	3.178534	0.000773	1.153598
910000	358497882	10699	2.789417	3.161151	0.000857	1.166578
1000000	358327476	9735	2.790743	3.147941	0.000939	1.157307

**ii) BV\_RLZ(Header as a sd\_vector)**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	367115943	22956	2.723935	3.760165	0.000108	1.318607
190000	364216743	12776	2.823130	3.883242	0.000196	1.268350
280000	362392667	8886	2.759438	3.500857	0.000263	1.144578
370000	360908220	6934	2.770788	3.415120	0.000343	1.150218
460000	360090409	5742	2.777080	3.348022	0.000433	1.155548
550000	359617139	4902	2.780735	3.460741	0.000516	1.147608
640000	359177800	4294	2.784136	3.405816	0.000594	1.137736
730000	358906559	3838	2.786241	3.304928	0.000690	1.158185
820000	358704602	3486	2.787809	3.294770	0.000773	1.154064
910000	358490381	3198	2.789475	3.278096	0.000851	1.144544
1000000	358320675	2934	2.790796	3.274195	0.000936	1.145100

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	513973724	1.945625	360390000	153583724	18.280424	0.001084	11.072866
190000	500667962	2.124640	360452400	110215562	14.295036	0.001447	7.846328
280000	495587888	2.017806	60450520	135137368	16.009707	0.002616	9.550252
370000	490499442	2.038738	360434238	130065204	15.667874	0.003319	9.189964
460000	487223533	2.052446	360410068	126813465	15.109641	0.004006	8.942398
550000	485147948	2.061227	360556723	124591225	15.185786	0.004690	8.745059
640000	483348749	2.068900	360510639	122838110	14.834742	0.005377	8.617352
730000	481514412	2.076781	360431930	121082482	14.645704	0.006054	8.525440
820000	480976477	2.079104	360539280	120437197	14.555551	0.006752	8.444506
910000	480214350	2.082403	360428040	119786310	4.512250	0.007455	8.414592
1000000	479202463	2.086801	360396000	118806463	14.459493	0.008114	8.324821

**c) With chunk sizes 10-100kb**

**i) RLZ Compression With Dictionary**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	346270419	970287	2.887916	8.068219	0.000020	2.247035
190000	333849381	510333	2.995363	8.419672	0.000037	2.166230
280000	327860159	346188	3.050081	7.808358	0.000054	2.150288
370000	324651012	261939	3.080231	7.466446	0.000069	2.113232
460000	322979558	210672	3.096171	7.314110	0.000083	2.017242
550000	321302134	176175	3.112335	7.015032	0.000098	2.013932
640000	319979064	151388	3.125204	7.000502	0.000112	1.989864
730000	319470871	132725	3.130176	6.912997	0.000126	1.956705
820000	318801518	118160	3.136748	6.848647	0.000142	1.957145
910000	318387282	106472	3.140829	6.722603	0.000153	1.907394
1000000	318072572	96881	3.143937	6.640118	0.000164	1.865828

**ii) RLZ Compression Without Dictionary**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	416811808	975368	2.399164	4.786613	0.000016	1.895310
190000	399578794	513103	2.502635	4.811059	0.000025	1.554879
280000	388291268	347957	2.575386	4.497116	0.000034	1.426114
370000	381618963	263234	2.620415	4.285090	0.000043	1.394681
460000	377357889	211687	2.650004	4.113326	0.000052	1.349783
550000	374381093	177015	2.671075	3.998062	0.000060	1.314130
640000	372107695	152103	2.687394	3.906582	0.000070	1.333069
730000	370441466	133344	2.699482	3.816156	0.000078	1.305969
820000	369103825	118706	2.709265	3.711329	0.000088	1.312473
910000	368064503	106963	2.716915	3.712898	0.000099	1.336186
1000000	367190310	97323	2.723383	3.678270	0.000107	1.299490

**iii) BV-RLZ Compression With Dictionary**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	345494971	194839	2.894398	8.144546	0.000020	2.272176
190000	333451482	112434	2.998937	8.417682	0.000037	2.183398
280000	327596329	82358	3.052537	7.914139	0.000053	2.135976
370000	324445693	56620	3.082180	7.395595	0.000069	2.090559
460000	322815457	46571	3.097745	7.367884	0.000083	2.014372
550000	321165753	39794	3.113657	7.186944	0.000099	2.021221
640000	319862009	34333	3.126348	7.071744	0.000112	1.967059
730000	319368615	30469	3.131178	7.061913	0.000127	1.960575
820000	318710714	27356	3.137642	6.959822	0.000142	1.960452
910000	318305750	24940	3.141633	6.910267	0.000153	1.901744
1000000	317998647	22956	3.144667	6.844909	0.000168	1.911041

**iv) BV RLZ Compression Without Dictionary**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
100000	416031311	194871	2.403665	4.920920	0.000017	1.915063
190000	399178141	112450	2.505147	4.938746	0.000025	1.554572
280000	388025669	82358	2.577149	4.600025	0.000034	1.427726
370000	381412357	56628	2.621834	4.380715	0.000043	1.401209
460000	377192797	46595	2.651164	4.205600	0.000054	1.404648
550000	374243880	39802	2.672054	4.095389	0.000062	1.361751
640000	371989933	34341	2.688245	3.995024	0.000070	1.341008
730000	370338591	30469	2.700232	3.898231	0.000078	1.291412
820000	369012475	27356	2.709935	3.831755	0.000089	1.314633
910000	367982480	24940	2.717521	3.806738	0.000097	1.317260
1000000	367115943	22956	2.723935	3.752662	0.000107	1.310402



### 3) IMDB

#### a) dictionary compression

##### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	389593543	97383	5.508914	8.396481	0.000236	2.839452
407785	386557268	51249	5.552185	8.157886	0.000422	2.697168
600947	384374273	34774	5.583718	8.046821	0.000605	2.614851
794109	382821983	26314	5.606359	8.134158	0.000790	2.602945
987271	381183800	21163	5.630453	8.090959	0.000953	2.518512
1180433	380086548	17708	5.646707	8.023856	0.001169	2.619935
1373595	378959540	15217	5.663500	7.955300	0.001347	2.583984
1566757	378072887	13338	5.676782	7.777491	0.001487	2.488099
1759919	377400632	11878	5.686894	7.943591	0.001664	2.495805
1953081	376584654	10700	5.699216	7.879415	0.001839	2.483997

##### ii) BV\_RLZ(Header as a sd\_vector)

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	389519116	22956	5.509967	8.498627	0.000235	2.816456
407785	386518795	12776	5.552738	8.424206	0.000423	2.689625
600947	384348385	8886	5.584094	8.320491	0.000604	2.606194
794109	382802603	6934	5.606643	8.107300	0.000803	2.643728
987271	381168379	5742	5.630681	8.205980	0.001008	2.684387
1180433	380073742	4902	5.646897	8.185932	0.001160	2.599605
1373595	378948617	4294	5.663664	8.093590	0.001319	2.510290
1566757	378063387	3838	5.676925	8.093316	0.001489	2.489804
1759919	377392240	3486	5.687021	8.104366	0.001693	2.538901
1953081	376577152	3198	5.699330	7.870162	0.001880	2.548345

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	600840796	3.572057	370267023	230573773	30.318437	0.001630	16.796515
407785	568824862	3.773108	370296080	198528782	27.358310	0.002616	14.254695
600947	551387509	3.892430	370294952	181092557	25.997977	0.003451	12.776573
794109	542685392	3.954847	370278564	172406828	25.618471	0.004315	12.146446
987271	538816099	3.983247	370251766	168564333	25.220058	0.005228	11.839002
1180433	535553956	4.007509	370404789	165149167	25.084552	0.006081	11.520820
1373595	528708289	4.059398	370357539	158350750	23.904331	0.006950	11.352416
1566757	525593488	4.083455	370275380	155318108	23.610011	0.007757	11.121195
1759919	523471895	4.100005	370387120	153084775	23.410968	0.008593	10.940263
1953081	521206641	4.117824	370271783	150934858	23.119955	0.009388	10.817291

**b) Without dictionary compression**

**i) Basic RLZ**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	387391598	97389	5.540227	5.149472	0.000168	2.185186
407785	384856817	51260	5.576717	4.843162	0.000311	2.128554
600947	383291804	34783	5.599487	4.874184	0.000447	2.045925
794109	382756086	26323	5.607324	4.681481	0.000592	2.047696
987271	382266320	21173	5.614508	4.630571	0.000737	2.079258
1180433	382054105	17716	5.617627	4.606945	0.000876	2.044530
1373595	381854769	15225	5.620560	4.629142	0.001021	2.053328
1566757	381627201	13345	5.623911	4.591427	0.001163	2.054421
1759919	381558994	11884	5.624916	4.591822	0.001315	2.077556
1953081	381472745	10707	5.626188	4.584870	0.001457	2.079092

**ii) BV\_RLZ(Header as a sd\_vector)**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	387317165	22956	5.541292	5.233214	0.000166	2.133276
407785	384818333	12776	5.577274	4.952236	0.000306	2.107899
600947	383265907	8886	5.599865	4.946857	0.000453	2.118774
794109	382736697	6934	5.607608	4.772159	0.000604	2.115374
987271	382250889	5742	5.614735	4.758657	0.000736	2.076661
1180433	382041291	4902	5.617815	4.702417	0.000892	2.118457
1373595	381843838	4294	5.620720	4.712336	0.001039	2.116436
1566757	381617694	3838	5.624051	4.679863	0.001164	2.065329
1759919	381550596	3486	5.625040	4.671889	0.001310	2.055071
1953081	381465236	3198	5.626299	4.673000	0.001449	2.051606

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
214623	588228346	3.648647	384488445	203739901	24.421062	0.001358	14.062750
407785	561982695	3.819045	384508880	177473815	21.986799	0.002186	11.984635
600947	549791252	3.903732	384511512	165279740	21.195944	0.002969	11.077190
794109	541278934	3.965123	384493641	156785293	20.253492	0.003795	10.750725
987271	539219376	3.980268	384467552	154751824	20.091352	0.004653	10.567406
1180433	537902271	3.990014	384625731	153276540	20.184167	0.005521	10.510131
1373595	536542278	4.000127	384576150	151966128	19.949446	0.006385	10.466989
1566757	535410059	4.008586	384491870	150918189	19.796596	0.007226	10.386938
1759919	534932596	4.012164	384606220	150326376	19.689948	0.008073	10.340764
1953081	534373183	4.016364	384487348	149885835	19.684260	0.008941	10.297791

## PROTEIN

### c) dictionary compression

#### i) Basic RLZ

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	23057014	85577	3.721970	0.570053	0.000009	0.112437
16305	21841640	45001	3.929078	0.539818	0.000015	0.097081
24029	21387941	30533	4.012425	0.530782	0.000021	0.095684
31753	21132360	23101	4.060952	0.499646	0.000026	0.092518
39477	20994714	18581	4.087577	0.482601	0.000032	0.089987
47201	20887087	15547	4.108639	0.480392	0.000038	0.090716
54925	20751977	13359	4.135389	0.468828	0.000044	0.091316
62649	20684844	11709	4.148811	0.456021	0.000049	0.087645
70373	20643733	10429	4.157073	0.456307	0.000055	0.085708
78097	20632299	9394	4.159377	0.441296	0.000061	0.087494

#### ii) BV\_RLZ(Header as a sd\_vector)

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	22989391	17954	3.732918	0.584598	0.000010	0.118688
16305	21806781	10142	3.935359	0.552590	0.000015	0.100891
24029	21364508	7100	4.016826	0.531545	0.000020	0.092937
31753	21114847	5588	4.064320	0.509820	0.000027	0.092709
39477	20980785	4652	4.090290	0.490976	0.000032	0.090088
47201	20875528	3988	4.110914	0.480181	0.000038	0.090282
54925	20742126	3508	4.137353	0.469021	0.000045	0.091583
62649	20676283	3148	4.150529	0.459326	0.000049	0.087921
70373	20636172	2868	4.158596	0.459284	0.000056	0.089521
78097	20625549	2644	4.160738	0.454079	0.000060	0.087846

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	42103480	2.038252	23732373	18371107	2.289744	0.000123	1.250561
16305	39064939	2.196791	23740640	15324299	1.925071	0.000190	1.021451
24029	37935450	2.262198	23743084	14192366	1.827939	0.000255	0.935561
31753	37443363	2.291928	23740449	13702914	1.758055	0.000323	0.895926
39477	37074087	2.314757	23744428	13329659	1.727364	0.000388	0.864233
47201	36855404	2.328492	23752502	13102902	1.702936	0.000455	0.849752
54925	36651038	2.341475	23746659	12904379	1.676818	0.000516	0.829604
62649	36340371	2.361492	23746210	12594161	1.646304	0.000572	0.805309
70373	36329877	2.362174	23753400	12576477	1.647333	0.000645	0.808052
78097	36278263	2.365535	23741697	12536566	1.660322	0.000711	0.803364

**d) Without dictionary compression**

**i) Basic RLZ**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	29267697	86179	2.932158	0.231130	0.000009	0.113498
16305	26841211	45279	3.197229	0.208157	0.000013	0.090963
24029	25936747	30708	3.308723	0.213367	0.000017	0.079132
31753	25431098	23230	3.374510	0.204924	0.000020	0.075325
39477	25107721	18680	3.417973	0.197254	0.000023	0.071299
47201	24887250	15629	3.448252	0.191535	0.000027	0.068323
54925	24689699	13428	3.475842	0.187065	0.000030	0.067487
62649	24559823	11770	3.494223	0.183255	0.000033	0.066422
70373	24471252	10482	3.506870	0.177443	0.000037	0.065576
78097	24361624	9442	3.522651	0.174180	0.000042	0.067132

**ii) BV\_RLZ(Header as a sd\_vector)**

chunk size(bytes)	compressed file size(bytes)	Header size(bytes)	Compression ratio	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	29199480	17962	2.939008	0.238960	0.000009	0.114991
16305	26806074	10142	3.201420	0.213886	0.000013	0.090926
24029	25913139	7100	3.311737	0.218893	0.000016	0.078280
31753	25413456	5588	3.376853	0.209768	0.000020	0.073405
39477	25093693	4652	3.419883	0.203285	0.000023	0.072492
47201	24875609	3988	3.449865	0.197936	0.000027	0.068405
54925	24679779	3508	3.477240	0.192512	0.000030	0.067184
62649	24551201	3148	3.495450	0.188282	0.000033	0.065692
70373	24463638	2868	3.507962	0.183405	0.000037	0.065843
78097	24354826	2644	3.523634	0.178949	0.000041	0.067694

**iii) Dense sparse(Tatwawadi-based scheme)**

chunk size(bytes)	compressed file size(bytes)	Compression ratio	Dense stream size	Compressed Sparse stream size	Avg. compression time(seconds)	Avg. random access time for a chunk (seconds)	Total time for decompression (seconds)
8581	52884880	1.622723	23622362	29262518	3.095063	0.000217	2.197082
16305	47891585	1.791912	23630096	24261489	2.573909	0.000326	1.737078
24029	46156015	1.859292	23632352	22523663	2.374100	0.000434	1.573185
31753	45221913	1.897697	23632329	21589584	2.277280	0.000544	1.493255
39477	44538715	1.926807	23631380	20907335	2.207671	0.000646	1.427192
47201	44116652	1.945241	23641543	20475109	2.160240	0.000748	1.380878
54925	43771487	1.960580	23637249	20134238	2.126719	0.000851	1.352569
62649	43514226	1.972171	23632500	19881726	2.112082	0.000952	1.325054
70373	43343395	1.979944	23639940	19703455	2.088036	0.001053	1.307124
78097	43128046	1.989831	23632896	19495150	2.076052	0.001154	1.291433