

# Does BEAM Really Matter to Construction Waste Management? What Big Data Does and Does Not Tell

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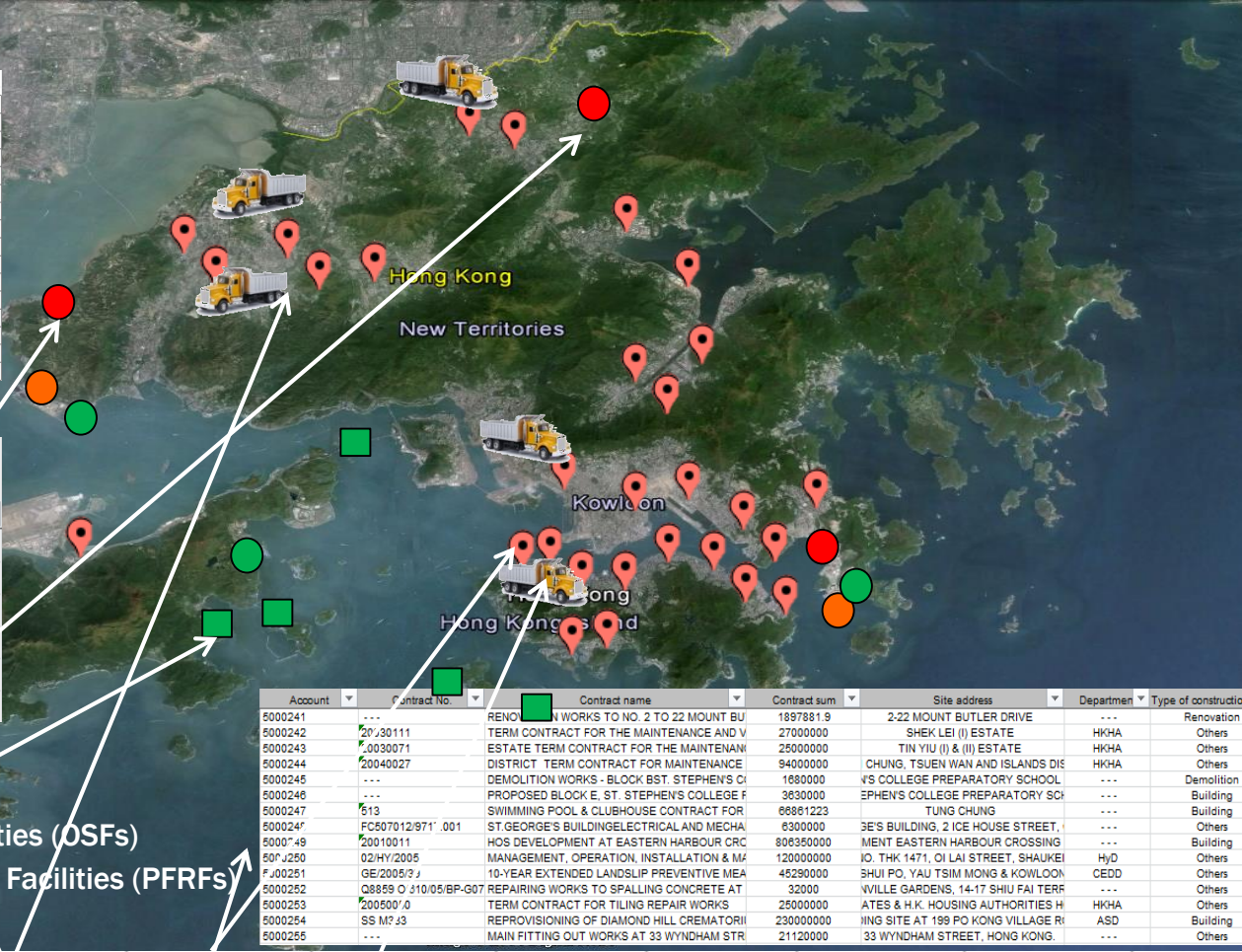
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政府廢物處理設施	
CW-PFBP	尚德山墳場上層廢物轉運站 Cheung Wan San Upper Refuse Transfer Station
MW-PFRF	梅窩臨時公眾廢物接收設施 Mau Wo Temporary Public Refuse Reception Facility
TKO137FB	將軍澳第1、3、5號廢物轉運站 Tsing Ma Area 1, 3 & 5 Refuse Transfer Station
TM38-FB	沙田新城市廣場廢物轉運站 Pit Block at Tuen Mun Area 38
TKO137SF	將軍澳第1、3、5號廢物中層廢物轉運站 Sorting Facility at Tsing Ma Area 1, 3 & 5
TM38-SF	沙田新城市廣場廢物中層廢物轉運站 Sorting Facility at Tuen Mun Area 38
堆填區 (Landfills)	
NENT	新界東北堆填區 North East New Territories Landfill
SENT	新界東堆填區 South East New Territories Landfill
WENT	新界西堆填區 West New Territories Landfill
離島廢物轉運設施 (OITF)	
CC	赤洲站 Cheung Chau Station
HLC	離島轉運站 Hoi Ling Chau Station
MWV	梅窩站 Mau Wo Station
MW	梅窩站 Mau Wo Station
PC	坪洲站 Ping Chau Station
SKW	沙嶼灣站 Sok Kwu Wan Station
YSW	鴨脷洲站 Yung Shue Wan Station



Vehicle No. 車牌號碼	Permitted Gross Weight (ton) 車身重量
AB522	30
AB6300	2.65
AC937	13
AC989	10.4
AE311	24
AK8989	16

- Landfills
- Offsite Sorting Facilities (OSFs)
- Public Fill Reception Facilities (PFRFs)

Account	Contract No.	Contract name	Contract sum	Site address	Department	Type of construction	Detail of construction work
5000241	...	RENOVATION WORKS TO NO. 2 TO 22 MOUNT BUTLER DRIVE	1897881.9	2-22 MOUNT BUTLER DRIVE	...	Renovation	...
5000242	20/30111	TERM CONTRACT FOR THE MAINTENANCE AND VACANT	27000000	SHEK LEI (I) ESTATE	HKHA	Others	BUILDING MAINTENANCE & VACANT
5000243	0030071	ESTATE TERM CONTRACT FOR THE MAINTENANCE AND VACANT	25000000	TIN YIU (I) & (II) ESTATE	HKHA	Others	BUILDING MAINTENANCE & VACANT
5000244	20040027	DISTRICT TERM CONTRACT FOR MAINTENANCE AND VACANT	94000000	CHUNG, TSUN WAN AND ISLANDS DISTRICT	HKHA	Others	BUILDING MAINTENANCE & VACANT
5000245	...	DEMOLITION WORKS - BLOCK BST, STEPHEN'S COLLEGE	1680000	STEPHEN'S COLLEGE PREPARATORY SCHOOL	...	Demolition	...
5000246	...	PROPOSED BLOCK E, ST. STEPHEN'S COLLEGE	3630000	STEPHEN'S COLLEGE PREPARATORY SCHOOL	...	Building	...
5000247	513	SWIMMING POOL & CLUBHOUSE CONTRACT FOR	66861223	TUNG CHUNG	...	Building	...
5000247	FC507012/9711_001	ST. GEORGE'S BUILDING ELECTRICAL AND MECHANICAL	6300000	3E'S BUILDING, 2 ICE HOUSE STREET, TUNG CHUNG	...	Others	CHILLER PLANT REPLACEMENT
5000749	20010011	HOS DEVELOPMENT AT EASTERN HARBOUR CROSSING	806350000	MENT EASTERN HARBOUR CROSSING	...	Building	...
5007250	02/HY/2005	MANAGEMENT, OPERATION, INSTALLATION & MAINTENANCE	120000000	10, THK 1471, OI LAI STREET, SHAUKEI	HyD	Others	ELECTRICAL INSTALLATIONS
F_00251	GE/2005/3	10-YEAR EXTENDED LANDSLIP PREVENTIVE MEASURES	45250000	SHUI PO, YAU TSIM MONG & KOWLOON	CEDD	Others	LANDSLIP PREVENTIVE WORKS
5000252	Q8859_0_10/05/BP-G07	REPAIRING WORKS TO SPALLING CONCRETE AT	32000	VILLE GARDENS, 14-17 SHUI FAI TERRACE	...	Others	住宅樓天花剝落石屎維修
5000253	2005007/0	TERM CONTRACT FOR TILING REPAIR WORKS	25000000	ATES & H.K. HOUSING AUTHORITIES HOUSING SITE	HKHA	Others	MAINTENANCE WORKS
5000254	SS M2/3	REPROVISIONING OF DIAMOND HILL CREMATORIUM	230000000	HONG KONG VILLAGE RECREATION SITE AT 199 PO KONG VILLAGE ROAD	ASD	Building	...
5000255	...	MAIN FITTING OUT WORKS AT 33 WYNDHAM STREET	21120000	33 WYNDHAM STREET, HONG KONG	...	Others	FITTING OUT WORKS

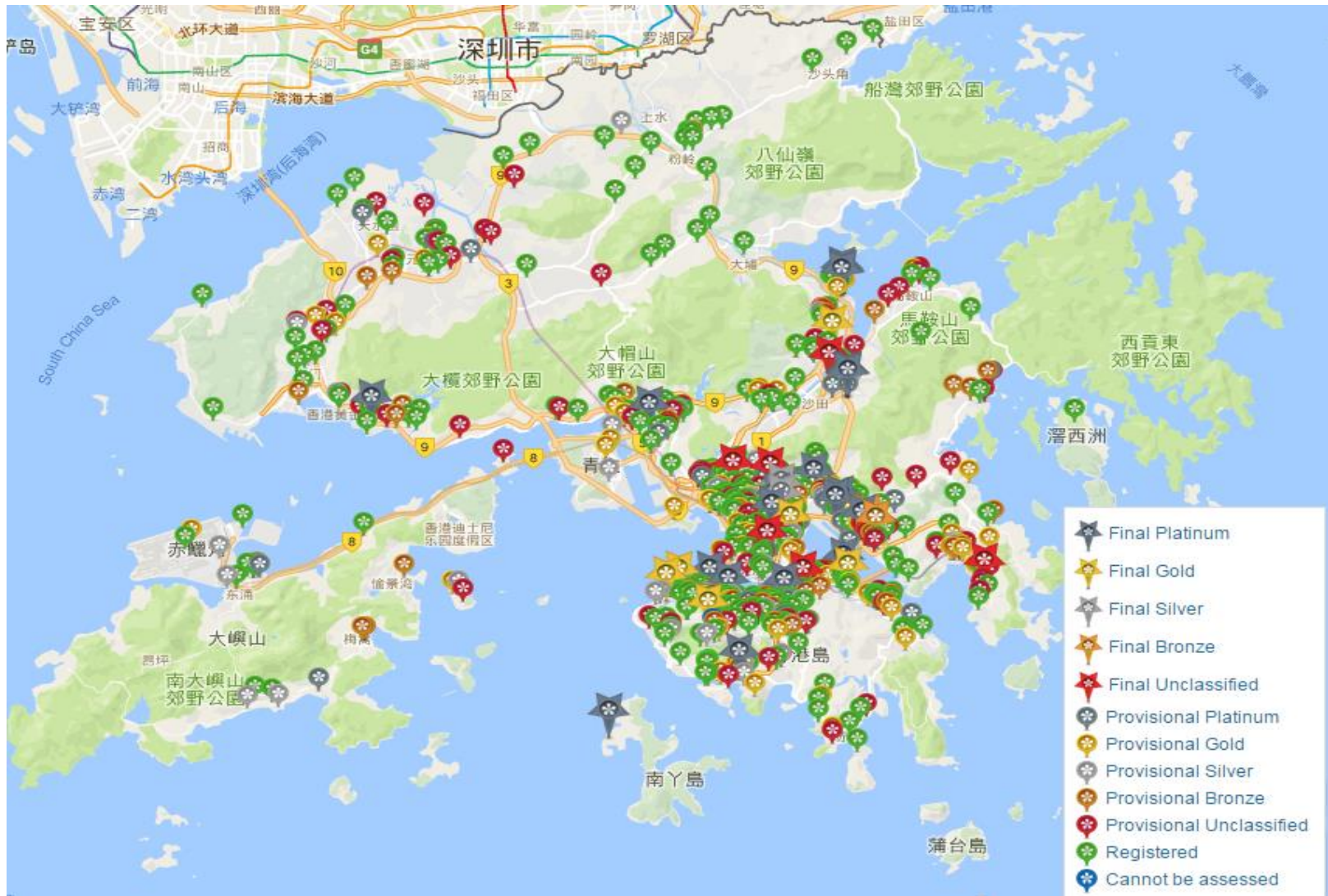
There were 1,142,998 records of this kind in a single year!

Facility 設施	Date of transaction 交易日期	Vehicle No. 車牌號碼	Account No. 帳戶編號	Chit No. 入帳票編號	Time-in 進入時間	Time-out 離開時間	depth (meter) 廢物深度 (米)	Weight-in (tonne) 入關重量 (公噸)	Weight-out (tonne) 出關重量 (公噸)	Net weight (tonne) 淨重量 (公噸)
MW--PFRF	12/08/14	FY2*6	7006832	11884164	13:56	14:00	0.00	24.77	14.04	10.73
MW--PFRF	12/08/14	JG8*5	7015857	12247378	14:10	14:13	0.00	22.44	14.70	7.74
MW--PFRF	12/08/14	PG3*20	7013729	11068891	15:58	16:01	0.00	21.20	11.86	9.34
SENT	12/08/14	PW8*6	7012859	12164850	08:05	08:23	0.77	17.13	15.55	1.58
SENT	12/08/14	NU5*09	7019002	11542037	08:06	08:36	0.95	19.14	15.21	3.93
SENT	12/08/14	PV8*54	7012910	11554351	08:07	08:31	0.72	17.63	14.84	2.79
SENT	12/08/14	JG1*01	7012312	11573737	08:07	08:25	1.03	15.01	14.68	0.33



# BEAM Plus cases in Hong Kong

## Totally 808 projects by Sep 2015



# Linking the databases of C&D waste management and BEAM Plus projects

Account	Contract No.	Contract name	Contract sum	Site address	Department	of construction	Detail of construction work
7000 31	09/02/01	INSTALLATION OF 275KV CABLES AND /	2608354.85	LAMMA POWER STATION	...	Others	CABLE INSTALLATION WORKS
7000 32	BD RFP 3/9/146	SITE FORMATION & FOUNDATION WORK	132680000	VILLAGE, TAI PO, NEW TERRITORIES ON	...	Others	SITE FORMATION AND FOUNDATION
7000 33	...	...	70666000	...	...	Others	...
7000 34	...	DANGEROUS HILLSIDE ORDER NO.S. DI	4182000	77 CAROLINE HILL ROAD CAU RAY BAY	...	Others	SLOPE UPGRADING WORKS
7000 35	...	DANGEROUS HILLSIDE ORDER NO.S. DI	3482000	ICLUS HALL, CAROLINE HILL ROAD HONG	...	Others	SLOPE UPGRADING WORK
7000 36	...	DESIGN, SUPPLY, INSTALLATION, T&C	2400000	I/W DATA CENTRE (PHASE 2) OF ADVANT	...	Others	INSTALLATION
7000 37	...	...	11907258	...	...	Renovation	...
7000 38	...	FOUNDATION WORKS FOR RESIDENTY	6280000	NWALL STREET, KOWLOON TONG, KOW	...	Foundation Work	...
7000 39	...	PROPOSED RESIDENTIAL DEVELOPME	36828886	NO 62 KENNEDY ROAD, HONG KONG	...	Others	SUPERSTRUCTURE WORKS
7000 40	LAM86386/1210	ONE YEAR SERVICES CONTRACT FOR	1099660	JOVEY PARK COMMERCIAL SERVICES (	...	Others	MAINTENANCE
7000 41	CT275-08C	STATION COMMERCIAL AND MODIFICAT	16890101	TSAM SHA TSUI STATION	...	Others	MODIFICATION
7000 42	WKS0008/038	MAINTENANCE WORKS FOR WEI HING	5272450	CITY UNIVERSITY OF HONG KONG	...	Renovation	...
7000 43	...	EXTERNAL WALL RENOVATION AND RE	2125689	2 CARRIAGE ROAD, TST, KOWLOON	...	Renovation	...
7000 44	BD SH 1254H	HONG KONG BAPTIST CH & HOSPITAL	1383285	ROAD, HAPPY VALLEY H.K. IS. 102 & EK	...	Site Formation	...
7000 45	0080052	REDECORATION OF DOMESTIC BLOCK	15059306	KWAI SHING EAST ESTAB.	...	Others	REDECORATION
7000 46	2C187P08	PROVISION OF CLEAN ROOM FOR PHA	1920000	EN ELIZABETH HOSPITAL, 30 GINGCOON	...	EMSO	PROVISION OF CLEAN ROOM
7000 47	CG2618-13-08E	REFURBISHMENT OF ENVIRONMENTAL	7944000	MTR-CURL STATIONS	...	Renovation	...
7000 48	MW042	FIT-OUT WORKS AT T1 OFFICE 4529	1300000	HONG KONG INTERNATIONAL AIRPORT	...	Others	FITTING OUT WORKS
7000 49	...	FITTING OUT WORKS FOR NEW LEARN	2839480	NAIUM CITY 3, 370 KWUN TON ROAD, K	...	Others	FITTING OUT WORKS
7000 50	35.46 OF 2008	IMPROVEMENT WORKS TO STREAM EN	1454500	MAU WO	...	HAO	IMPROVEMENT WORKS TO ST
7000 51	2C278C108	REPLACEMENT OF AIR HANDLING UNIT	1563600	SPORTS CENTRE AND KOWLOON CITY M	...	EMSO	HVAC REPLACEMENT WORKS
7000 52	...	...	3107623	...	...	Others	...
7000 53	AL 1327	GENERAL IMPROVEMENT WORKS TO S	3002397.3	SUI KWANG MARKET	...	ASD	RENOVATION
7000 54	0080050	REDECORATION OF FURNISHING ESTAB	14837000	FU CHEONG ESTATE	...	Renovation	REDECORATION
7000 55	...	...	...	...	...	NA	...
7000 56	7WS0108	REPLACEMENT AND REHABILITATION O	621338000	EAST KOWLOON	...	WSD	CONSTRUCTION
7000 57	NO. 08-06	RENOVATION WORKS AT LOK FU SHOP	151833249.8	LOK FU	...	Renovation	...
7000 58	...	RECTIFICATION AND IMPROVEMENT W	1713520	KWUN LUNG LAU	...	Others	RECTIFICATION AND IMPROVE
7000 59	08/0234	LAMMA POWER STATION COMPLETE EE	2466800	LAMMA POWER STATION	...	Others	ELECTRICAL & MECHANICAL I
7000 60	CI15	OCEAN PARK MASTER REDEVELOPME	1161801.28	OCEAN PARK, ABERDEEN, HONG KONG	...	Others	GROUND INVESTIGATION
7000 61	9722 OF 2008	IMPROVEMENT TO KWUN PING ROAD #	10225668	PING ROAD AND MAI TSI LAM ROAD, SI	...	HAO	SLOPE REMEDIAL WORK
7000 62	4553/1001/045	SLOPE REMEDIAL WORKS FOR FLAT 18	2742195	REDKEN MAIN RD SHING GAO INDUSTRIA	...	HAO	SLOPE REMEDIAL WORK
7000 63	14/9/0208	REPLACEMENT AND REHABILITATION	215020000	IN AND YUEN LONG	...	Others	...
7000 64	EP/SP/056/07	ISLAND EAST TRANSFER STATION FOU	20594368	ST TRANSFER STATION	...	Others	...
7000 65	...	THE HONG KONG POLYTECHNIC UNIVE	1798000	UNIVERSITY HUNG HOM	...	The MARK	...
7000 66	...	安樂大廈翻新工程	25568000	康翠苑(557-515)區	...	Others	...
7000 67	...	PROPOSED HOTEL DEVELOPMENT AT	120000000	38 C-ONG YIP ST.	...	Somerset Victoria Park	...
7000 68	0080053	DEMOLITION OF KWUN TONG FLATTED	13800000	KWUN TONG FLATTED	...	Others	...
7000 69	SHCL416108	...	2275912	...	...	Others	...
7000 70	...	...	7450000	...	...	Others	...
7000 71	FAM96321	OPERATION AND MAINTENANCE OF Mv	1800000	NEW WILD TOW	...	Others	...
7000 72	...	...	3645350	...	...	Others	...
7000 73	DC/2008/57	LAM TSIUEN VALLEY AND KAU LUNG HA	168557172	1 KAM RO... TAI WO SE	...	Others	...
7000 74	...	...	3645350	...	...	Others	...

Database for 26,556 construction and demolition projects

Database for 808 projects having applied HK-BEAM

Project name	Address	Locatio	Type	Developer/	BEAM Pro	Tool	award
The Peak Galleria	118 Peak Road, Hong	H.K.	Commercial	Worldmax	CHEUNG Wai	BEAM Plus NB	Final Bronze
Redevelopment of High West	9-11 Tsing Chau	KLN	Residentia	HKSAR	LEE Kin	BEAM Plus NB	Final Gold
Postgraduate Residence at	10 Ching Lin	H.K.	Residentia	The	LEONG Lai	BEAM Plus NB	Final Gold
Wholesale Conversion of	The Rays, No. 71	KLN	Commercial	Alfa	WONG Man	BEAM Plus NB	Final Bronze
...	...	...	...	...	...	...	...

Database for 7,046,395 waste disposal records

Facility	Date of transaction	Vehicle No.	Account	Chit No.	Time-in	Time-out	Waste depth (meter)	Weight-in (tonne)	Weight-out (tonne)	Net weight (tonne)	Tool	award
TKO1375F	09/12/15	GR2*6	7001783	13784733	08:00	08:11	0.82	22.24	15.26	6.98	BEAM Plus EB	Final Platinum
TKO1375F	09/12/15	TB5*38	7018345	12102822	08:00	08:10	1.22	22.27	15.81	6.46	BEAM Plus EB	Final Platinum
MW-PFRF	09/12/15	JG8*5	7015857	14749113	08:38	08:42	0	23.21	14.64	8.57	BEAM Plus NB	Final Platinum
MW-PFRF	09/12/15	SL7*29	7010462	14004370	08:45	08:51	0	14.15	9.37	4.78	BEAM Plus NB	Final Platinum
MW-PFRF	09/12/15	GX1*32	7010723	13942460	10:27	10:31	0	23.64	13.54	10.1	BEAM Plus NB	Final Platinum
MW-PFRF	09/12/15	JG8*5	7015857	14749114	10:35	10:39	0	22.23	14.82	7.41	BEAM Plus NB	Final Platinum
MW-PFRF	09/12/15	HT6*08	7021204	13126812	10:43	10:47	0	22	14	8	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	SV6*81	7017114	10713937	08:02	08:15	1.11	22.97	14.73	8.24	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	RL8*0	7017114	10713938	08:02	08:14	0.98	21.24	15.83	5.41	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	FP1*17	7018737	12167704	08:03	08:20	0.96	22.41	14.64	7.77	BEAM Plus EB	Final Platinum
TM38-SF	09/12/15	TJ2*5	7017749	14084718	08:09	08:13	1.12	19.58	14.59	4.99	BEAM Plus NB	Final Platinum
TM38-SF	09/12/15	FF6*99	7010365	14612011	08:10	08:14	1.01	22.03	15.23	6.8	BEAM Plus NB	Final Platinum
TM38-SF	09/12/15	LX8*85	7023223	14651731	08:11	08:17	1.24	21.25	15.29	5.96	BEAM Plus NB	Final Platinum
TM38-SF	09/12/15	JP3*81	7021142	14806613	08:18	08:22	1.09	23.11	15.16	7.95	BEAM Plus NB	Final Platinum
TM38-SF	09/12/15	SZ1*86	7020107	14852362	08:24	08:29	1.09	23.6	16.62	6.98	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	MW3*72	7014089	14303129	08:07	08:20	1.25	20.74	16.13	4.61	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	TN6*68	7021726	14796873	08:11	08:24	0.75	24.81	15.9	8.91	BEAM Plus NB	Final Platinum
TKO1375F	09/12/15	EG2*68	7021163	14829685	08:18	08:30	0.79	22.14	14.92	7.22	BEAM Plus NB	Final Platinum
SENT	09/12/15	HJ8*3	7022403	13946975	08:10	08:23	0.8	16.46	15.07	1.39	BEAM Plus NB	Final Platinum

## Proxy of construction waste management performances

- Waste generation rate (WGR) for a construction work  $i$

$$WGR_i = (WG_{i1} + WG_{i2} + WG_{i3} + \dots + WG_{ij}) / CS_i$$

- Where the sum of  $WG_{ij}$  represent the waste generation of construction work  $i$  and  $CS_i$  is the contract sum of work  $i$ . In Hong Kong, construction waste is divided into two categories: (a) inert CW and (b) non-inert CW that could be generated any stage of a project including demolition, foundation, and building works. The WGR formula is thus applied to computing six groups of WGRs, i.e., inert CW and non-inert CW for each type of construction work.
- References of using the WGR: Lu et al. (2015 and 2016)



# Identifying factors affecting waste generation and their interrelations

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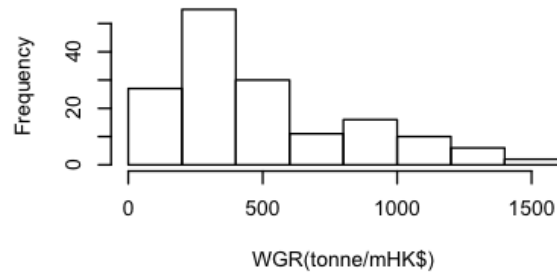
# Comparing the WGRs between BEAM-driven and ordinary construction works

## Profiles of the construction works

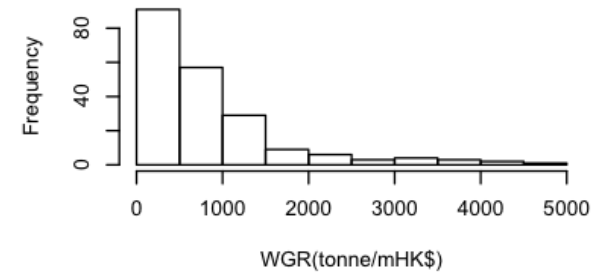
Construction type	BEAM-driven	Ordinary
Demolition	158	205
Foundation	238	276
Building	61	200
Whole process	26	120

Previous studies have discovered that the WGRs at project level follow a positively skewed distribution, and therefore median instead of mean used to present the WGR value (i.e. waste management performance) (e.g. Lu et al., 2015 and Lu et al., 2016a). This is further evident in this study after plotting the histograms of the identified groups.

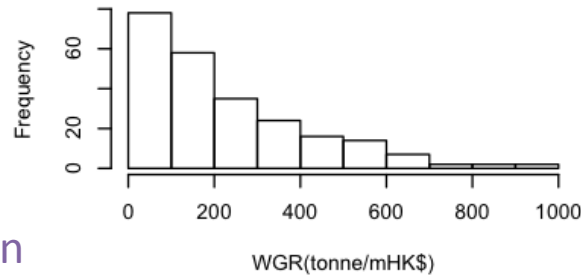
**BEAM-driven demolition works**



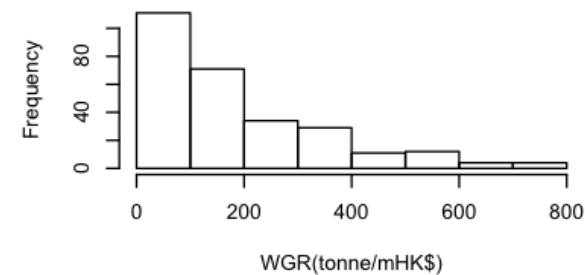
**Ordinary demolition works**



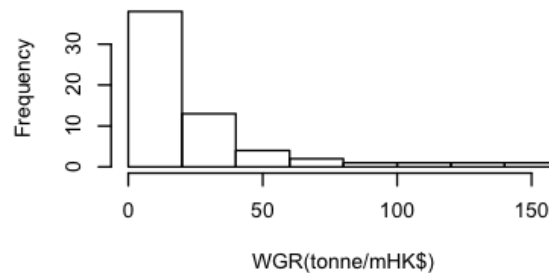
**BEAM-driven foundation works**



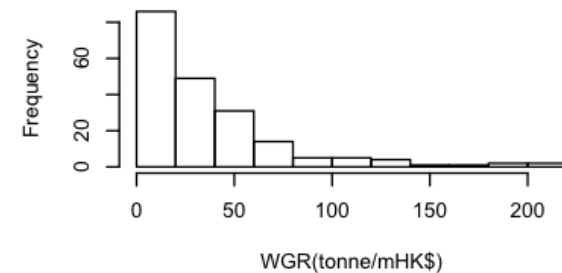
**Ordinary foundation works**



**BEAM-driven building works**



**Ordinary building works**



## Comparing the WGRs between BEAM-driven and ordinary construction works

Mood's median test results: BEAM-driven and ordinary construction works compared

Construction type	BEAM-driven (ton/mHKD)	Ordinary (ton/mHKD)	<i>p</i> -value	Difference (ton/mHKD)	Difference significance
Demolition	385.43	605.65	0.005	220.22	Yes
Foundation	170.65	127.541	0.066	-43.11	No
Building	13.25	22.99	0.288	9.74	No
Whole process	36.98	40.08	0.296	3.1	No



# Discussions

Weighting of the items aiming for CWM in HK-BEAM

Items	Attainable credits	Attainable bonus	Attainable overall grade
Site Aspects (SA)			
SA7	Landscaping and Planters (using previous materials)	1	1.14%
Material Aspects (MA)			
MA P1	Timber Used for Temporary Works	Required	
MA P3	Construction/Demolition Waste Management Plan	Required	
MA P4	Waste Recycle Facilities	Required	
MA1	Building reuse	2	1.09%
MA2	Modular and Standardised design	1	0.36%
MA3	Prefabrication	2	0.73%
MA4	Adaptability and Deconstruction	3	1.09%
MA 6	Sustainable Forest Products	1	0.36%
MA10	Demolition Waste Reduction	2	0.73%
MA11	Construction Waste Reduction	2	0.73%

the attainable credits and bonus by meeting these items account for 6.23% of overall credits: 4.05% for demolition and 2.18% for construction. Attainable points for achieving CWM-related items in some globally recognized GBRs comprise 10% in LEED, 8.16% in BREEAM, 11.5% in Green Globes, 11.84% in Evaluation Standard for Green Building, and 8% in Green Building Index (Wu et al., 2016).

## Conclusions

- BEAM Plus barely affects the C&D waste minimization in Hong Kong
- The reasons might be (1) low attainable credits in BEAM Plus; (2) it needs much more efforts to achieve C&D waste minimization than other aspects, such as building a shelter for bicycle.